Maximum Ratings / Höchstzulässige Werte

Parameter	Condition		Symbol	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}	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
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, T_c=80°C	I_C	45 59	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	t_p=1ms	T_h=80°C	I_{cpuls}	90	A
Power dissipation per IGBT Verlustleistung pro IGBT	T_j=150°C	T_h=80°C T_c=80°C	P_{tot}	82 125	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung			V_{GE}	±20	V
SC withstand time Kurzschlußverhalten	Tj≤125°C V_{CC}=900V	V_{GE}=15V	t_{SC}	10	us
Diode Inverter **Diode Wechselrichter**					
DC forward current Dauergleichstrom	T_j=150°C	T_h=80°C, T_c=80°C	I_F	40 54	A
Repetitive peak forward current Periodischer Spitzenstrom	t_p=1ms	T_h=80°C	I_{FRM}	79	A
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C	T_h=80°C T_c=80°C	P_{tot}	57 86	W

Maximum Ratings / Höchstzulässige Werte

Parameter	Condition		Symbol	Values max.	Unit
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_j=150°C	T_h=80°C T_c=80°C	I_C	56 64	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	t_p=1ms	T_h=80°C	I_{cpuls}	111	A
Power dissipation per IGBT Verlustleistung pro IGBT	T_j=150°C	T_h=80°C T_c=80°C	P_{tot}	109 165	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung			V_{GE}	±20	V
SC withstand time Kurzschlußverhalten	Tj≤125°C VCE=900 V	VGE=15V	t_{SC}	10	us
Diode BRC **Diode BRC**					
DC forward current Dauergleichstrom	T_j=150°C T_j=150°C	T_h=80°C T_c=80°C	I_F	44 55	A
Repetitive peak forward current Periodischer Spitzenstrom	t_p=1ms	T_h=80°C	I_{FRM}	87	A
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C	T_h=80°C T_c=80°C	P_{tot}	65 99	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

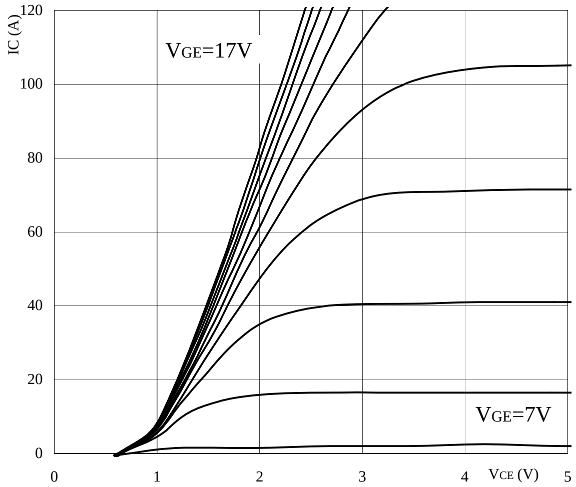
Description	Symbol	Conditions					Values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	V_R(V) V_{CE}(V) VDS(V)	IC(A) IF(A) Id(A)	Min	Typ	Max	
Input Rectifier Bridge										
Gleichrichter										
Forward voltage	V_F	Tj=25°C				35	0,8	1,02	1,35	V
Durchlaßpannung		Tj=125°C						0,94		
Threshold voltage (for power loss calc. only)	V_{to}	Tj=25°C						0,88		V
Schleusenspannung		Tj=125°C				35		0,75		
Slope resistance (for power loss calc. only)	r_t	Tj=25°C						0,004		Ohm
Ersatzwiderstand		Tj=125°C				35		0,006		
Reverse current	I_r	Tj=25°C			1500		0		0,1	mA
Sperrstrom		Tj=140±10°C			1500		0		2	
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	$V_{GE(th)}$	Tj=25°C	VCE=VGE			0,002	5	5,8	6,5	V
Gate-Schwellenspannung		Tj=125°C								
Collector-emitter saturation voltage	$V_{CE(sat)}$	Tj=25°C		15		50	1,35	1,66	2,15	V
Kollektor-Emitter Sättigungsspannung		Tj=125°C		15		50		1,87		
Collector-emitter cut-off current incl. Diode	I_{CES}	Tj=25°C		0	1224		0		0,005	mA
Kollektor-Emitter Reststrom		Tj=125°C								
Gate-emitter leakage current	I_{GES}	Tj=25°C		25	0		0		300	nA
Gate-Emitter Reststrom		Tj=125°C								
Integrated Gate resistor	R_{gint}							4		Ohm
Integrirter Gate Widerstand										
Turn-on delay time	$t_{d(on)}$	Tj=25°C	Rgoff=18 Ohm							ns
Einschaltverzögerungszeit		Tj=125°C	Rgon= 18 Ohm	±15	600	50		66		
Rise time	t_r	Tj=25°C	Rgoff=18 Ohm							ns
Anstiegszeit		Tj=125°C	Rgon= 18 Ohm	±15	600	50		23		
Turn-off delay time	$t_{d(off)}$	Tj=25°C	Rgoff=18 Ohm							ns
Abschaltverzögerungszeit		Tj=125°C	Rgon= 18 Ohm	±15	600	50		492		
Fall time	t_f	Tj=25°C	Rgoff=18 Ohm							ns
Fallzeit		Tj=125°C	Rgon= 18 Ohm	±15	600	50		205		
Turn-on energy loss per pulse	E_{on}	Tj=25°C	Rgoff=18 Ohm							mWs
Einschaltverlustenergie pro Puls		Tj=125°C	Rgon= 18 Ohm	±15	600	50		5,48		
Turn-off energy loss per pulse	E_{off}	Tj=25°C	Rgoff=18 Ohm							mWs
Abschaltverlustenergie pro Puls		Tj=125°C	Rgon= 18 Ohm	±15	600	50		5,47		
Input capacitance	C_{ies}	Tj=25°C	f=1MHz	0	25			3,7		nF
Eingangskapazität		Tj=125°C								
Output capacitance	C_{oss}	Tj=25°C	f=1MHz	0	25			0,8		nF
Ausgangskapazität		Tj=125°C								
Reverse transfer capacitance	C_{rss}	Tj=25°C	f=1MHz	0	25			0,7		nF
Rückwirkungskapazität		Tj=125°C								
Gate charge	Q_{Gate}	Tj=25°C	VCE=600V	±15				360		nC
Gate Ladung		Tj=125°C	ICpulse=50A							
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					0,85		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,56		K/W
Diode Inverter										
Diode Wechselrichter										
Diode forward voltage	V_F	Tj=25°C				50	1,3	1,57	1,9	V
Durchlaßspannung		Tj=125°C				50		1,56		
Peak reverse recovery current	I_{RM}	Tj=25°C	Rgon= 18 Ohm		600	50				A
Rückstromspitze		Tj=125°C	diF/dt = 2554 A/us	0	600	50		95		
Reverse recovery time	t_{rr}	Tj=25°C	Rgon= 18 Ohm		600	50				ns
Sperreverzögerungszeit		Tj=125°C	diF/dt = 2554 A/us	0	600	50		455		
Reverse recovered charge	Q_{rr}	Tj=25°C	Rgon= 18 Ohm		600	50				uC
Sperrverzögerungsladung		Tj=125°C	diF/dt = 2554 A/us	0	600	50		12,5		
Reverse recovered energy	Erec	Tj=25°C	Rgon= 18 Ohm		600	50				mWs
Sperrverzögerungsenergie		Tj=125°C	diF/dt = 2554 A/us	0	600	50		5,17		
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,23		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,81		K/W

Characteristic values

Description	Symbol	Conditions T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	V_R(V) V_{CE}(V) VDS(V)	IC(A) IF(A) Id(A)	Values Min	Typ	Max	Unit
Transistor BRC **Transistor BRC**										
Gate emitter threshold voltage Gate-Schwellenspannung	$V_{GE(th)}$	Tj=25°C Tj=125°C	VCE=VGE			0,002	5	5,8	6,5	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	$V_{CE(sat)}$	Tj=25°C Tj=125°C		15 15		50 50	1,35	1,6 1,79	2,15	V
Collector-emitter cut-off Kollektor-Emitter Reststrom	I_{CES}	Tj=25°C Tj=125°C		0	1224		0		0,05	mA
Gate-emitter leakage current Gate-Emitter Reststrom	I_{GES}	Tj=25°C Tj=125°C		25	0		0		300	nA
Integrated Gate resistor Integrirter Gate Widerstand	R_{gint}							4		Ohm
Turn-on delay time Einschaltverzögerungszeit	$t_{d(on)}$	Tj=25°C Tj=125°C	Rgon= 18 Ohm Rgoff= 18 Ohm	±15	600	50		70,5		ns
Rise time Anstiegszeit	t_r	Tj=25°C Tj=125°C	Rgon= 18 Ohm Rgoff= 18 Ohm	±15	600	50		24		ns
Turn-off delay time Abschaltverzögerungszeit	$t_{d(off)}$	Tj=25°C Tj=125°C	Rgon= 18 Ohm Rgoff= 18 Ohm	±15	600	50		486		ns
Fall time Fallzeit	t_f	Tj=25°C Tj=125°C	Rgon= 18 Ohm Rgoff= 18 Ohm	±15	600	50		194		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	E_{on}	Tj=25°C Tj=125°C	Rgon= 18 Ohm Rgoff= 18 Ohm	±15	600	50		5,61		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	E_{off}	Tj=25°C Tj=125°C	Rgon= 18 Ohm Rgoff= 18 Ohm	±15	600	50		5,28		mWs
Input capacitance Eingangskapazität	C_{iss}	Tj=25°C Tj=125°C	f=1MHz	0	25			3,7		nF
Output capacitance Ausgangskapazität	C_{oss}	Tj=25°C Tj=125°C	f=1MHz	0	25			0,8		nF
Reverse transfer capacitance Rückwirkungskapazität	C_{ies}	Tj=25°C Tj=125°C	f=1MHz	0	25			0,7		nF
Gate charge Gate Ladung	Q_{gate}	Tj=25°C Tj=125°C	VCE=600V Icpulse=50A	±15				360		nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					0,64		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,43		K/W
Diode BRC **Diode BRC**										
Diode forward voltage Durchlaßspannung	V_F	Tj=25°C Tj=125°C				50 50	1,3	1,52 1,55	1,9	V
Reverse current Sperrstrom	I_r	Tj=25°C Tj=125°C			1224		0		50	uA
Reverse recovery time Sperreverzögerungszeit	t_{rr}	Tj=25°C Tj=125°C	Rgon= 18 Ohm diF/dt = 2036 A/us	0	600	50		467,4		ns
Reverse recovered charge Sperrverzögerungsladung	Q_{rr}	Tj=25°C Tj=125°C	Rgon= 18 Ohm diF/dt = 2036 A/us	0	600	50		11,22		uC
Reverse recovery energy Sperrverzögerungsenergie	E_{rec}	Tj=25°C Tj=125°C	Rgon= 18 Ohm diF/dt = 2036 A/us	0	600	50		4,56		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,08		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,71		K/W
PTC-Thermistor **PTC-Widerstand**										
Nominal resistance Nominaler Widerstand	R_{25} R_{100}	Tj=25°C Tj=100°C	tolerance = 3% tolerance = 2%				0,97 1,637	1 1,67	1,03 1,703	kOhm kOhm
Typical temperature coefficient Tipischer Temperaturkoeffizient	α	Tj=25°C Tj=125°C						0,76		%/K
Recommended measuring current Empfohlener Messstrom	I_m	Tj=25°C Tj=125°C					1		3	mA
Measured values Gemessene Werte	V_{PTC}	Tj=25°C	I_m = 1mA I_m = 3mA				0,93 2,84		1,03 3,4	V

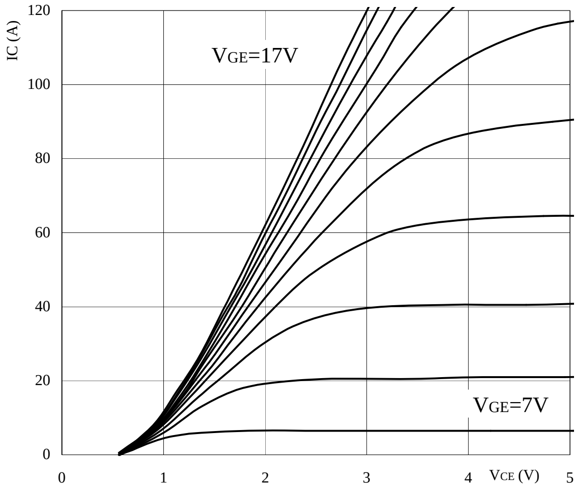
Output inverter

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



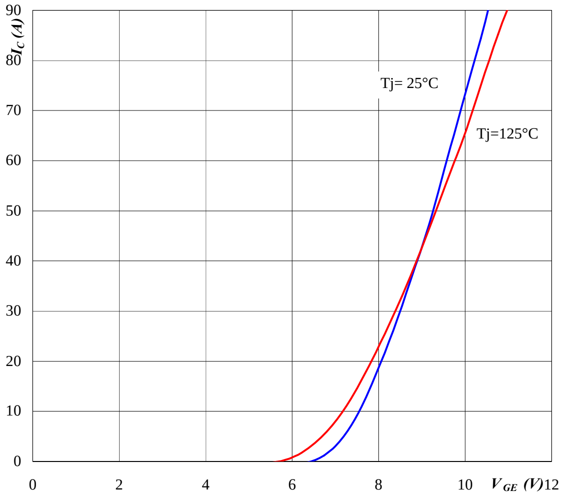
parameter: tp = 250 us Tj = 25 °C
V_{GE} parameter: from: 7 V to 17 V
in 1 V steps

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



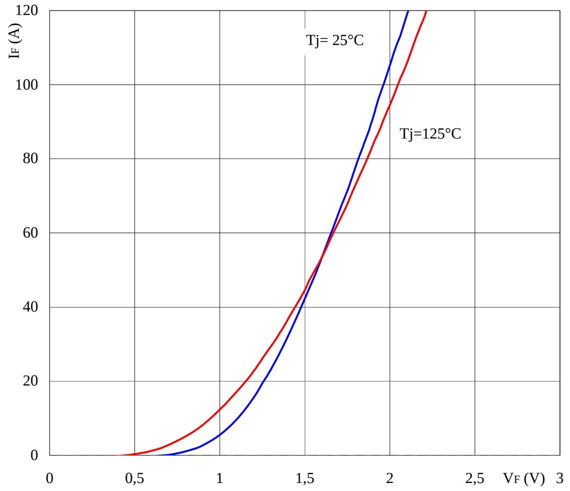
parameter: tp = 250 us Tj = 125 °C
V_{GE} parameter: from: 7 V to 17 V
in 1 V steps

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



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

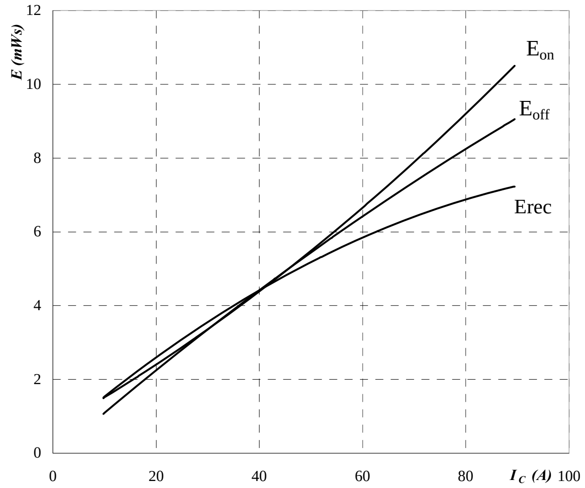
Figure 4. Typical diode forward current as a function of forward voltage
Output inverter FRED $I_F = f(V_F)$



parameter: tp = 250 us

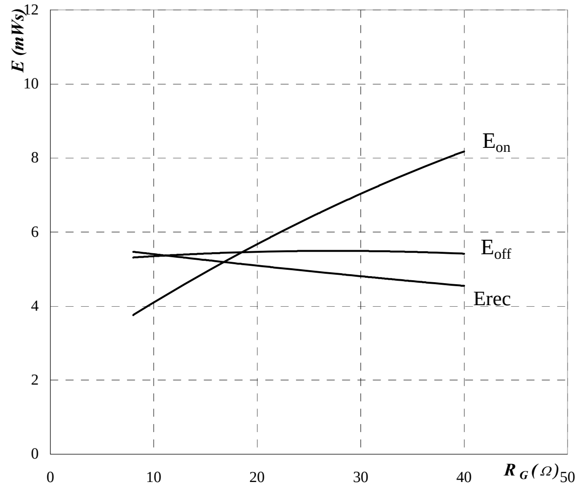
Output inverter

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



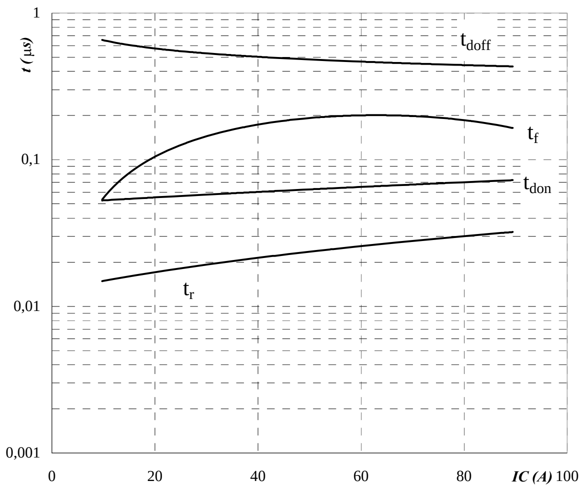
inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Rgon= 18 Ω
Rgoff= 18 Ω

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



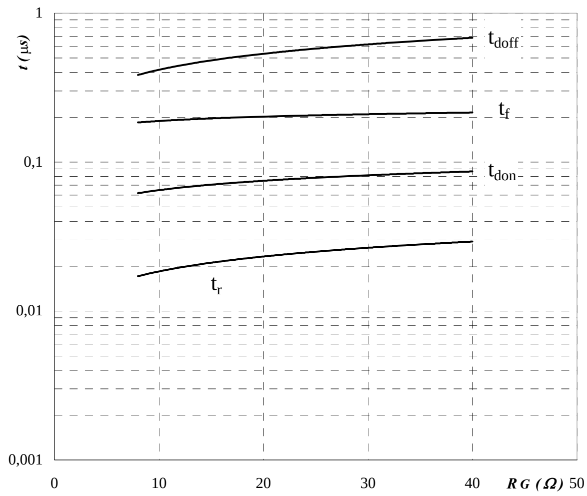
inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Ic = 50 A

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= 18 Ω
Rgoff= 18 Ω

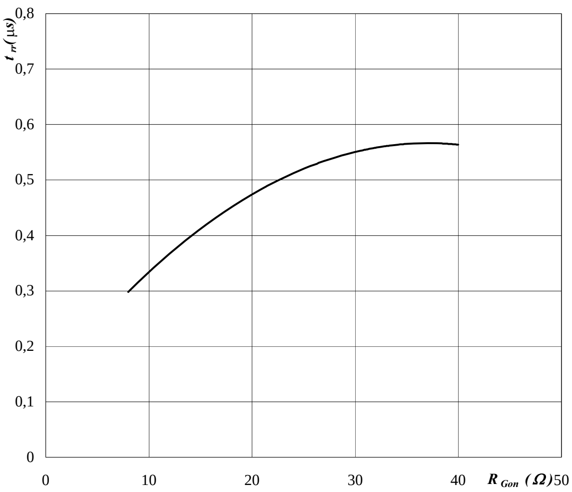
Figure 8. Typical switching times as a function of gate resistor
Output inverter IGBT
t = f (RG)



inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Ic = 50 A

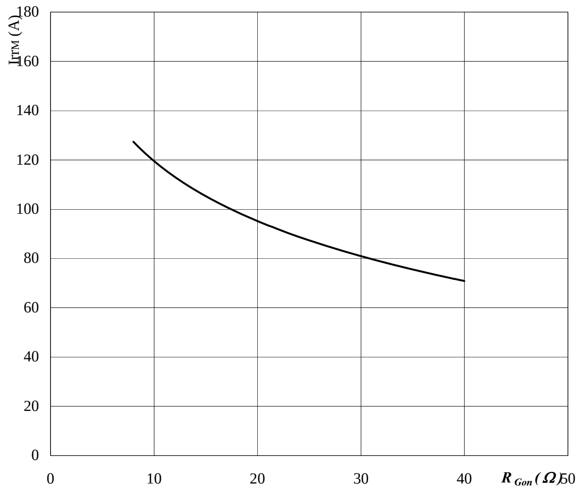
Output inverter

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



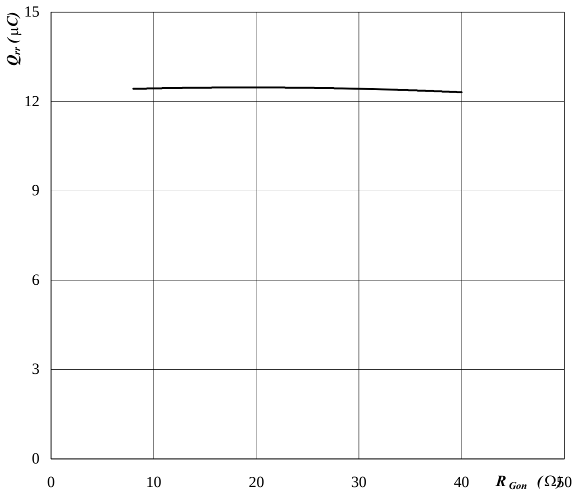
Tj = 125 °C
V_R = 600 V
I_F= 50 A
V_{GE}= ±15 V

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



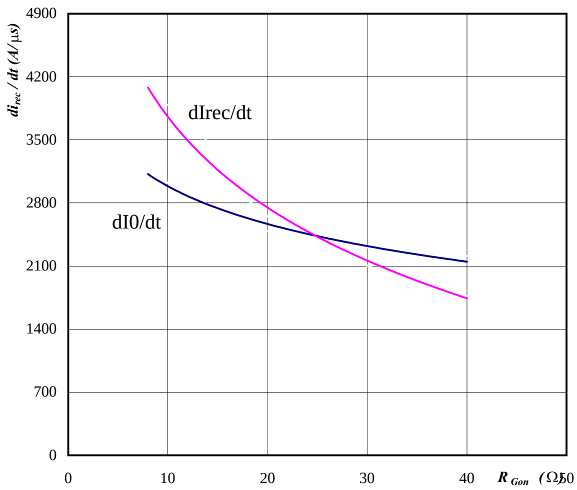
Tj = 125 °C
V_R = 600 V
I_F= 50 A
V_{GE}= ±15 V

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



Tj = 125 °C
V_R = 600 V
I_F= 50 A
V_{GE}= ±15 V

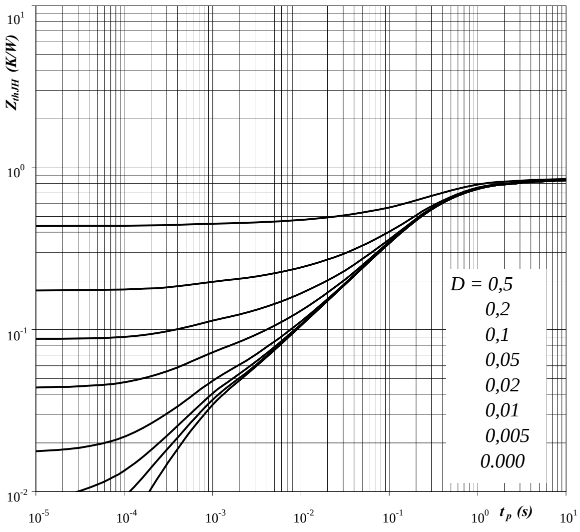
Figure 12. Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
Output inverter FRED diode
dI0/dt,dIrec/dt= f (Rgon)



Tj = 125 °C
V_R = 600 V
I_F= 50 A
V_{GE}= ±15 V

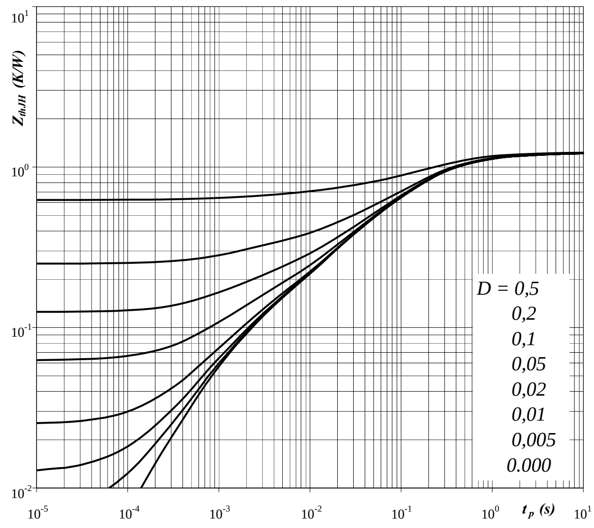
Output inverter

Figure 13. **IGBT transient thermal impedance as a function of pulse width**
$Z_{th}JH = f(tp)$



Parameter: D = tp / T RthJH= 0,85 K/W

Figure 14. **FRED transient thermal impedance as a function of pulse width**
$Z_{th}JH = f(tp)$



Parameter: D = tp / T RthJH= 1,23 K/W

IGBT thermal model values

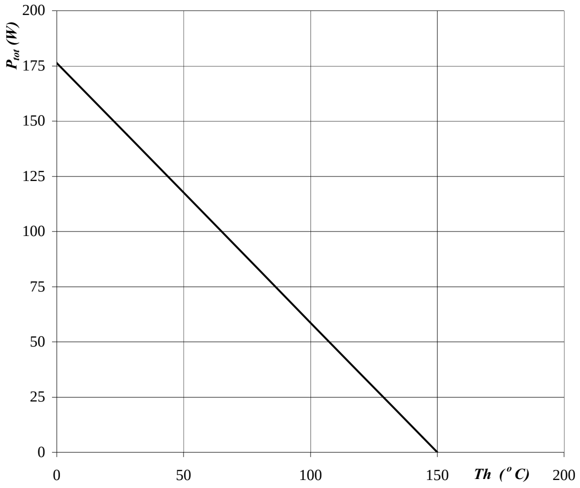
R (C/W)	Tau (s)
0,06	2,6E+01
0,11	1,8E+00
0,44	3,2E-01
0,18	8,5E-02
0,06	9,5E-03
0,03	6,6E-04
0,05	1,2E-04
0,00	0,0E+00

FRED thermal model values

R (C/W)	Tau (s)
0,04	3,0E+01
0,11	1,9E+00
0,44	3,1E-01
0,43	8,7E-02
0,15	1,3E-02
0,07	1,3E-03
0,04	2,0E-04
0,06	1,4E-04

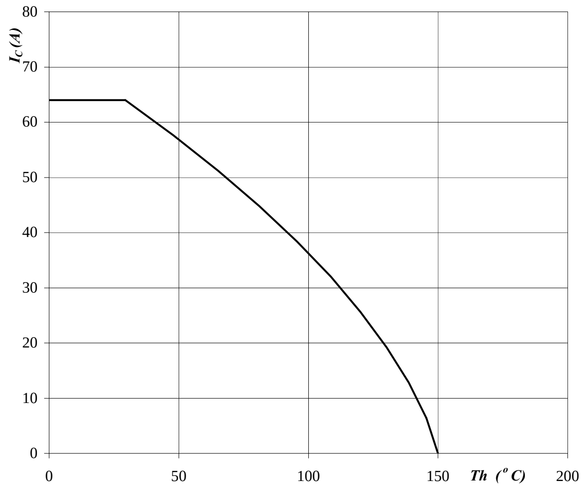
Output inverter

Figure 15. Power dissipation as a function of heatsink temperature
Output inverter IGBT
$P_{tot} = f(Th)$



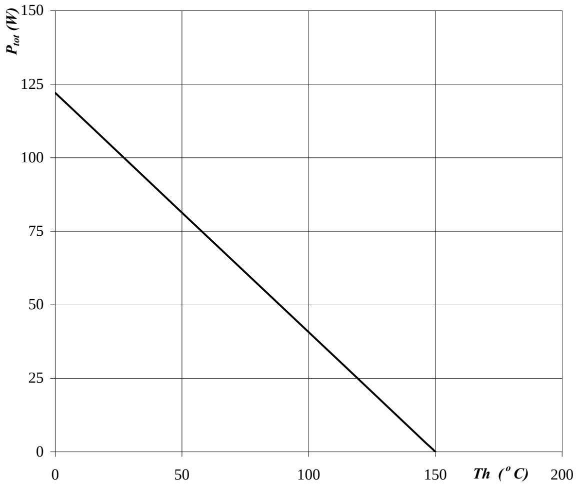
parameter: Tj = 150°C

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



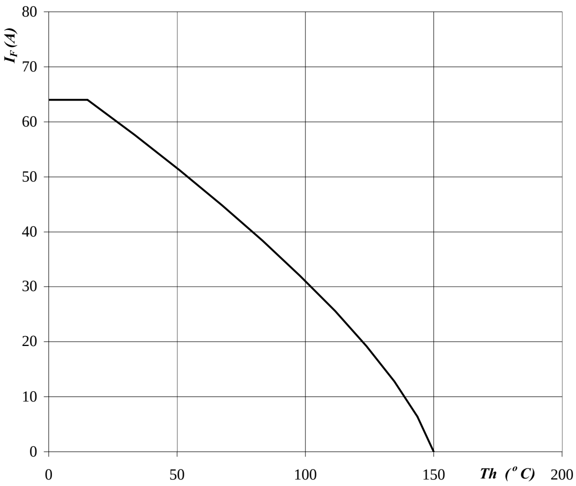
parameter: Tj = 150°C
V_{GE}= 15 V

Figure 17. Power dissipation as a function of heatsink temperature
Output inverter FRED
$P_{tot} = f(Th)$



parameter: Tj = 150°C

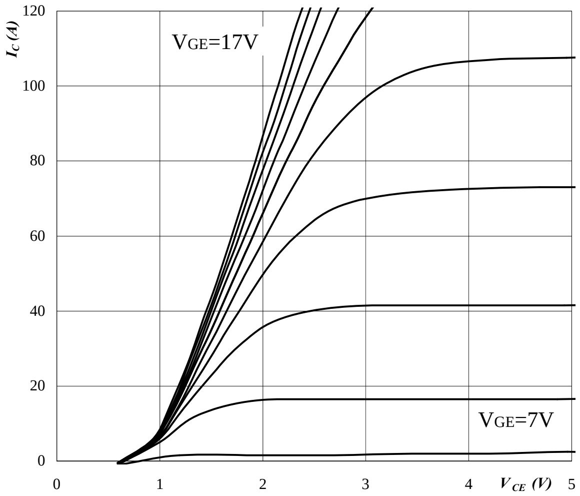
Figure 18. Forward current as a function of heatsink temperature
Output inverter FRED
$I_F = f(Th)$



parameter: Tj = 150°C

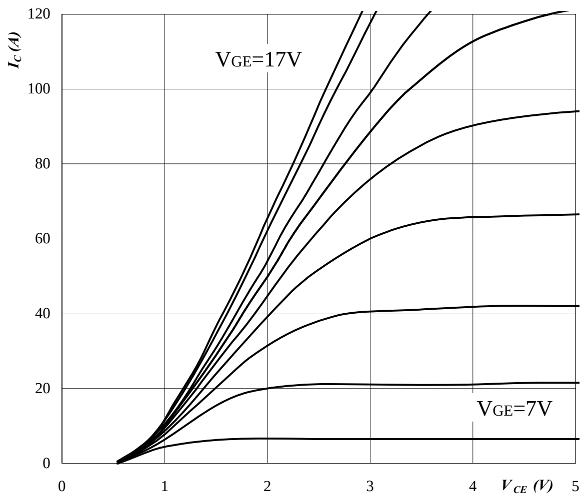
Brake

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



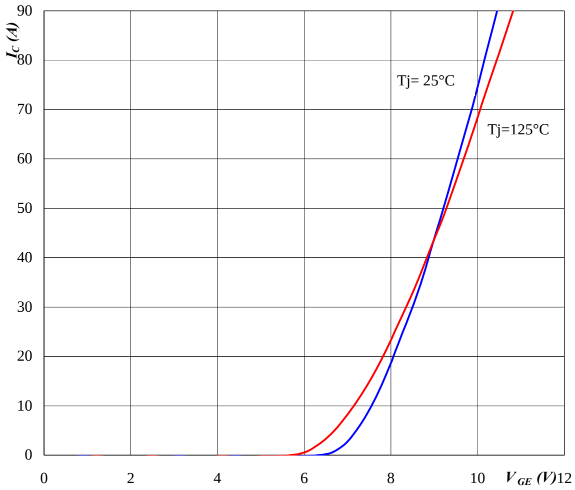
parameter: tp = 250 us Tj = 25 °C
VGE parameter: from: 7 V to 17 V
in 1 V steps

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



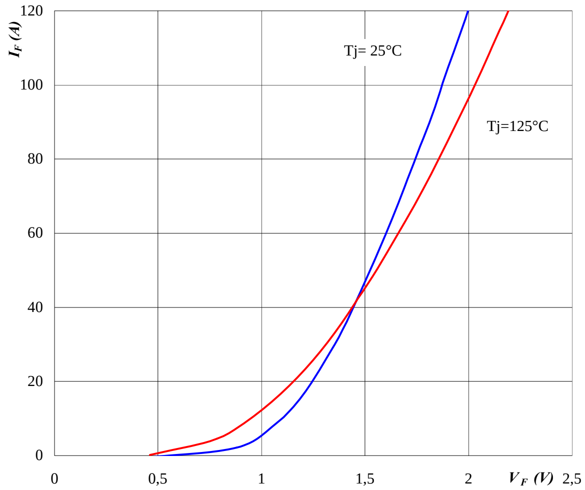
parameter: tp = 250 us Tj = 125 °C
VGE parameter: from: 7 V to 17 V
in 1 V steps

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



parameter: tp = 250 us VCE = 10 V

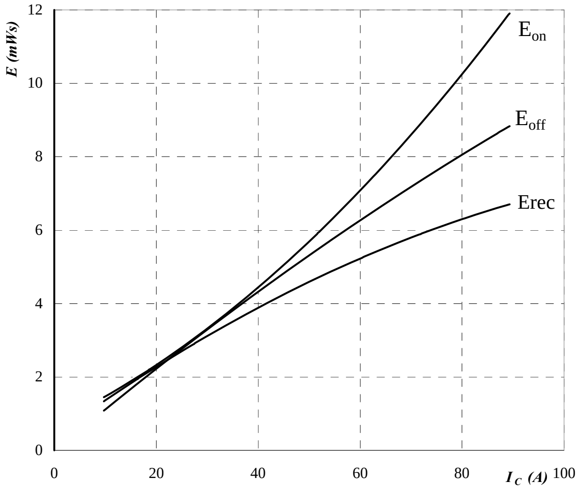
Figure 22. Typical diode forward current as a function of forward voltage
Brake FRED IF=f(VF)



parameter: tp = 250 us

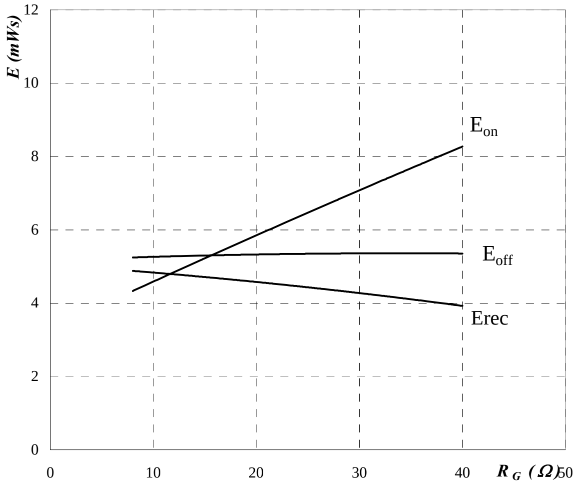
Brake

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



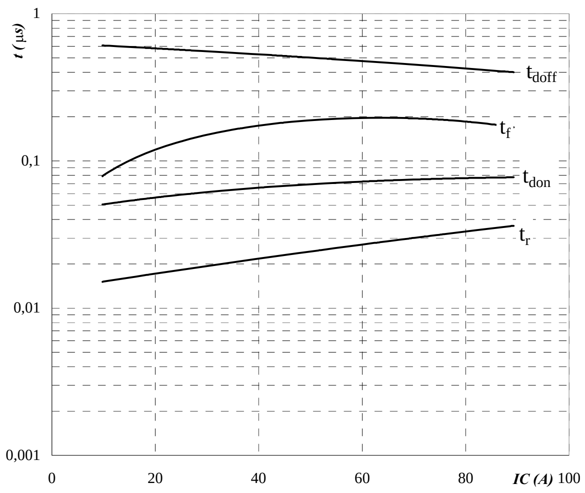
inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Rgon = 18 Ω
Rgoff = 18 Ω

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



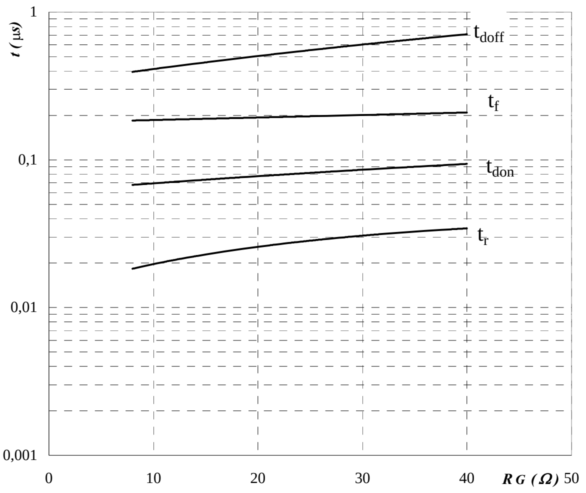
inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Ic = 50 A

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 = 18 Ω
Rgoff = 18 Ω

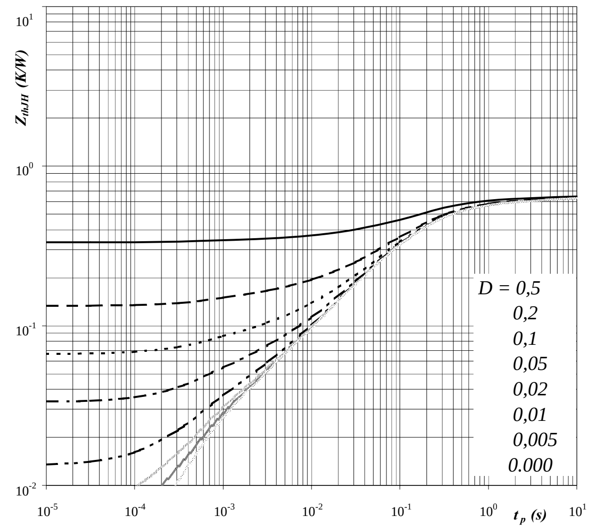
Figure 26. Typical switching times as a function of gate resistor
Brake IGBT
t = f (RG)



inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Ic = 50 A

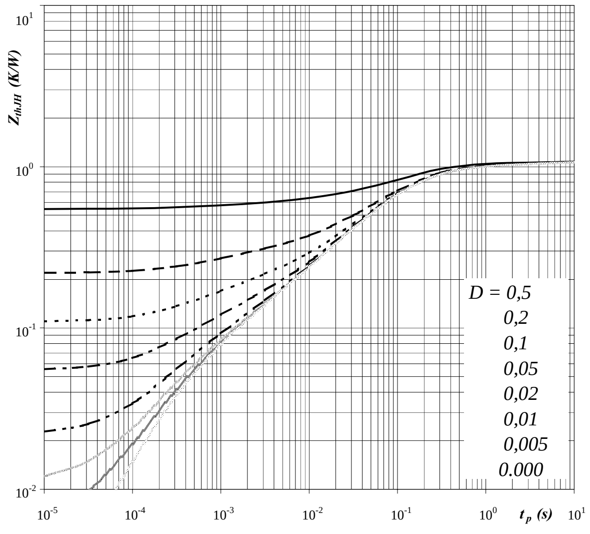
Brake

Figure 27. IGBT transient thermal impedance as a function of pulse width
$Z_{thJH} = f(t_p)$



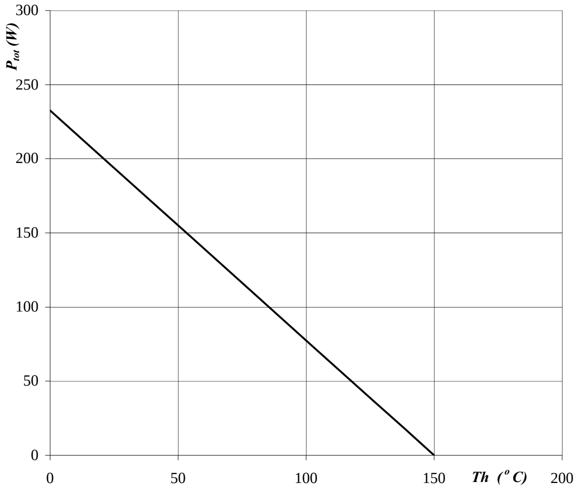
Parameter: D = tp / T   RthJH= 0,64 K/W

Figure 28. FRED transient thermal impedance as a function of pulse width
$Z_{thJH} = f(t_p)$



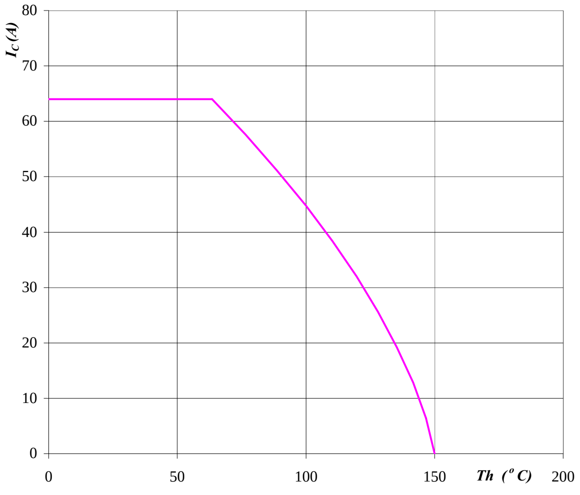
Parameter: D = tp / T   RthJH= 1,08 K/W

Figure 29. Power dissipation as a function of heatsink temperature
Brake IGBT
$P_{tot} = f(T_h)$



parameter: Tj = 150°C

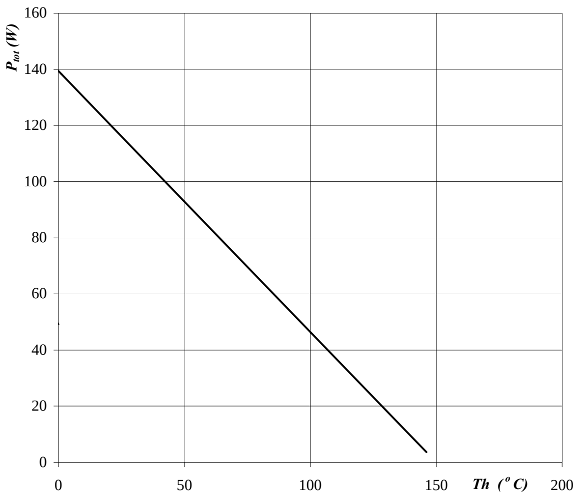
Figure 30. Collector current as a function of heatsink temperature
Brake IGBT
$I_c = f(T_h)$



parameter: Tj = 150°C
VGE= 15 V

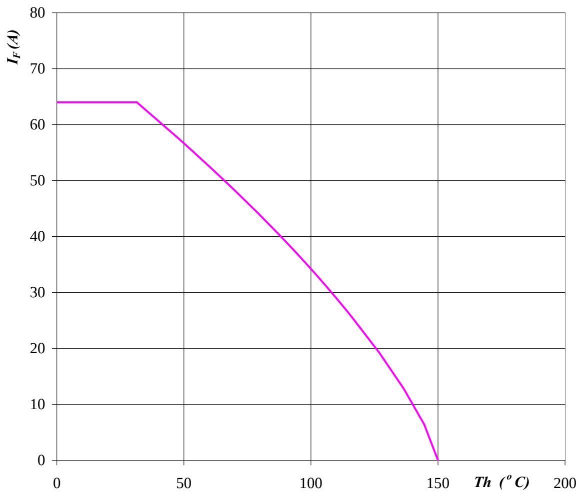
Brake

Figure 31. Power dissipation as a function of heatsink temperature
Brake FRED
$P_{tot} = f\ (Th)$



parameter: Tj = 150°C

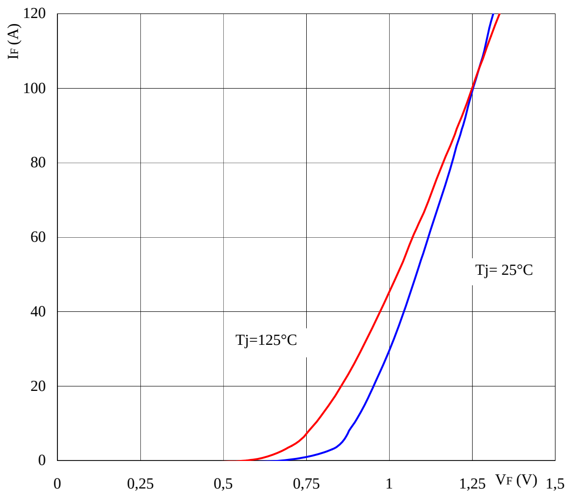
Figure 32. Forward current as a function of heatsink temperature
Brake FRED
$I_F = f\ (Th)$



parameter: Tj = 150°C

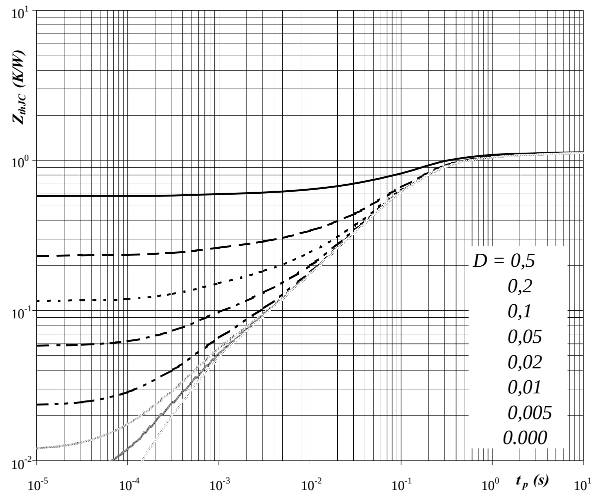
Input rectifier bridge

Figure 33. Typical diode forward current as a function of forward voltage
Rectifier diode $I_F = f(V_F)$



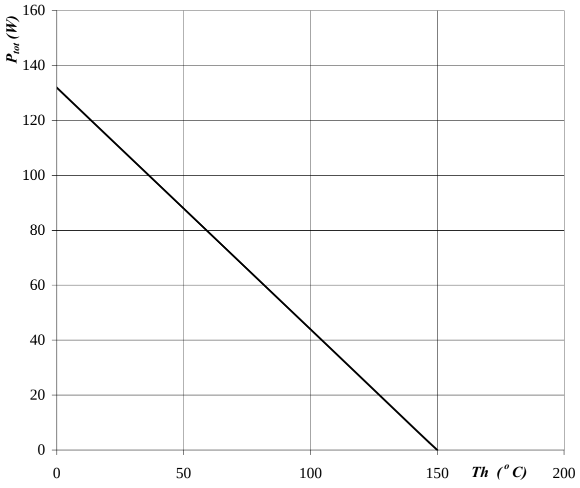
parameter: tp = 250 us

Figure 34. Diode transient thermal impedance as a function of pulse width
$Z_{thJH} = f(t_p)$



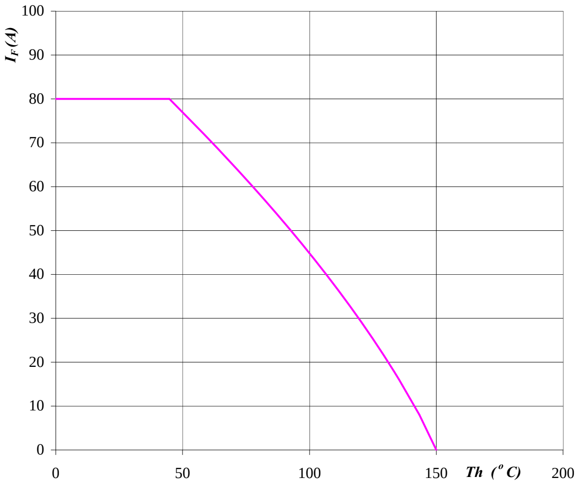
Parameter: D = tp / T   RthJH= 1,14 K/W

Figure 35. Power dissipation as a function of heatsink temperature
Rectifier diode
$P_{tot} = f(T_h)$



parameter: Tj = 150°C

Figure 36. Forward current as a function of heatsink temperature
Rectifier diode
$I_F = f(T_h)$



parameter: Tj = 150°C

Thermistor

Figure 37. Typical PTC characteristic as afunction of temperature

$R_T = f(T)$