

flow PIM® 1, 600V
Maximum Ratings / Höchstzulässige Werte

Parameter	Condition	Symbol	Datasheet values max.	Unit
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Input Rectifier Bridge
Gleichrichter

Repetitive peak reverse voltage Periodische Rückw. Spitzensperrspannung		V_{RRM}	1600	V
Forward current per diode Dauergrenzstrom	DC current $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	I_{FAV}	28,9 40, limited by nr. wires	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 ² s
Power dissipation per Diode Verlustleistung pro Diode	$T_j=150^\circ\text{C}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	P_{tot}	35 53	W

Transistor Inverter
Transistor Wechselrichter

Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung		V_{CE}	600	V
DC collector current Kollektor-Dauergleichstrom	$T_j=150^\circ\text{C}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	I_C	8, limited by nr. of wires 8, limited by nr. of wires	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	$t_p=1\text{ms}$ $T_h=80^\circ\text{C}$	I_{cpuls}	19,3	A
Power dissipation per IGBT Verlustleistung pro IGBT	$T_j=150^\circ\text{C}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	P_{tot}	28,4 43,1	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	±20	V
SC withstand time Kurzschlußverhalten	$T_j \leq 150^\circ\text{C}$ $V_{CE}=600\text{ V}$	t_{SC}	10	us

Diode Inverter
Diode Wechselrichter

DC forward current Dauergleichstrom	$T_j=150^\circ\text{C}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	I_F	8, limited by nr. of wires 8, limited by nr. of wires	A
Repetitive peak forward current Periodischer Spitzenstrom	$t_p=1\text{ms}$ $T_h=80^\circ\text{C}$	I_{FRM}	29,6	A
Power dissipation per Diode Verlustleistung pro Diode	$T_j=150^\circ\text{C}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	P_{tot}	25,8 39,1	W

Transistor BRC
Transistor BRC

Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung		V_{CE}	600	V
DC collector current Kollektor-Dauergleichstrom	$T_j=150^\circ\text{C}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	I_C	8, limited by nr. of wires 8, limited by nr. of wires	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	$t_p=1\text{ms}$ $T_h=80^\circ\text{C}$	I_{cpuls}	19,3	A
Power dissipation per IGBT Verlustleistung pro IGBT	$T_j=150^\circ\text{C}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	P_{tot}	28,4 43,1	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	±20	V
SC withstand time Kurzschlußverhalten	$T_j \leq 150^\circ\text{C}$ $V_{CE}=600\text{ V}$	t_{SC}	10	us

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Maximum Ratings / Höchstzulässige Werte

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Diode BRC
Diode BRC

DC forward current Dauergleichstrom	$T_j=150^{\circ}\text{C}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	I_F	8, limited by nr. of wires 8, limited by nr. of wires	A
Repetitive peak forward current Periodischer Spitzenstrom	$t_p=1\text{ms}$ $T_h=80^{\circ}\text{C}$	I_{FRM}	30	A
Power dissipation per Diode Verlustleistung pro Diode	$T_j=150^{\circ}\text{C}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	P_{tot}	25,8 39,1	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

flowPIM® 1, 600V
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 Durchlaßpannung	VF	Tj=25°C				30	0,8	1,24 1,23	1,4	V
Threshold voltage (for power loss calc. only) Schleusenspannung	Vto	Tj=25°C				30		0,92		V
Slope resistance (for power loss calc. only) Ersatzwiderstand	rt	Tj=25°C				30		10		mOhm
Reverse current Sperrstrom	Ir	Tj=25°C			1200				0,01	mA
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	RthJH		Thermal grease thickness≤50um Wärmeleitpaste Dicke≤50um λ = 0,61 W/mK						2	K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC								1,3	K/W
Transistor Inverter, inductive load										
Transistor Wechselrichter										
Gate emitter threshold voltage Gate-Schwellenspannung	VGE(th)	Tj=25°C Tj=125°C	VCE=VGE			0,0002	3	4	5	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	VCE(sat)	Tj=25°C Tj=125°C		15		8	1,5	2,3 2,6	3	V
Collector-emitter cut-off incl.FRED Kollektor-Emitter Reststrom inkl.FRED	ICES	Tj=25°C Tj=125°C		0	600				0,25	mA
Gate-emitter leakage current Gate-Emitter Reststrom	IGES	Tj=25°C Tj=125°C		25	0				180	nA
Turn-on delay time Einschaltverzögerungszeit	td(on)	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		12		ns
Rise time Anstiegszeit	tr	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		12		ns
Turn-off delay time Abschaltverzögerungszeit	td(off)	Tj=25°C Tj=125°C	Rgoff=25,5 Ohm	15	300	8		130		ns
Fall time Fallzeit	tf	Tj=25°C Tj=125°C	Rgoff=25,5 Ohm	15	300	8		18		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	Eon	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		0,19		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	Eoff	Tj=25°C Tj=125°C	Rgoff=25,5 Ohm	15	300	8		0,13		mWs
Input capacitance Eingangskapazität	Cies	Tj=25°C Tj=125°C	f=1MHz	0	25			0,35	0,42	nF
Output capacitance Ausgangskapazität	Coss	Tj=25°C Tj=125°C	f=1MHz	0	25			0,038		nF
Reverse transfer capacitance Rückwirkungskapazität	Crss	Tj=25°C Tj=125°C	f=1MHz	0	25			0,023		nF
Gate charge Gate Ladung	QGate	Tj=25°C Tj=125°C		15	480	6		32	42	nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	RthJH		Thermal grease thickness≤50um Wärmeleitpaste Dicke≤50um λ = 0,61 W/mK					2,5		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC							1,6		K/W

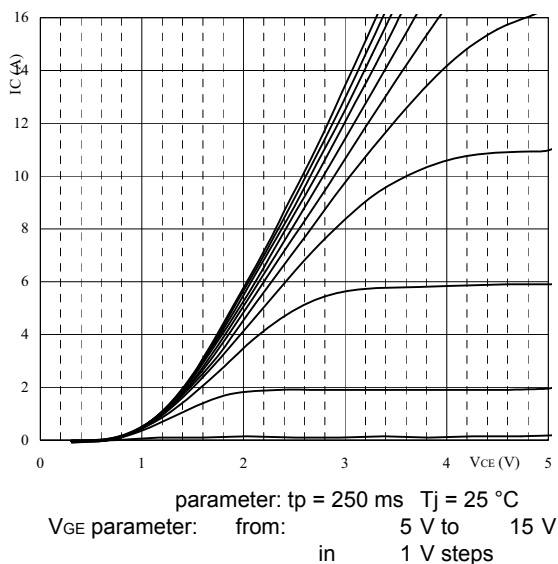
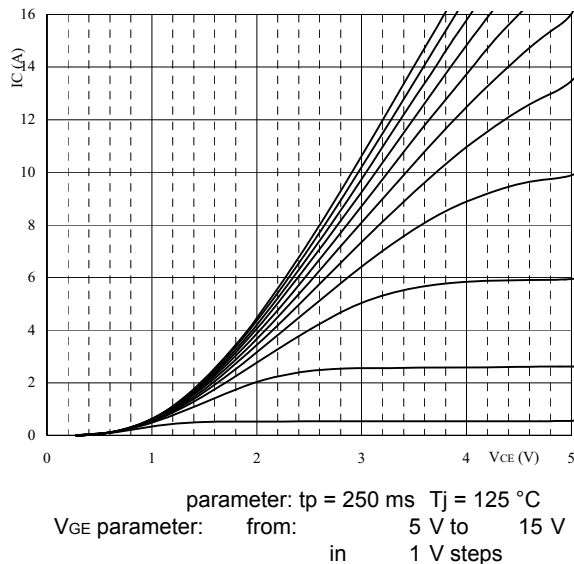
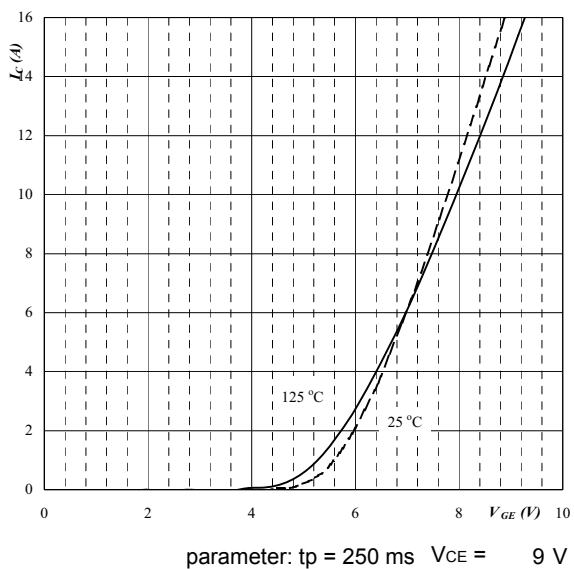
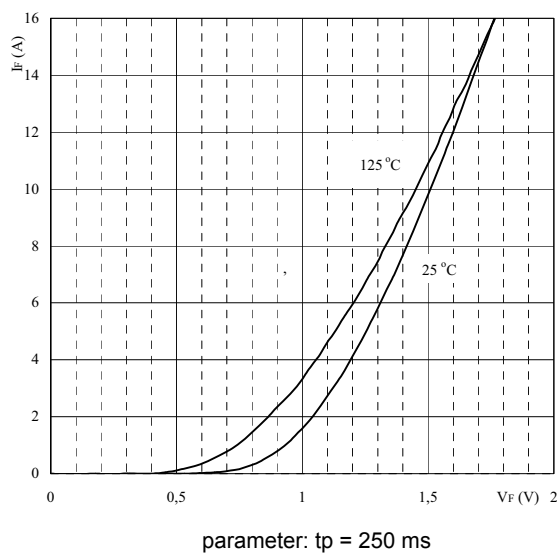
flowPIM® 1, 600V
Characteristic values

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	VF	Tj=25°C Tj=125°C				8	0,7	1,4 1,3	1,75	V
Peak reverse recovery current Rückstromspitze	IRRM	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		12,6		A
Reverse recovery time Sperrverzögerungszeit	trr	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		59		ns
Reverse recovered charge Sperrverzögerungsladung	Qrr	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		0,37		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		0,057		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	RthJH		Thermal grease thickness≤50um Wärmeleitpaste					2,7		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC		Dicke≤50um λ = 0,61 W/mK					1,8		K/W
Transistor BRC										
Transistor BRC										
Gate emitter threshold voltage Gate-Schwellenspannung	VGE(th)	Tj=25°C Tj=125°C	VCE=VGE			0,0002	3	4	5	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	VCE(sat)	Tj=25°C Tj=125°C		15		8	1,6	2,25 2,6	2,55	V
Collector-emitter cut-off Kollektor-Emitter Reststrom	ICES	Tj=25°C Tj=125°C		0	600				0,03	mA
Gate-emitter leakage current Gate-Emitter Reststrom	IGES	Tj=25°C Tj=125°C		25	0				180	nA
Turn-on delay time Einschaltverzögerungszeit	td(on)	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		12		ns
Rise time Anstiegszeit	tr	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		12		ns
Turn-off delay time Abschaltverzögerungszeit	td(off)	Tj=25°C Tj=125°C	Rgoff=25,5 Ohm	15	300	8		130		ns
Fall time Fallzeit	tf	Tj=25°C Tj=125°C	Rgoff=25,5 Ohm	15	300	8		18		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	Eon	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		0,19		uWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	Eoff	Tj=25°C Tj=125°C	Rgoff=25,5 Ohm	15	300	8		0,13		uWs
Input capacitance Eingangskapazität	Ciss	Tj=25°C Tj=125°C	f=1MHz	0	25			0,35	0,42	nF
Output capacitance Ausgangskapazität	Coss	Tj=25°C Tj=125°C	f=1MHz	0	25			0,038		nF
Reverse transfer capacitance Rückwirkungskapazität	Crss	Tj=25°C Tj=125°C	f=1MHz	0	25			0,023		nF
Gate charge Gate Ladung	QGate	Tj=25°C Tj=125°C		15	480	6		32	42	nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	RthJH		Thermal grease thickness≤50um Wärmeleitpaste					2,5		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC		Dicke≤50um λ = 0,61 W/mK					1,6		K/W

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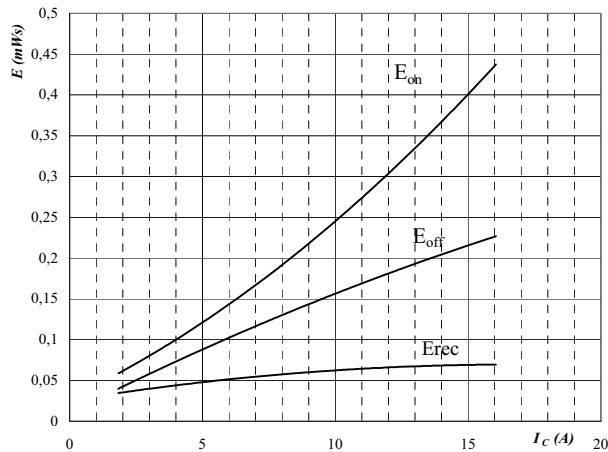
Characteristic values

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 BRC										
Diode BRC										
Diode forward voltage Durchlaßspannung	VF	Tj=25°C Tj=125°C				8	0,7	1,37 1,28	1,35	V
Reverse current Sperrstrom	IR	Tj=25°C			600				0,25	uA
Peak reverse recovery current Rückstromspitze	IRRM	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		12,6		A
Reverse recovery time Sperrverzögerungszeit	trr	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		59		ns
Reverse recovered charge Sperrverzögerungsladung	Qrr	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		0,37		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon=51 Ohm	15	300	8		0,057		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	RthJH		Thermal grease thickness≤50um Wärmeleitpaste Dicke≤50um λ = 0,61 W/mK					2,7		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC							1,8		K/W
NTC-Thermistor										
NTC-Widerstand										
Rated resistance Nennwiderstand	R25	TC=25°C	Tol. ±5%				4,2	4,7	5,3	kOhm
Deviation of R100 Abweichung von R100	DR/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
 $I_C = f(V_{CE})$

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

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

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


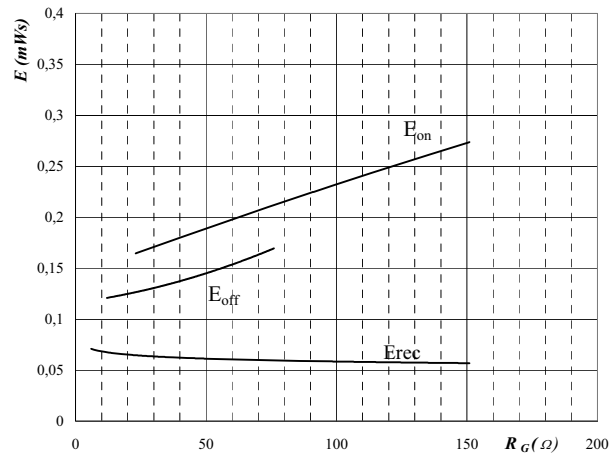
Output inverter

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



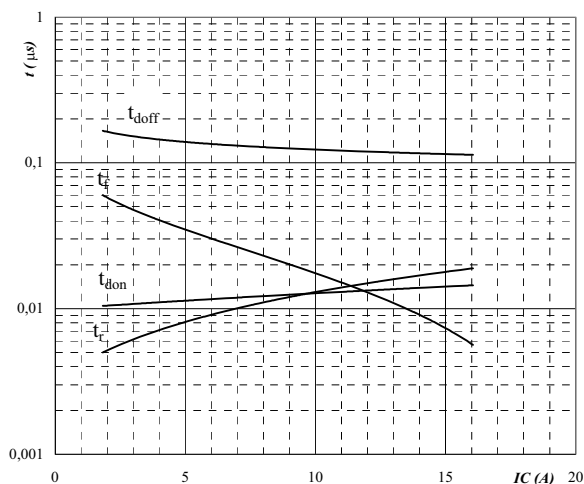
inductive load, $T_j = 125^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = 15\text{ V}$
 $R_{gon} = 2 \cdot R_{goff} = 51\text{ Ohm}$

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



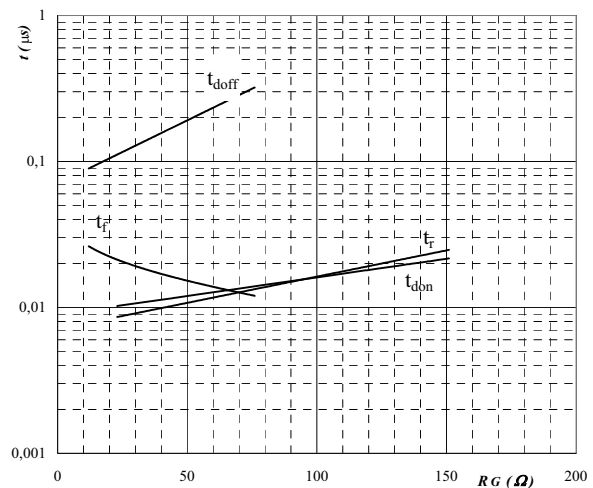
inductive load, $T_j = 125^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = 15\text{ V}$
 $I_c = 8\text{ A}$

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



inductive load, $T_j = 125^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = 15\text{ V}$
 $R_{gon} = 2 \cdot R_{goff} = 51\text{ Ohm}$

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

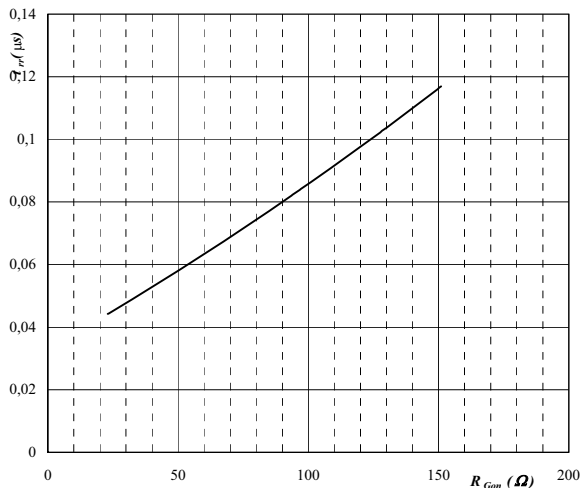


inductive load, $T_j = 125^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = 15\text{ V}$
 $I_c = 8\text{ A}$

Output inverter

Figure 9. Typical reverse recovery time as a function of IGBT turn on gate resistor

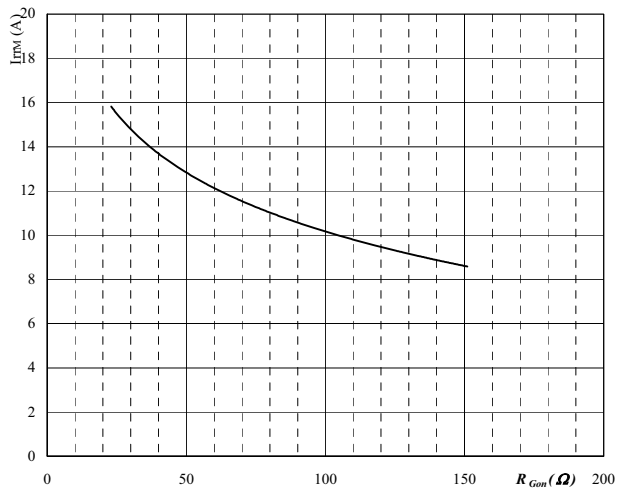
Output inverter FRED diode
 $t_{rr} = f(R_{gon})$



$T_j = 125\text{ }^{\circ}\text{C}$
 $V_R = 300\text{ V}$
 $I_F = 8\text{ A}$

Figure 10. Typical reverse recovery current as a function of IGBT turn on gate resistor

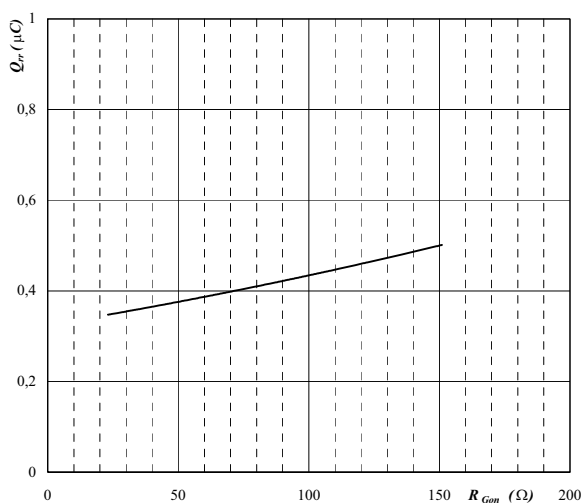
Output inverter FRED diode
 $I_{RRM} = f(R_{gon})$



$T_j = 125\text{ }^{\circ}\text{C}$
 $V_R = 300\text{ V}$
 $I_F = 8\text{ A}$

Figure 11. Typical reverse recovery charge as a function of IGBT turn on gate resistor

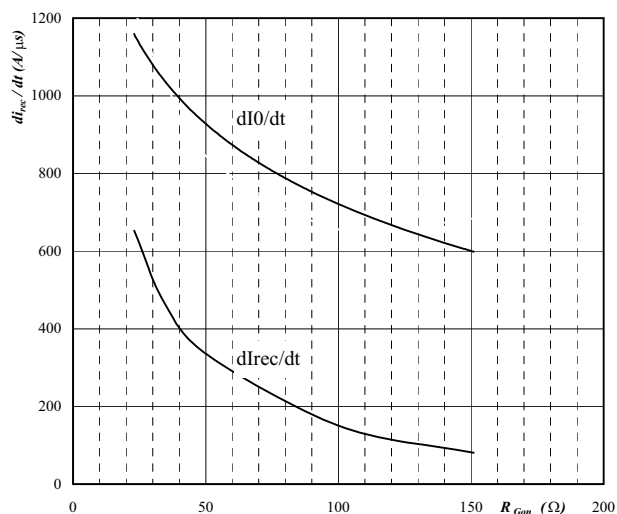
Output inverter FRED diode
 $Q_{rr} = f(R_{gon})$



$T_j = 125\text{ }^{\circ}\text{C}$
 $V_R = 300\text{ V}$
 $I_F = 8\text{ A}$

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
 $dI_0/dt, dI_{rec}/dt = f(R_{gon})$

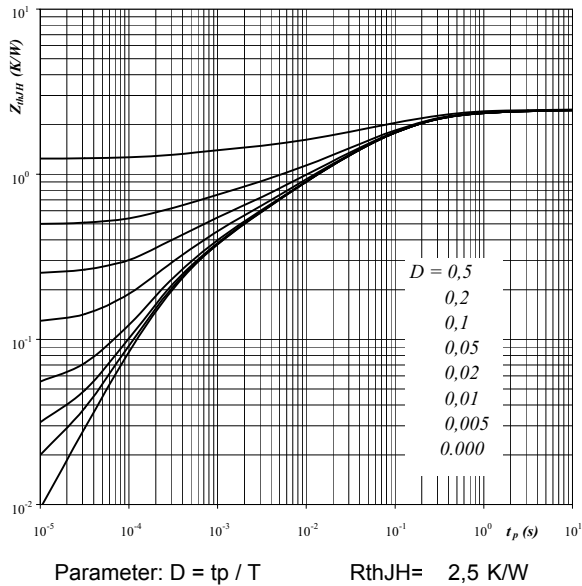


$T_j = 125\text{ }^{\circ}\text{C}$
 $V_R = 300\text{ V}$
 $I_F = 8\text{ A}$

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Output inverter

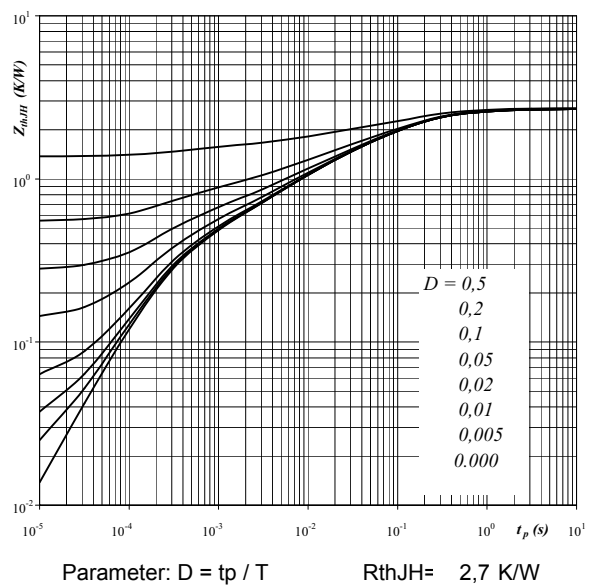
Figure 13. IGBT transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$



IGBT thermal model values

R (C/W)	Tau (s)
0,05	1,2E+02
0,16	1,7E+00
0,65	2,0E-01
0,71	5,3E-02

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



FRED thermal model values

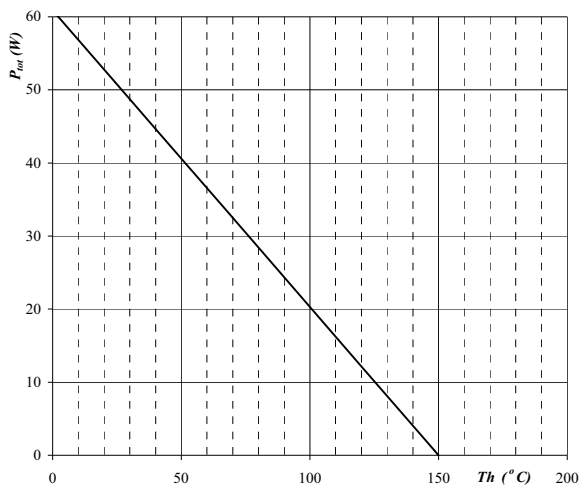
R (C/W)	Tau (s)
0,07	9,5E+01
0,13	1,8E+00
0,49	2,8E-01
0,85	8,0E-02

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Output inverter

Figure 15. Power dissipation as a function of heatsink temperature

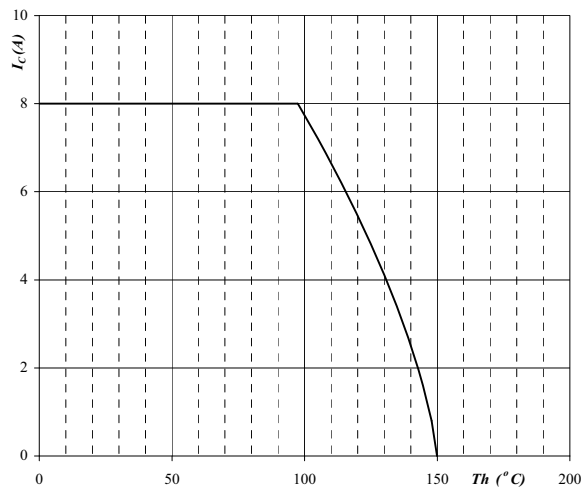
Output inverter IGBT
 $P_{tot} = f(T_h)$



parameter: $T_j = 150^{\circ}C$

Figure 16. Collector current as a function of heatsink temperature

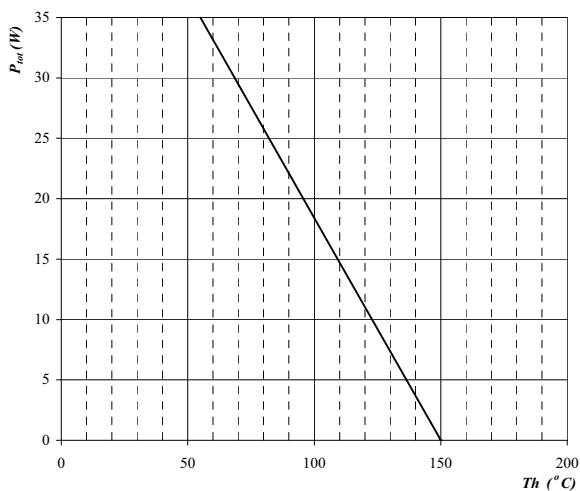
Output inverter IGBT
 $I_c = f(T_h)$



parameter: $T_j = 150^{\circ}C$
 $V_{GE} = 15\text{ V}$

Figure 17. Power dissipation as a function of heatsink temperature

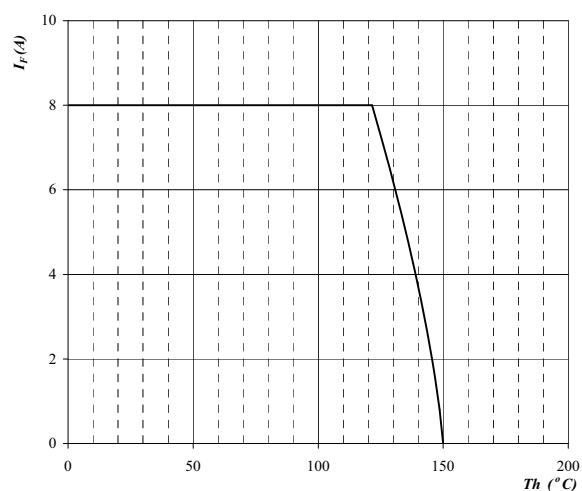
Output inverter FRED
 $P_{tot} = f(T_h)$



parameter: $T_j = 150^{\circ}C$

Figure 18. Forward current as a function of heatsink temperature

Output inverter FRED
 $I_F = f(T_h)$



parameter: $T_j = 150^{\circ}C$

Brake

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

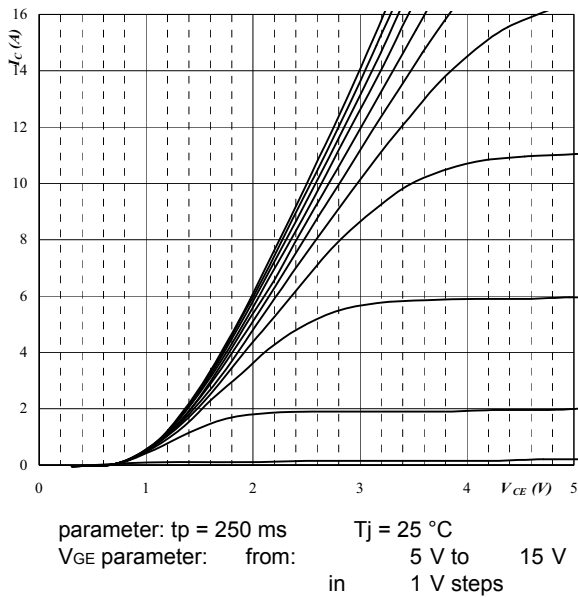


Figure 20. Typical output characteristics
Brake IGBT
 $I_c = f(V_{CE})$

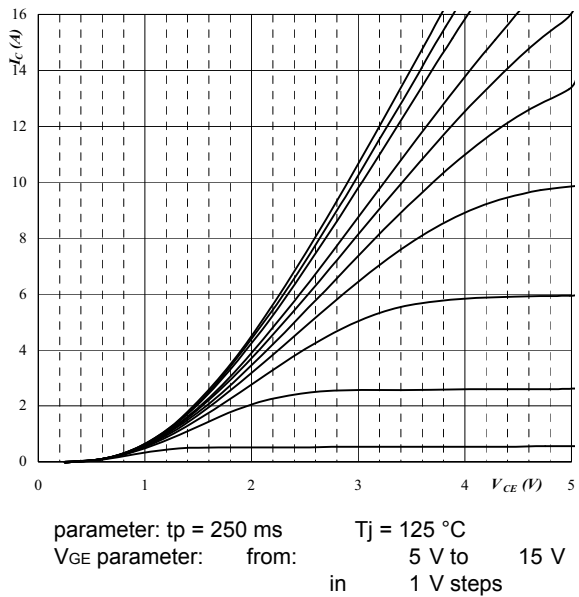


Figure 21. Typical transfer characteristics
Brake IGBT
 $I_c = f(V_{GE})$

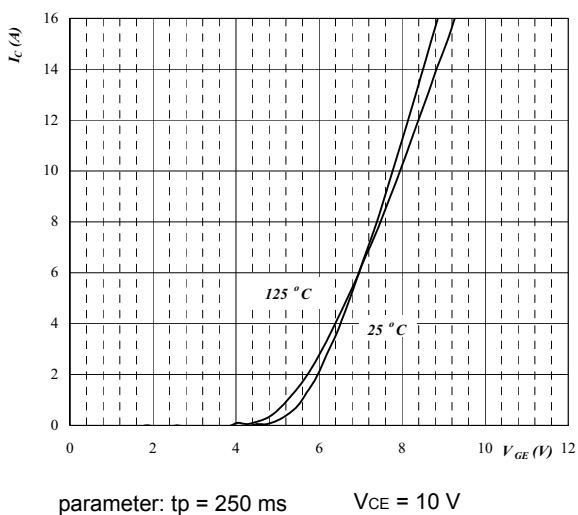
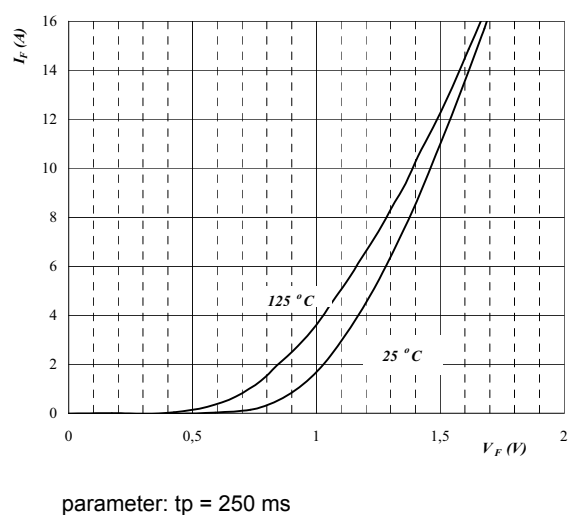


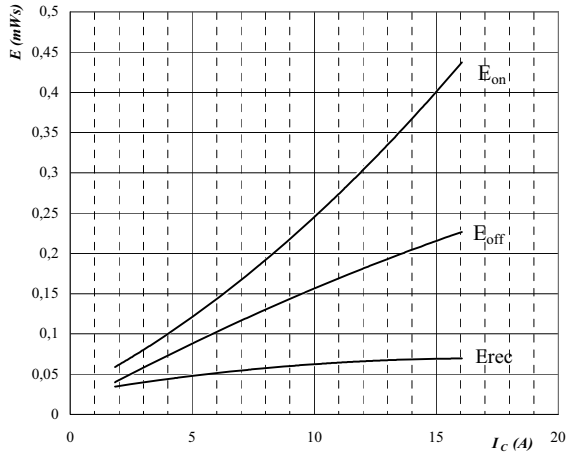
Figure 22. Typical diode forward current as a function of forward voltage
Brake FRED
 $I_F = f(V_F)$



Brake

Figure 23. Typical switching energy losses as a function of collector current
Brake IGBT

$$E = f(I_C)$$



inductive load, $T_j = 125^\circ\text{C}$

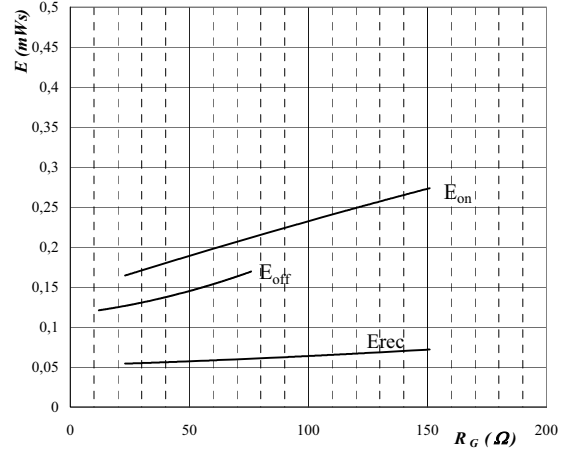
$V_{CE} = 300\text{ V}$

$V_{GE} = 15\text{ V}$

$R_{Gon} = 2 \cdot R_{Goff} = 51\text{ Ohm}$

Figure 24. Typical switching energy losses as a function of gate resistor
Brake IGBT

$$E = f(R_G)$$



inductive load, $T_j = 125^\circ\text{C}$

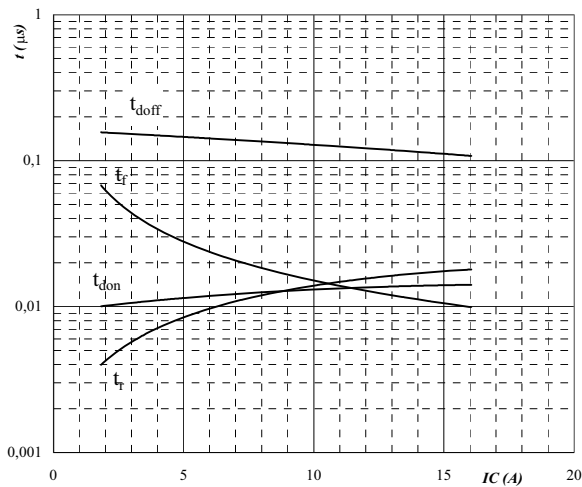
$V_{CE} = 300\text{ V}$

$V_{GE} = 15\text{ V}$

$I_C = 8\text{ A}$

Figure 25. Typical switching times as a function of collector current
Brake IGBT

$$t = f(I_C)$$



inductive load, $T_j = 125^\circ\text{C}$

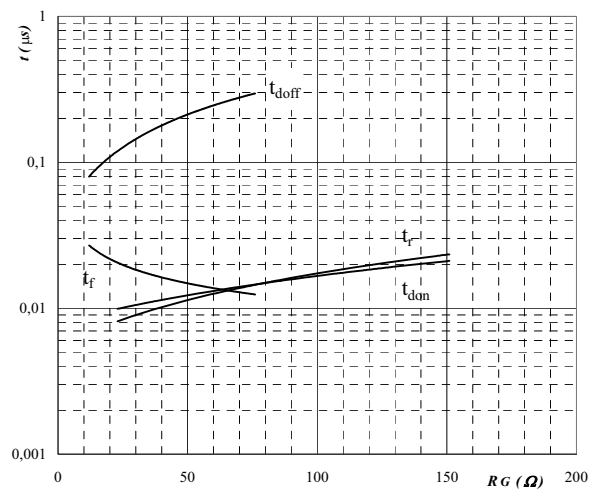
$V_{CE} = 300\text{ V}$

$V_{GE} = 15\text{ V}$

$R_{Gon} = 2 \cdot R_{Goff} = 51\text{ Ohm}$

Figure 26. Typical switching times as a function of gate resistor
Brake IGBT

$$t = f(R_G)$$



inductive load, $T_j = 125^\circ\text{C}$

$V_{CE} = 300\text{ V}$

$V_{GE} = 15\text{ V}$

$I_C = 8\text{ A}$

flowPIM® 1, 600V

Brake

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

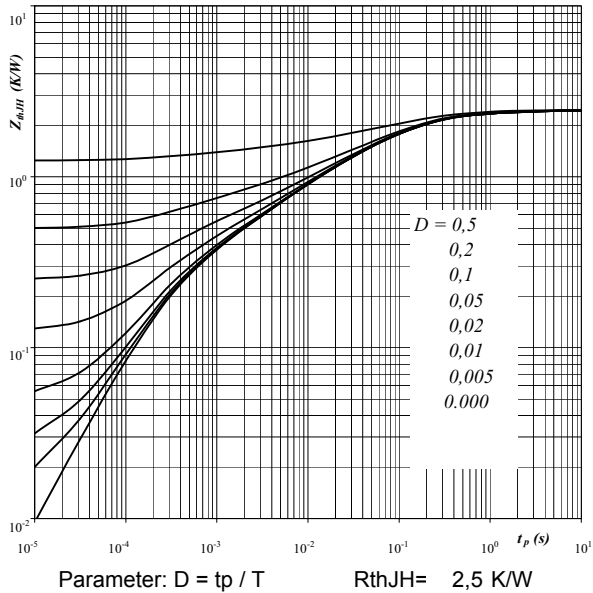


Figure 28. FRED transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$

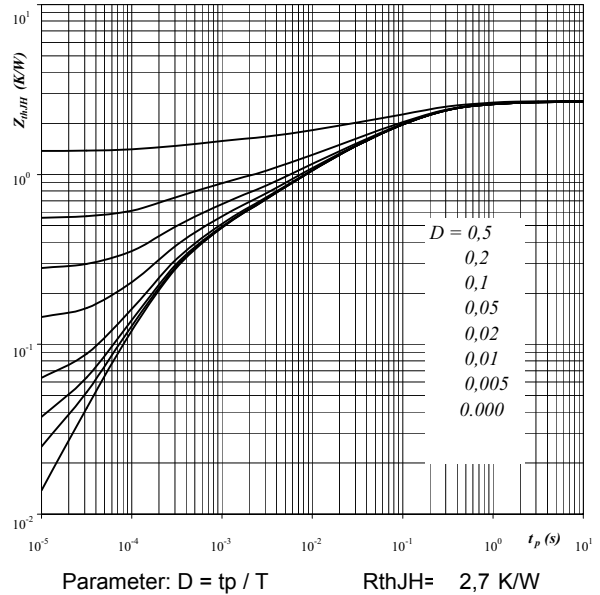


Figure 29. Power dissipation as a function of heatsink temperature
 Brake IGBT
 $P_{tot} = f(T_h)$

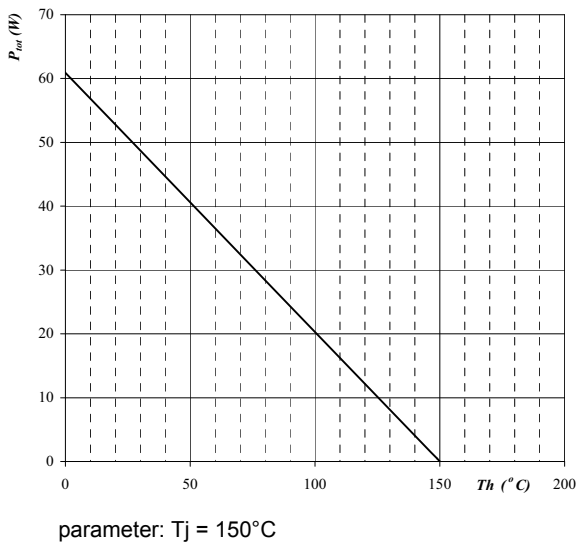
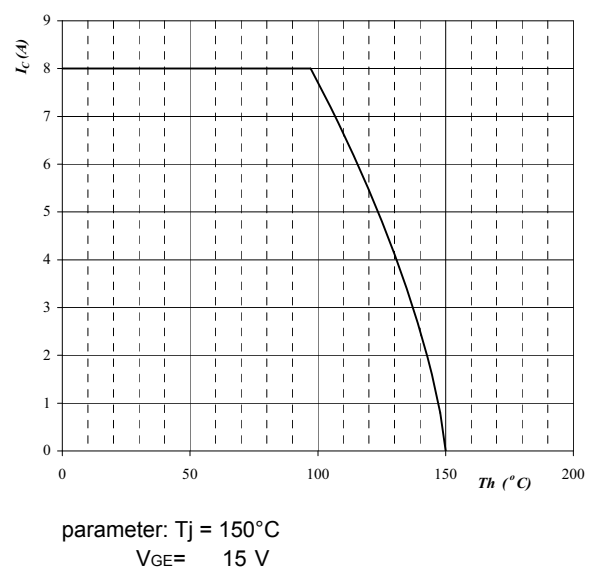


Figure 30. Collector current as a function of heatsink temperature
 Brake IGBT
 $I_c = f(T_h)$



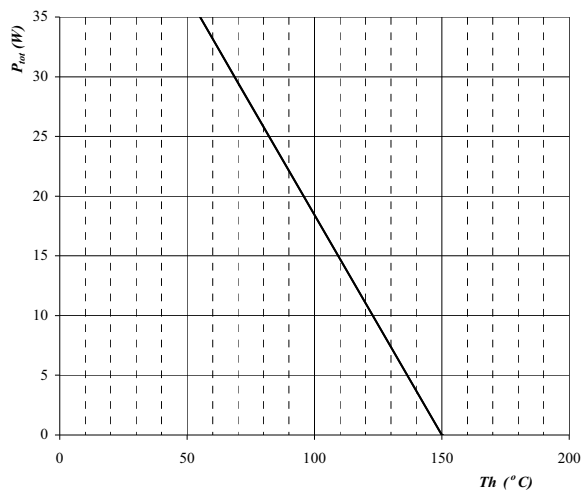
flowPIM® 1, 600V

Brake

Figure 31. Power dissipation as a function of heatsink temperature

Brake FRED

$P_{tot} = f(T_h)$

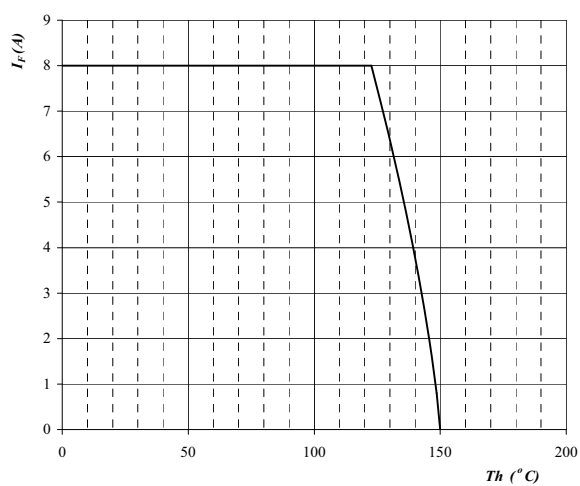


parameter: $T_j = 150^\circ\text{C}$

Figure 32. Forward current as a function of heatsink temperature

Brake FRED

$I_F = f(T_h)$



parameter: $T_j = 150^\circ\text{C}$

flowPIM® 1, 600V

Input rectifier bridge

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

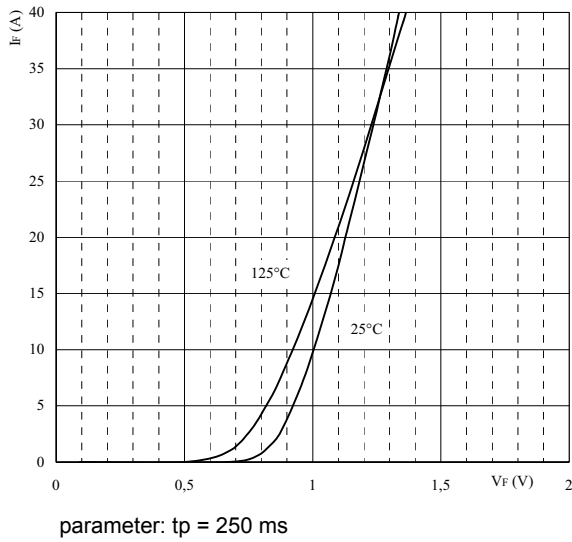


Figure 34. Diode transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$

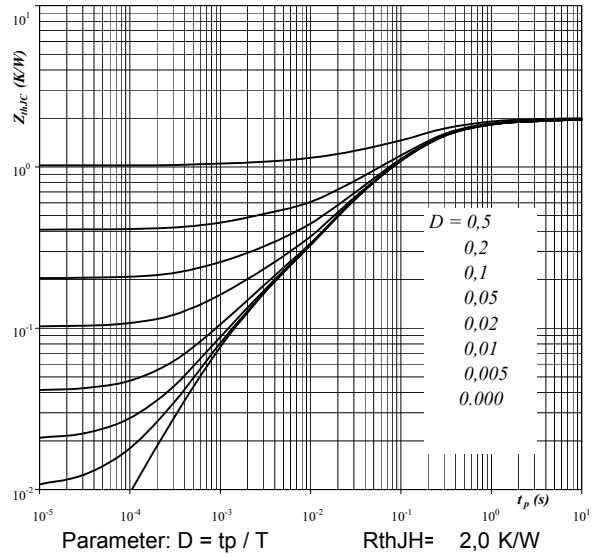


Figure 35. Power dissipation as a function of heatsink temperature
Rectifier diode $P_{tot} = f(T_h)$

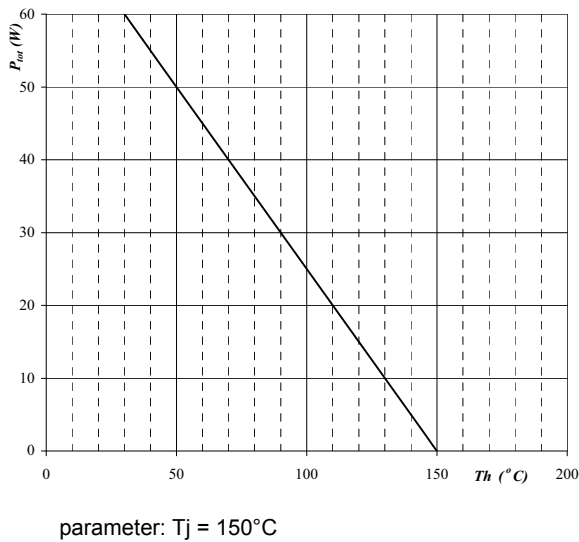
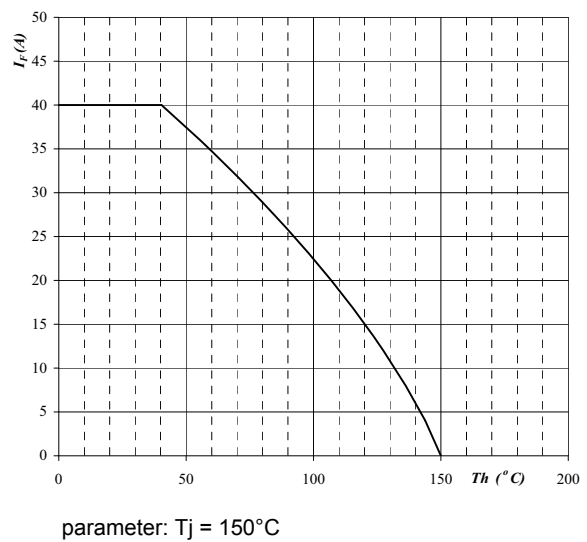


Figure 36. Forward current as a function of heatsink temperature
Rectifier diode $I_F = f(T_h)$



flowPIM® 1, 600V

Thermistor

**Figure 37. Typical NTC characteristic
as a function of temperature**

$$R_T = f(T)$$

