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}	40 limited by power terminal 40 limited by power terminal	A
Surge forward current Stoßstrom Grenzwert	t_p=10ms T_j=25°C	I_{FSM}	370	A
I^2t-value Grenzlastintegral	t_p=10ms T_j=25°C	I^2t	680	A^2s
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C T_h=80°C T_c=80°C	P_{tot}	50 76	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	27 35	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	t_p=1ms T_h=80°C	I_{cpuls}	54	A
Power dissipation per IGBT Verlustleistung pro IGBT	T_j=150°C T_h=80°C T_c=80°C	P_{tot}	56 85	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	±20	V
SC withstand time Kurzschlußverhalten	Tj≤125°C V_{GE}=15V V_{CC}=900V	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	23 31	A
Repetitive peak forward current Periodischer Spitzenstrom	t_p=1ms T_h=80°C	I_{FRM}	47	A
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C T_h=80°C T_c=80°C	P_{tot}	41 62	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 T_j=150°C T_c=80°C	I_C	32 36	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	t_p=1ms T_h=80°C	I_{cpuls}	64	A
Power dissipation per IGBT Verlustleistung pro IGBT	T_j=150°C T_h=80°C T_c=80°C	P_{tot}	69 105	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	±20	V
SC withstand time Kurzschlußverhalten	Tj≤125°C VGE=15V VCE=900 V	t_{SC}	10	us

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Maximum Ratings / Höchstzulässige Werte

Parameter	Condition		Symbol	Values	Unit
				max.	
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	25 31	A
Repetitive peak forward current Periodischer Spitzenstrom	t_p=1ms	T_h=80°C	I_{FRM}	49	A
Power dissipation per Diode Verlustleistung pro Diode	T_j=150°C	T_h=80°C T_c=80°C	P_{tot}	45 69	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

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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				25	0,8	1,08	1,35	V
Durchlaßpannung		Tj=125°C						1,03		
Threshold voltage (for power loss calc. only)	V_{to}	Tj=25°C						0,89		V
Schleusenspannung		Tj=125°C				25		0,78		
Slope resistance (for power loss calc. only)	r_t	Tj=25°C						0,008		Ohm
Ersatzwiderstand		Tj=125°C				25		0,01		
Reverse current	I_r	Tj=25°C			1500		0		0,1	mA
Sperrstrom		Tj=140±10°C			1500		0		1,5	
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,39		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,92		K/W
Transistor Inverter **Transistor Wechselrichter**										
Gate emitter threshold voltage	$V_{GE(th)}$	Tj=25°C	VCE=VGE			0,001	5	5,8	6,5	V
Gate-Schwellenspannung		Tj=125°C								
Collector-emitter saturation voltage	$V_{CE(sat)}$	Tj=25°C		15		25	1,35	1,71	2,15	V
Kollektor-Emitter Sättigungsspannung		Tj=125°C		15		25		1,9		
Collector-emitter cut-off current incl. Diode	I_{CES}	Tj=25°C		0	1224		0		0,05	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}							8		Ohm
Integrirter Gate Widerstand										
Turn-on delay time	$t_{d(on)}$	Tj=25°C	Rgoff= 36 Ohm							ns
Einschaltverzögerungszeit		Tj=125°C	Rgon= 36 Ohm	±15	600	25		76		
Rise time	t_r	Tj=25°C	Rgoff= 36 Ohm							ns
Anstiegszeit		Tj=125°C	Rgon= 36 Ohm	±15	600	25		25		
Turn-off delay time	$t_{d(off)}$	Tj=25°C	Rgoff= 36 Ohm							ns
Abschaltverzögerungszeit		Tj=125°C	Rgon= 36 Ohm	±15	600	25		495		
Fall time	t_f	Tj=25°C	Rgoff= 36 Ohm							ns
Fallzeit		Tj=125°C	Rgon= 36 Ohm	±15	600	25		207		
Turn-on energy loss per pulse	E_{on}	Tj=25°C	Rgoff= 36 Ohm							mWs
Einschaltverlustenergie pro Puls		Tj=125°C	Rgon= 36 Ohm	±15	600	25		3,15		
Turn-off energy loss per pulse	E_{off}	Tj=25°C	Rgoff= 36 Ohm							mWs
Abschaltverlustenergie pro Puls		Tj=125°C	Rgon= 36 Ohm	±15	600	25		2,8		
Input capacitance	C_{ies}	Tj=25°C	f=1MHz	0	25			1,8		nF
Eingangskapazität		Tj=125°C								
Output capacitance	C_{oss}	Tj=25°C	f=1MHz	0	25			0,3		nF
Ausgangskapazität		Tj=125°C								
Reverse transfer capacitance	C_{rss}	Tj=25°C	f=1MHz	0	25			0,2		nF
Rückwirkungskapazität		Tj=125°C								
Gate charge	Q_{Gate}	Tj=25°C	VCE=600V	±15				160		nC
Gate Ladung		Tj=125°C	ICpulse=25A							
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,25		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Dicke≤50um λ = 0,61 W/mK					0,83		K/W
Coupled thermal resistance inverter diode-transistor	R_{thJH}		Thermal grease thickness≤50um					0,4		K/W
Gekoppelte Wärmewiderstand Wechselrichter Diode-Transistor			Warmeleitpaste Dicke≤50um λ = 0,61 W/mK							

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Characteristic values

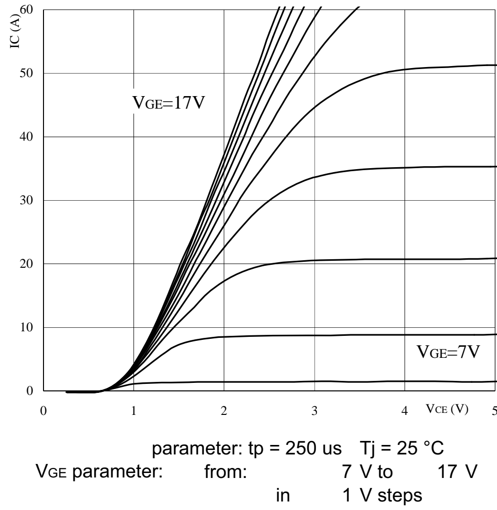
Description	Symbol	Conditions T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	V_R(V) V_{CE}(V) VDS(V)	IC(A) IF(A) Id(A)	Values Min	Typ	Max	Unit
Diode Inverter **Diode Wechselrichter**										
Diode forward voltage Durchlaßspannung	V_F	Tj=25°C Tj=125°C				25 25	1,4	1,7 1,77	2,2	V
Peak reverse recovery current Rückstromspitze	I_{RM}	Tj=25°C Tj=125°C	Rgon= 36 Ohm diF/dt = 1125 A/us	 0	600 600	25 25		 33		A
Reverse recovery time Sperreverzögerungszeit	t_{rr}	Tj=25°C Tj=125°C	Rgon= 36 Ohm diF/dt = 1125 A/us	 0	600 600	25 25		 560		ns
Reverse recovered charge Sperrverzögerungsladung	Q_{rr}	Tj=25°C Tj=125°C	Rgon= 36 Ohm diF/dt = 1125 A/us	 0	600 600	25 25		 5,7		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon= 36 Ohm diF/dt = 1125 A/us	 0	600 600	25 25		 2,22		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,71		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					1,13		K/W
Transistor BRC **Transistor BRC**										
Gate emitter threshold voltage Gate-Schwellenspannung	$V_{GE(th)}$	Tj=25°C Tj=125°C	VCE=VGE			0,001	5	5,8	6,5	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	$V_{CE(sat)}$	Tj=25°C Tj=125°C		15 15		25 25	1,35	1,61 1,81	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}									Ohm
Turn-on delay time Einschaltverzögerungszeit	$t_{d(on)}$	Tj=25°C Tj=125°C	Rgoff= 36 Ohm Rgon= 36 Ohm	 ±15	 600	 25		 72,2		ns
Rise time Anstiegszeit	t_r	Tj=25°C Tj=125°C	Rgoff= 36 Ohm Rgon= 36 Ohm	 ±15	 600	 25		 26,8		ns
Turn-off delay time Abschaltverzögerungszeit	$t_{d(off)}$	Tj=25°C Tj=125°C	Rgoff= 36 Ohm Rgon= 36 Ohm	 ±15	 600	 25		 481		ns
Fall time Fallzeit	t_f	Tj=25°C Tj=125°C	Rgoff= 36 Ohm Rgon= 36 Ohm	 ±15	 600	 25		 192,9		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	E_{on}	Tj=25°C Tj=125°C	Rgoff= 36 Ohm Rgon= 36 Ohm	 ±15	 600	 25		 3,18		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	E_{off}	Tj=25°C Tj=125°C	Rgoff= 36 Ohm Rgon= 36 Ohm	 ±15	 600	 25		 2,65		mWs
SC withstand time Kurzschlußverhalten	t_{SC}	 Tj=150°C		 15	 1200			 10		us
Input capacitance Eingangskapazität	C_{iss}	Tj=25°C Tj=125°C	f=1MHz	0	25			1,8		nF
Output capacitance Ausgangskapazität	C_{oss}	Tj=25°C Tj=125°C	f=1MHz	0	25			0,3		nF
Reverse transfer capacitance Rückwirkungskapazität	C_{ies}	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	VCE=600V ICpulse=25A	±15				160		nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,01		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					0,67		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)	I_C(A) IF(A) I_d(A)	Min	Typ	Max	
Diode BRC										
Diode BRC										
Diode forward voltage	V_F	Tj=25°C				25	1,4	1,52	2,2	V
Durchlaßspannung		Tj=125°C				25		1,49		
Reverse current	I_r	Tj=25°C			1224		0		50	uA
Sperrstrom		Tj=125°C								
Reverse recovery time	t_{rr}	Tj=25°C	Rgon= 36 Ohm							ns
Sperreverzögerungszeit		Tj=125°C	diF/dt = 875 A/us	0	600	25		625,6		
Reverse recovered charge	Q_{rr}	Tj=25°C	Rgon= 36 Ohm							uC
Sperrverzögerungsladung		Tj=125°C	diF/dt = 875 A/us	0	600	25		5,41		
Reverse recovery energy	E_{rec}	Tj=25°C	Rgon= 36 Ohm							mWs
Sperrverzögerungsenergie		Tj=125°C	diF/dt = 875 A/us	0	600	25		2,13		
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤50um					1,54		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitpaste Dicke≤50um λ = 0,61 W/mK					1,02		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

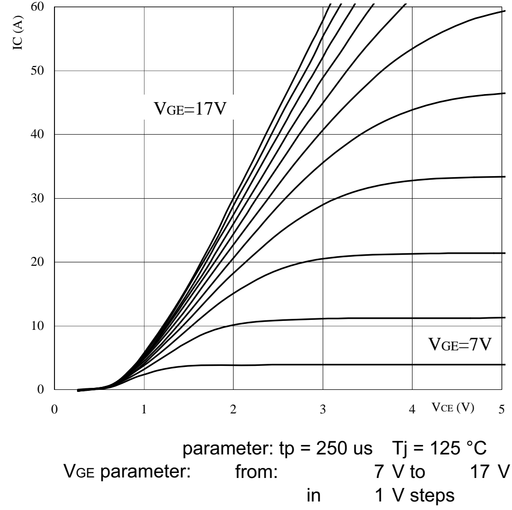
Output inverter

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



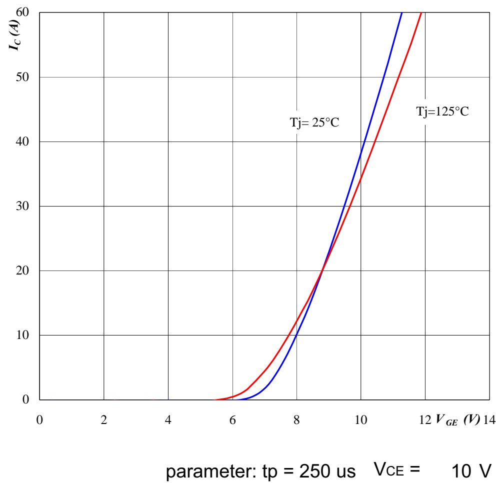
parameter: tp = 250 us Tj = 25 °C
VGE parameter: from: 7 V to 17 V
in 1 V steps

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



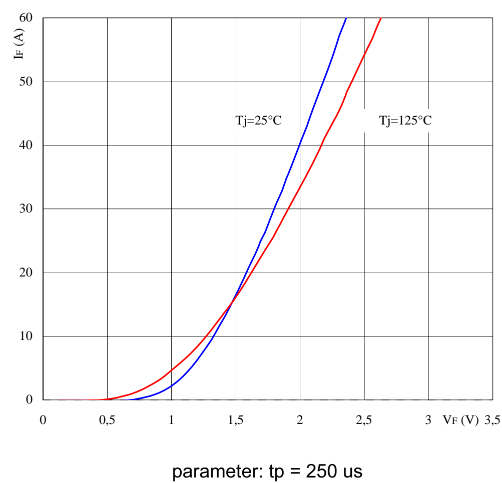
parameter: tp = 250 us Tj = 125 °C
VGE parameter: from: 7 V to 17 V
in 1 V steps

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



parameter: tp = 250 us VCE = 10 V

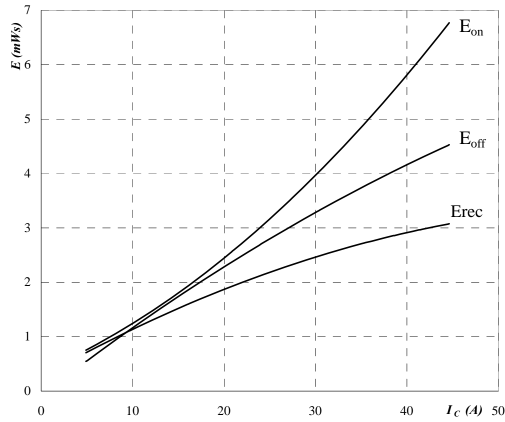
Figure 4. Typical diode forward current as a function of forward voltage
Output inverter FRED IF=f(VF)



parameter: tp = 250 us

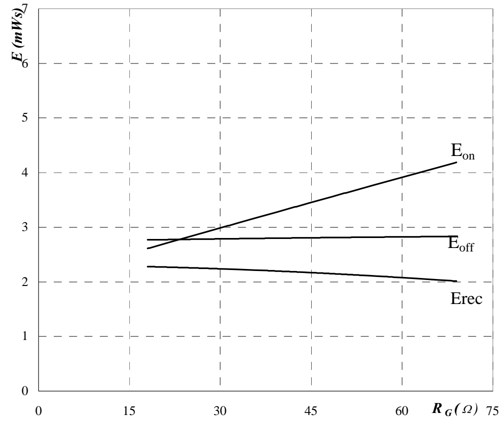
Output inverter

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



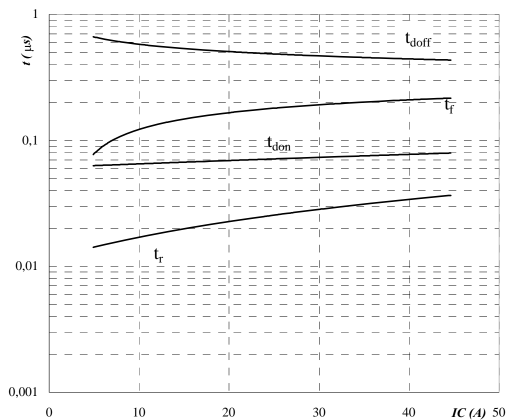
inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Rgon= 36 Ω
Rgoff= 36 Ω

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



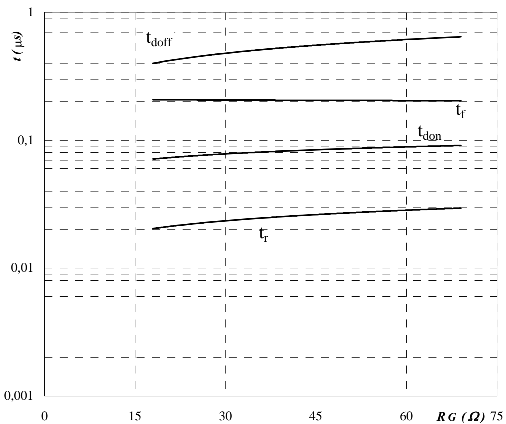
inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Ic = 25 A

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= 36 Ω
Rgoff= 36 Ω

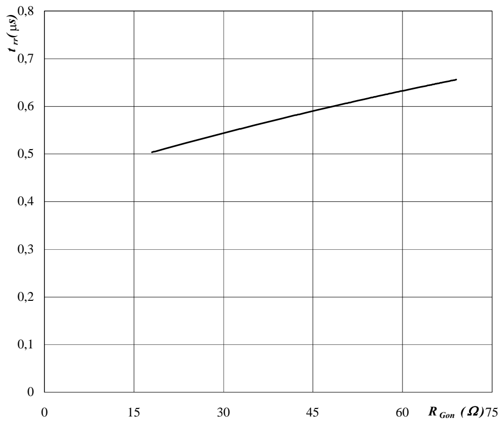
Figure 8. Typical switching times as a function of gate resistor
Output inverter IGBT
t = f (RG)



inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Ic = 25 A

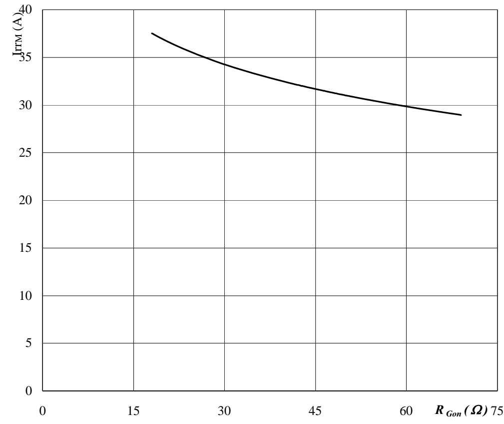
Output inverter

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



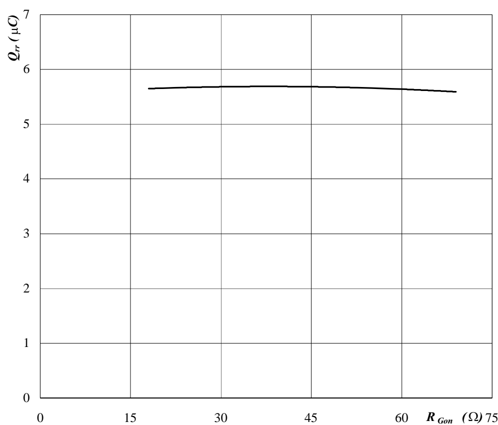
Tj = 125 °C
V_R = 600 V
I_F = 25 A
V_{GE} = ±15 V

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



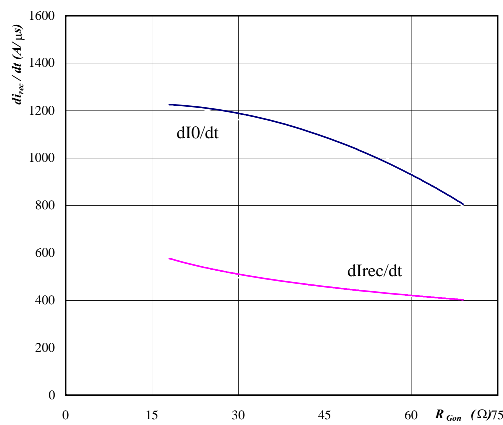
Tj = 125 °C
V_R = 600 V
I_F = 25 A
V_{GE} = ±15 V

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 = 25 A
V_{GE} = ±15 V

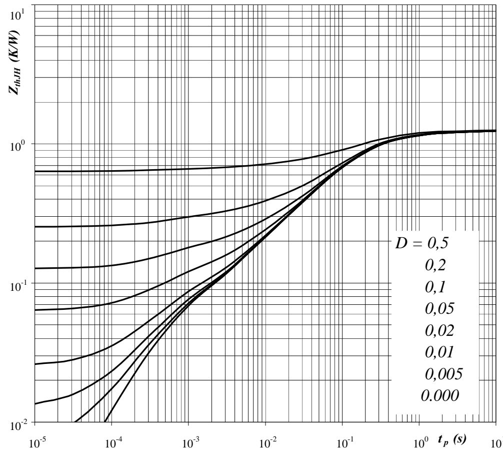
Figure 12. Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
Output inverter FRED diode
dI0/dt,dIrec/dt= f (Rgon)



Tj = 125 °C
V_R = 600 V
I_F = 25 A
V_{GE} = ±15 V

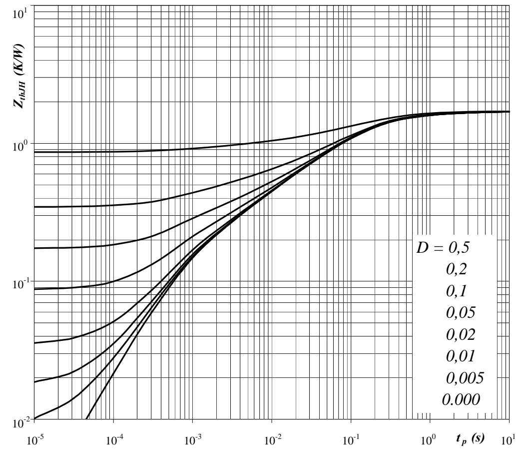
Output inverter

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



Parameter: D = tp / T   RthJH= 1,25 K/W

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



Parameter: D = tp / T   RthJH= 1,71 K/W

IGBT thermal model values

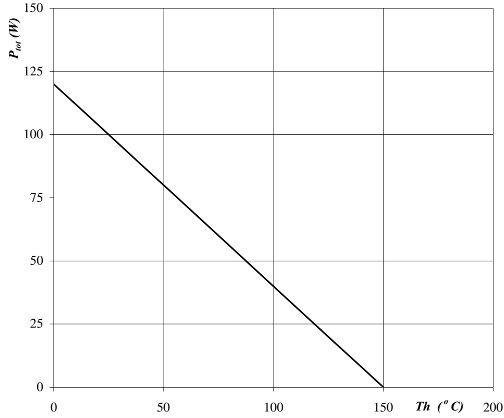
R (C/W)	Tau (s)
0,05	2,1E+01
0,13	1,5E+00
0,61	2,0E-01
0,33	5,3E-02
0,10	7,0E-03
0,05	4,9E-04
0,05	1,2E-04
0,00	0,0E+00

FRED thermal model values

R (C/W)	Tau (s)
0,06	1,9E+01
0,16	1,2E+00
0,65	1,8E-01
0,48	4,7E-02
0,23	7,4E-03
0,15	8,3E-04
0,09	4,7E-04
0,06	1,4E-04

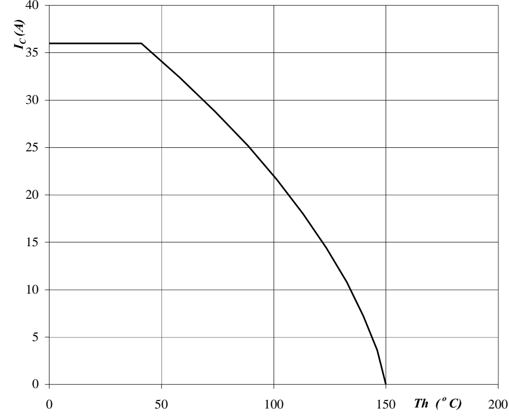
Output inverter

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



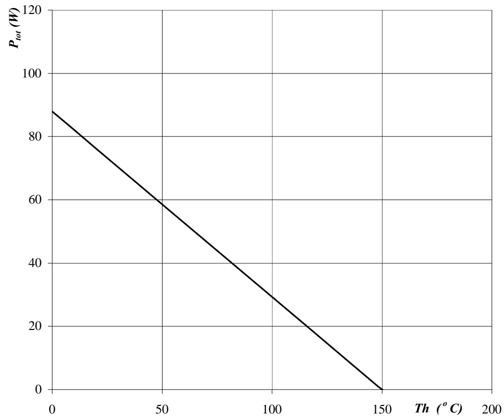
parameter: Tj = 150°C

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



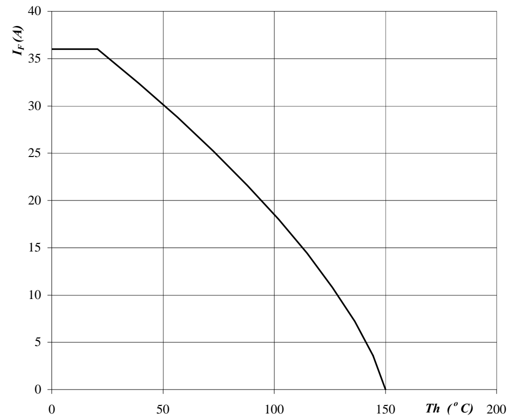
parameter: Tj = 150°C
V_{GE} = 15 V

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



parameter: Tj = 150°C

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



parameter: Tj = 150°C

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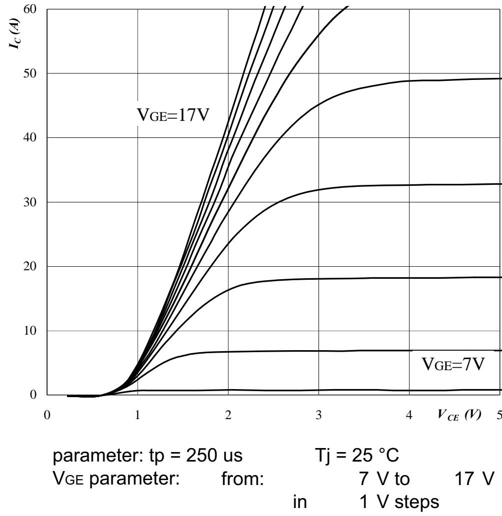
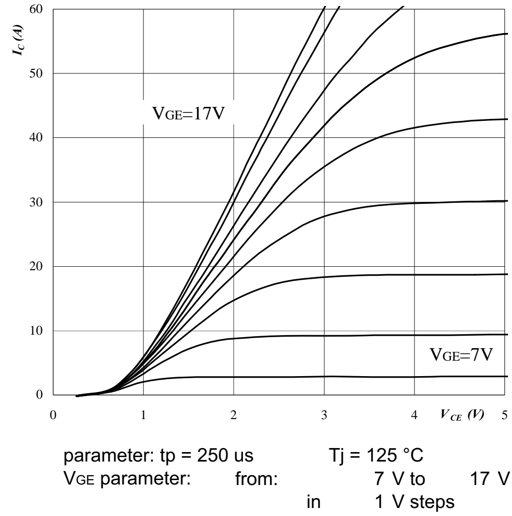
Brake

Figure 19. Typical output characteristics
Brake IGBT
$I_C = f(V_{CE})$



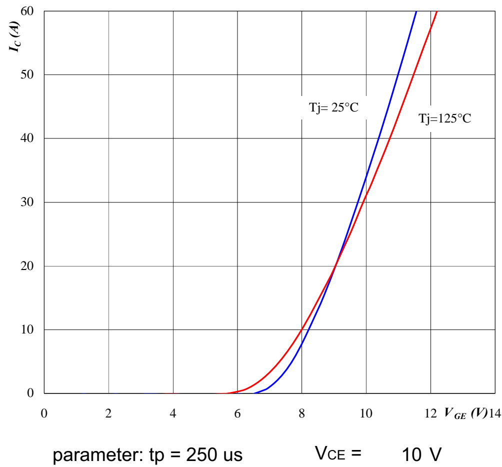
parameter: tp = 250 us Tj = 25 °C
V_{GE} parameter: from: 7 V to 17 V
in 1 V steps

Figure 20. Typical output characteristics
Brake IGBT
$I_C = f(V_{CE})$



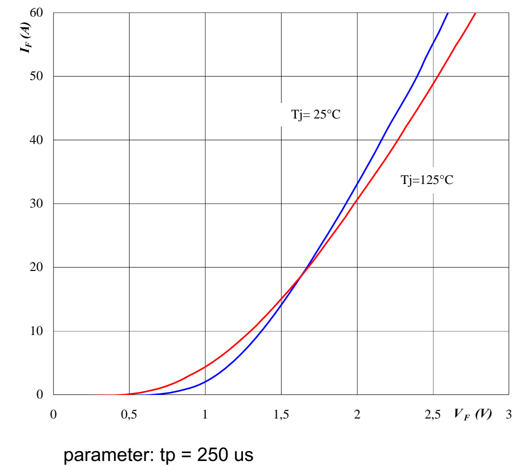
parameter: tp = 250 us Tj = 125 °C
V_{GE} parameter: from: 7 V to 17 V
in 1 V steps

Figure 21. Typical transfer characteristics
Brake IGBT
$I_C = f(V_{GE})$



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

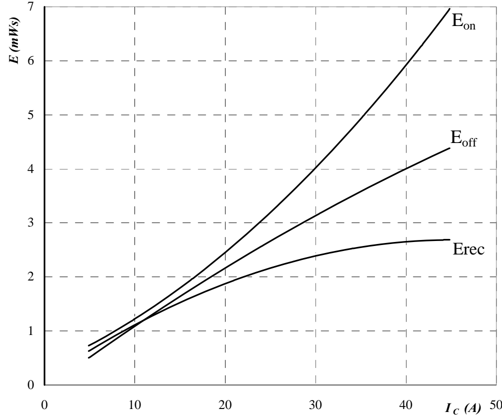
Figure 22. Typical diode forward current as a function of forward voltage
Brake FRED $I_F = f(V_F)$



parameter: tp = 250 us

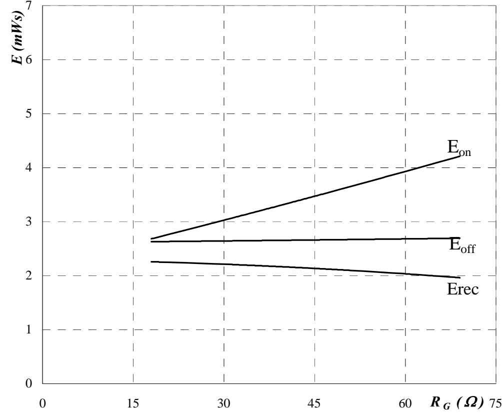
Brake

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



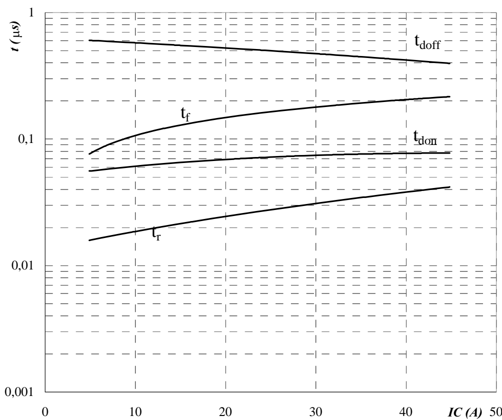
inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Rgon = 36 Ω
Rgoff = 36 Ω

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



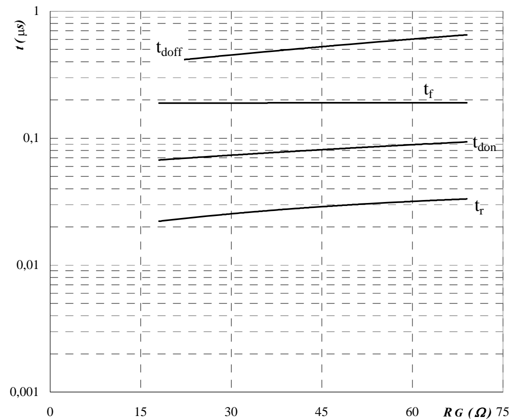
inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Ic = 25 A

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 = 36 Ω
Rgoff = 36 Ω

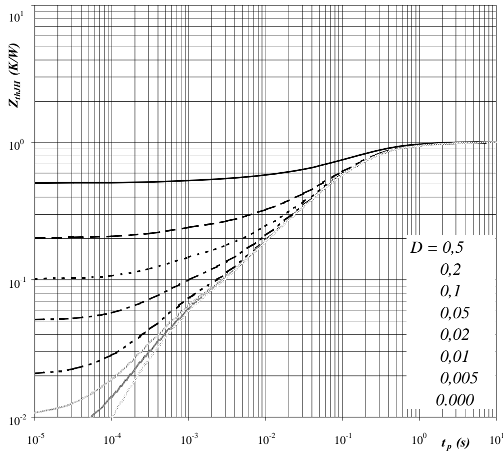
Figure 26. Typical switching times as a function of gate resistor
Brake IGBT
t = f (RG)



inductive load, Tj = 125 °C
VCE = 600 V
VGE= ±15 V
Ic = 25 A

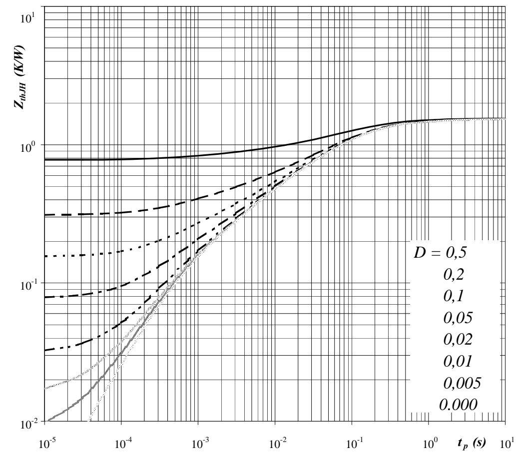
Brake

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



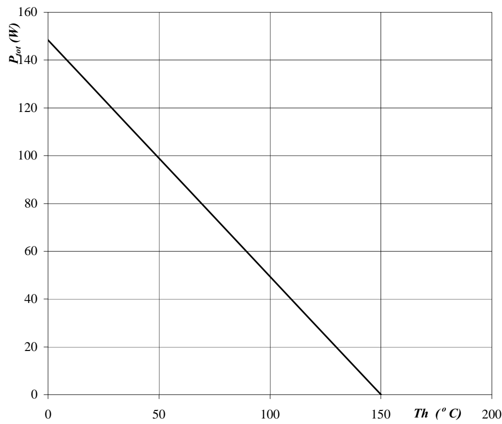
Parameter: D = tp / T   RthJH= 1,01 K/W

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



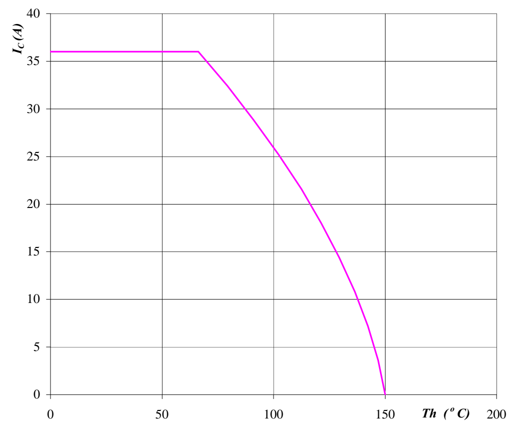
Parameter: D = tp / T   RthJH= 1,54 K/W

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



parameter: Tj = 150°C

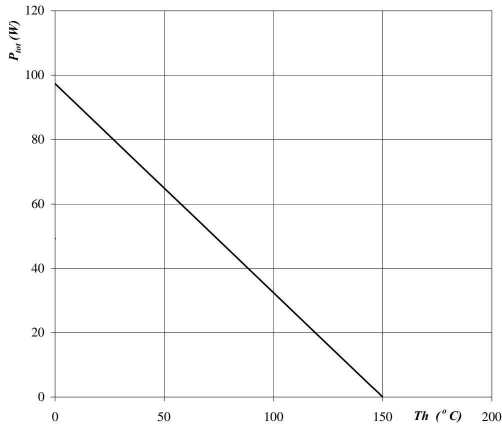
Figure 30. Collector current as a function of heatsink temperature
Brake IGBT
$I_c = f(Th)$



parameter: Tj = 150°C
V_{GE}= 15 V

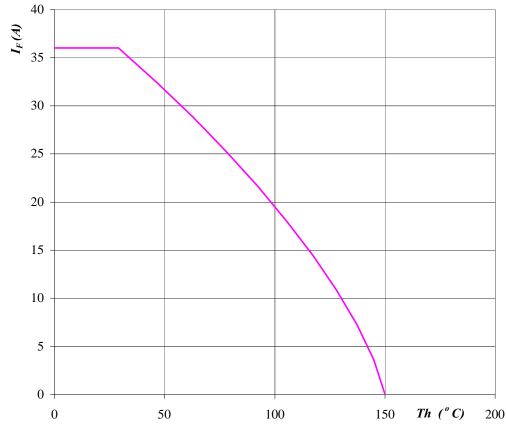
Brake

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



parameter: Tj = 150°C

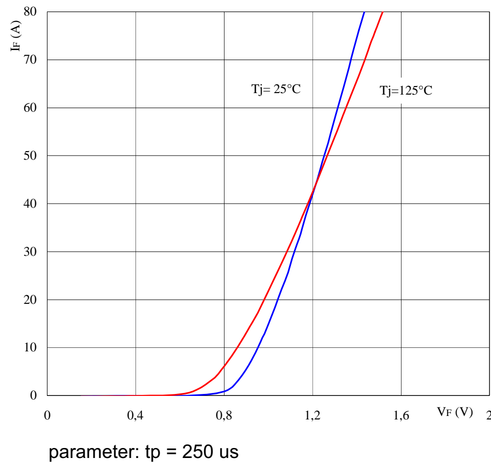
Figure 32. Forward current as a function of heatsink temperature
Brake FRED
$I_F = f\ (T_h)$



parameter: Tj = 150°C

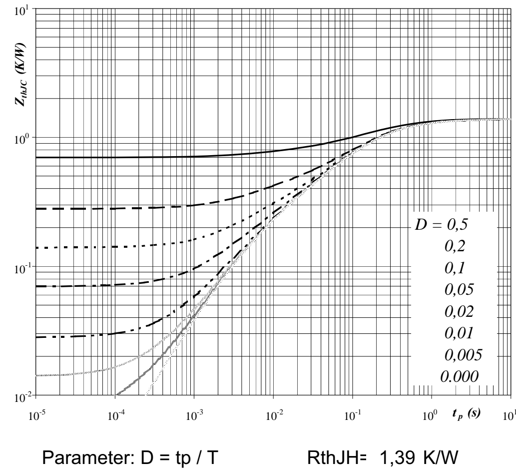
Input rectifier bridge

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



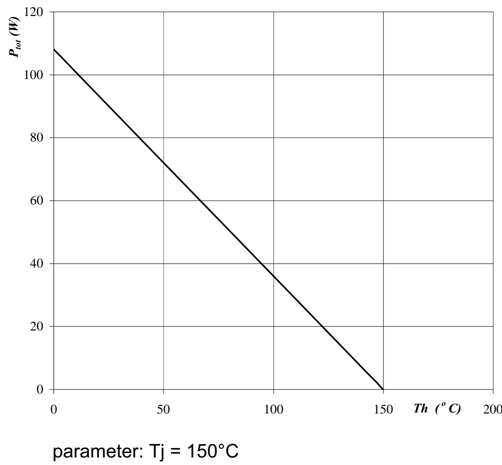
parameter: tp = 250 us

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



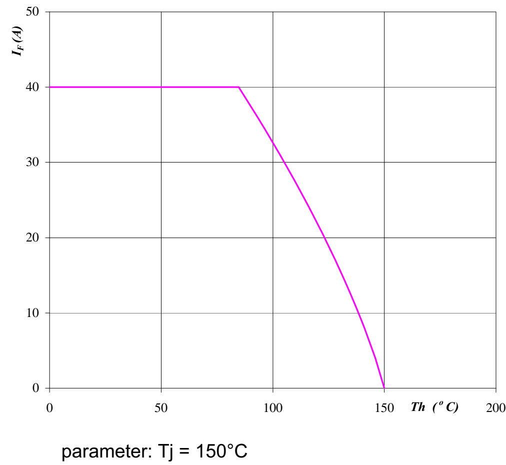
Parameter: D = tp / T   RthJH= 1,39 K/W

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



parameter: Tj = 150°C

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



parameter: Tj = 150°C

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Thermistor

Figure 37. **Typical PTC characteristic as afunction of temperature**

$R_T = f(T)$