

flowPIM® 1, 600V
Maximum Ratings / Höchstzulässige Werte

Parameter	Condition	Symbol	Datasheet values	Unit
			max.	

Input Rectifier Bridge
Gleichrichter

Repetitive peak reverse voltage Periodische Rückw. Spitzensperrespannung		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}	35,7 40, limited by nr. wires	A
Surge forward current Stoßstrom Grenzwert	$t_p=10\text{ms}$ $T_j=25^{\circ}\text{C}$	I_{FSM}	250	A
I^2t -value Grenzlastintegral	$t_p=10\text{ms}$ $T_j=25^{\circ}\text{C}$	I^2t	310	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}	42,4 64,2	W

Transistor Inverter
Transistor Wechselrichter

Collector-emitter break down voltage Kollektor-Emitter-Sperrespannung		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	22,0 24, 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}	44,1	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}	44,8 67,9	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	± 20	V
SC withstand time Kurzschlußverhalten	$T_j \leq 150^{\circ}\text{C}$ $V_{GE}=15\text{V}$ $V_{CE}=600\text{V}$	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	24, limited by nr.of wires 24, 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}	50	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}	36,4 55,1	W

Transistor BRC
Transistor BRC

Collector-emitter break down voltage Kollektor-Emitter-Sperrespannung		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	14,6 16, 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}	29,2	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}	34,8 52,8	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	± 20	V
SC withstand time Kurzschlußverhalten	$T_j \leq 150^{\circ}\text{C}$ $V_{GE}=15\text{V}$ $V_{CE}=600\text{V}$	t_{SC}	10	us

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Maximum Ratings / Höchstzulässige Werte

Parameter	Condition	Symbol	Datasheet values	Unit
			max.	

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	15,0 16, 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_{slg}	-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

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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	
Input Rectifier Bridge										
Gleichrichter										
Forward voltage Durchlaßspannung	VF	Tj=25°C				30	0,8	1,16 1,13	1,35	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				0,02	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					1,7		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC							1,1		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	4,5	5,5	6,5	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	VCE(sat)	Tj=25°C Tj=125°C		15		30	1,7	2 2,30	2,75	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=12 Ohm	15	300	30		25		ns
Rise time Anstiegszeit	tr	Tj=25°C Tj=125°C	Rgon=12 Ohm	15	300	30		25		ns
Turn-off delay time Abschaltverzögerungszeit	td(off)	Tj=25°C Tj=125°C	Rgoff=6 Ohm	15	300	30		140		ns
Fall time Fallzeit	tf	Tj=25°C Tj=125°C	Rgoff=6 Ohm	15	300	30		30		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	Eon	Tj=25°C Tj=125°C	Rgon=12 Ohm	15	300	30		0,8		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	Eoff	Tj=25°C Tj=125°C	Rgoff=6 Ohm	15	300	30		0,7		mWs
Input capacitance Eingangskapazität	Cies	Tj=25°C Tj=125°C	f=1MHz	0	25			1,3		nF
Output capacitance Ausgangskapazität	Coss	Tj=25°C Tj=125°C	f=1MHz	0	25					nF
Reverse transfer capacitance Rückwirkungskapazität	Crss	Tj=25°C Tj=125°C	f=1MHz	0	25			0,1		nF
Gate charge Gate Ladung	QGate	Tj=25°C Tj=125°C		15	300			64		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					1,6		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC							1,0		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 Inverter										
Diode Wechselrichter										
Diode forward voltage Durchlaßspannung	VF	Tj=25°C Tj=125°C				30	1	1,73 1,60	2	V
Peak reverse recovery current Rückstromspitze	IRRM	Tj=25°C Tj=125°C	Rgon=12 Ohm	15	300	30		20,4		A
Reverse recovery time Sperreverzögerungszeit	trr	Tj=25°C Tj=125°C	Rgon=12 Ohm	15	300	30		130		ns
Reverse recovered charge Sperrverzögerungsladung	Qrr	Tj=25°C Tj=125°C	Rgon=12 Ohm	15	300	30		1,3		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon=12 Ohm	15	300	30		0,2		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	RthJH		Thermal grease thickness≤50um Wärmeleitpaste					1,9		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC		Dickes≤50um λ = 0,61 W/mK					1,3		K/W
Transistor BRC										
Transistor BRC										
Gate emitter threshold voltage Gate-Schwellenspannung	VGE(th)	Tj=25°C Tj=125°C	VCE=VGE			0	4,5	5,5	6,5	V
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	VCE(sat)	Tj=25°C Tj=125°C		15		15	1,7	2 2,3	2,55	V
Collector-emitter cut-off Kollektor-Emitter Reststrom	ICES	Tj=25°C Tj=125°C		0	600				0,05	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=23 Ohm	15	300	15		18		ns
Rise time Anstiegszeit	tr	Tj=25°C Tj=125°C	Rgon=23 Ohm	15	300	15		18		ns
Turn-off delay time Abschaltverzögerungszeit	td(off)	Tj=25°C Tj=125°C	Rgoff=11,5 Ohm	15	300	15		105		ns
Fall time Fallzeit	tf	Tj=25°C Tj=125°C	Rgoff=11,5 Ohm	15	300	15		35		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	Eon	Tj=25°C Tj=125°C	Rgon=23 Ohm	15	300	15		0,4		uWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	Eoff	Tj=25°C Tj=125°C	Rgoff=11,5 Ohm	15	300	15		0,385		uWs
Input capacitance Eingangskapazität	Ciss	Tj=25°C Tj=125°C	f=1MHz	0	25			0,8		nF
Output capacitance Ausgangskapazität	Coss	Tj=25°C Tj=125°C	f=1MHz	0	25					nF
Reverse transfer capacitance Rückwirkungskapazität	Crss	Tj=25°C Tj=125°C	f=1MHz	0	25			0,06		nF
Gate charge Gate Ladung	QGate	Tj=25°C Tj=125°C		15	300			58		nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	RthJH		Thermal grease thickness≤50um Wärmeleitpaste					2		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehäuse pro Chip	RthJC		Dickes≤50um λ = 0,61 W/mK					1,3		K/W

flow PIM® 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 BRC										
Diode BRC										
Diode forward voltage Durchlaßspannung	VF	Tj=25°C Tj=125°C				15	1	1,70 1,75	2,3	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=23 Ohm	15	300	15		13,5		A
Reverse recovery time Sperrverzögerungszeit	trr	Tj=25°C Tj=125°C	Rgon=23 Ohm	15	300	15		117		ns
Reverse recovered charge Sperrverzögerungsladung	Qrr	Tj=25°C Tj=125°C	Rgon=23 Ohm	15	300	15		0,8		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon=23 Ohm	15	300	15		0,14		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
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
 $I_C = f(V_{CE})$

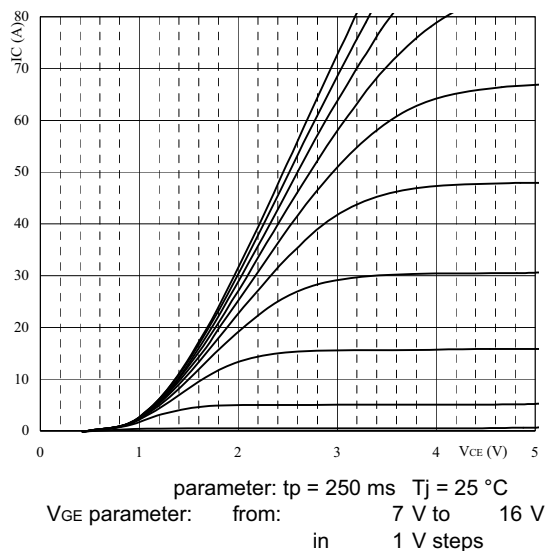


Figure 2. Typical output characteristics
Output inverter IGBT
 $I_C = f(V_{CE})$

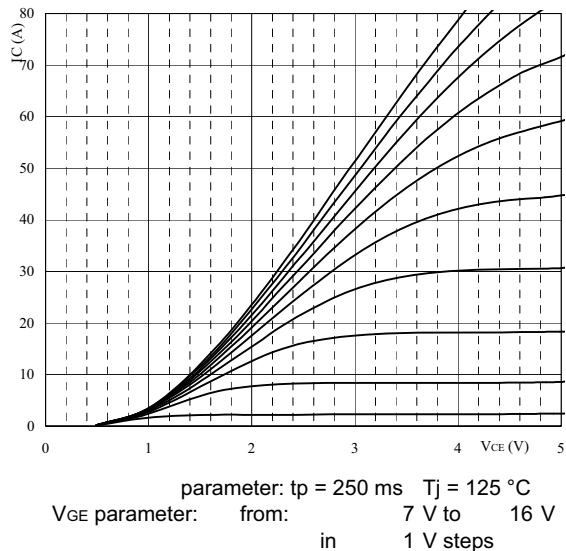


Figure 3. Typical transfer characteristics
Output inverter IGBT
 $I_C = f(V_{GE})$

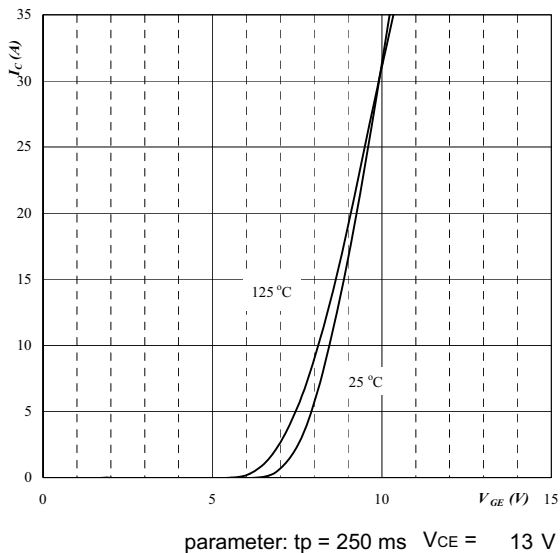
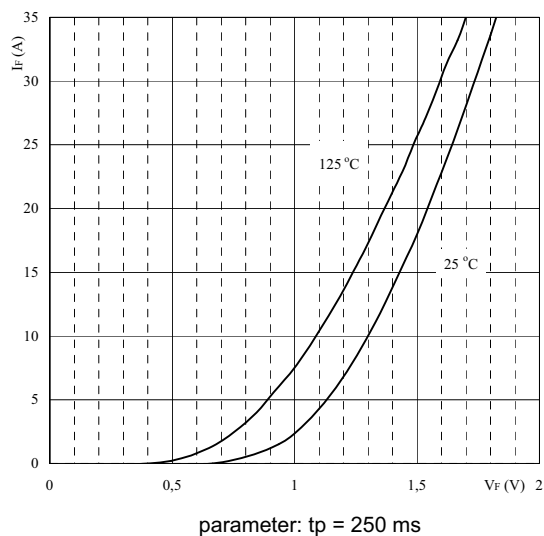


Figure 4. Typical diode forward current as a function of forward voltage
Output inverter FRED $I_F = f(V_F)$



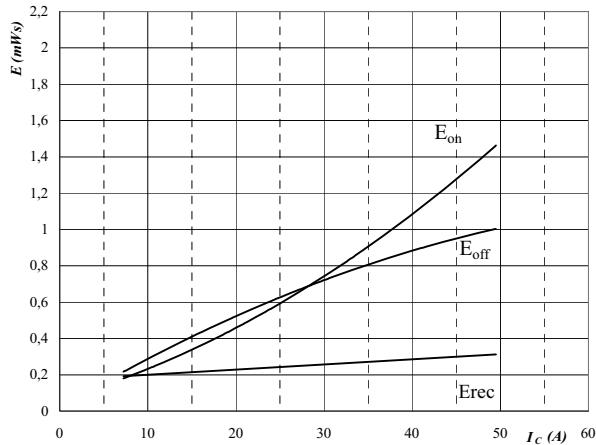
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Output inverter

Figure 5. Typical switching energy losses as a function of collector current

Output inverter IGBT

$$E = f(I_c)$$



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

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

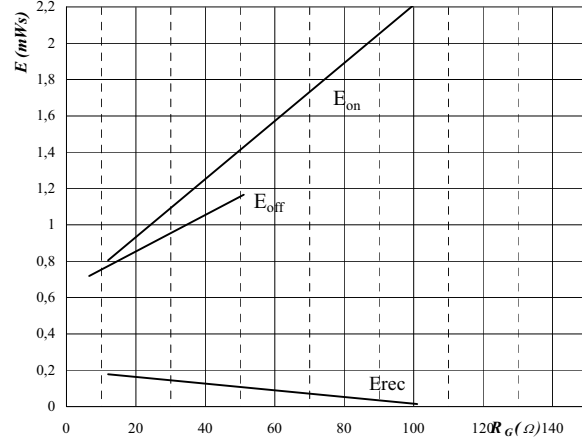
$$V_{GE} = 15\text{ V}$$

$$R_{gon} = 2 \cdot R_{Goff} = 12\text{ Ohm}$$

Figure 6. Typical switching energy losses as a function of gate resistor

Output inverter IGBT

$$E = f(R_G)$$



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

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

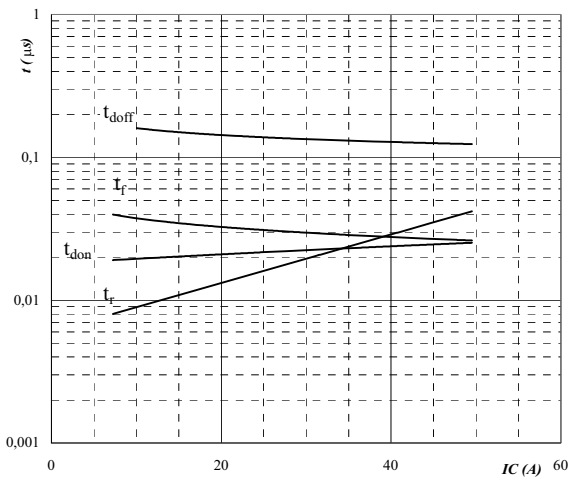
$$V_{GE} = 15\text{ V}$$

$$I_c = 30\text{ A}$$

Figure 7. Typical switching times as a function of collector current

Output inverter IGBT

$$t = f(I_c)$$



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

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

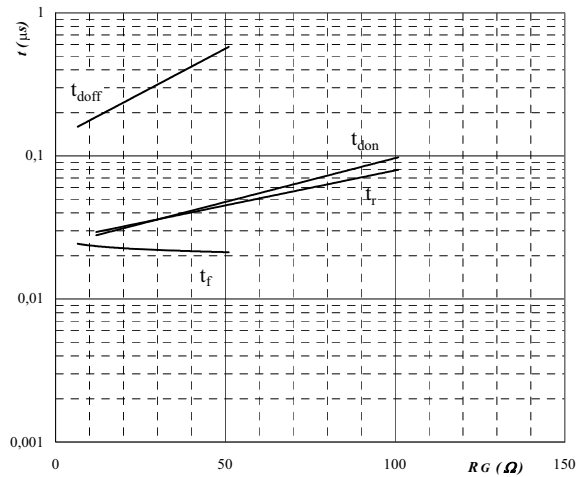
$$V_{GE} = 15\text{ V}$$

$$R_{gon} = 2 \cdot R_{Goff} = 12\text{ Ohm}$$

Figure 8. Typical switching times as a function of gate resistor

Output inverter IGBT

$$t = f(R_G)$$



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

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

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

$$I_c = 30\text{ A}$$

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Output inverter

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

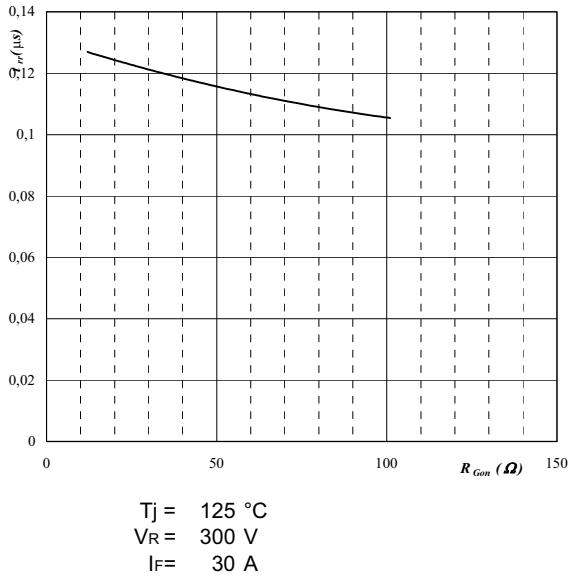


Figure 10. Typical reverse recovery current as a function of IGBT turn on gate resistor
Output inverter FRED diode
 $I_{RRM} = f(R_{gon})$

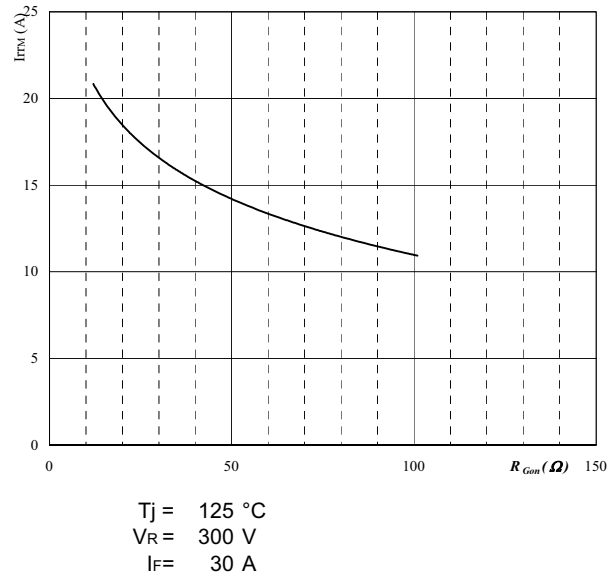


Figure 11. Typical reverse recovery charge as a function of IGBT turn on gate resistor
Output inverter FRED diode
 $Q_{rr} = f(R_{gon})$

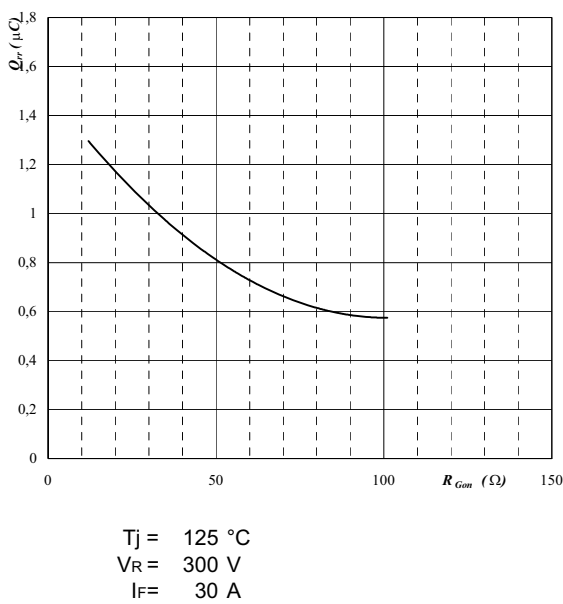
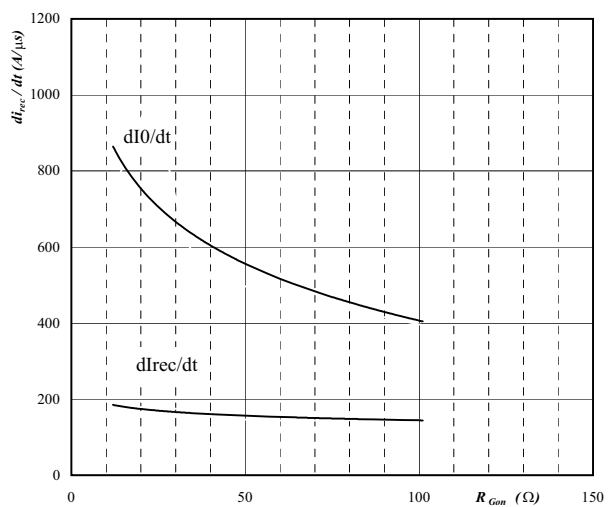


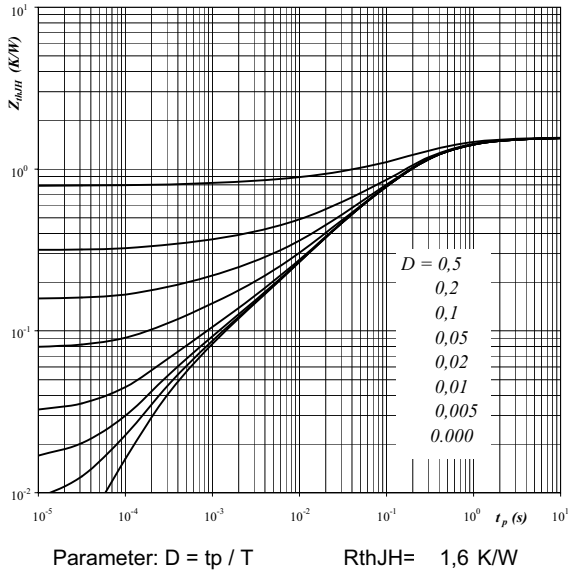
Figure 12. Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
Output inverter FRED diode
 $dI_O/dt, dI_{rec}/dt = f(R_{gon})$



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Output inverter

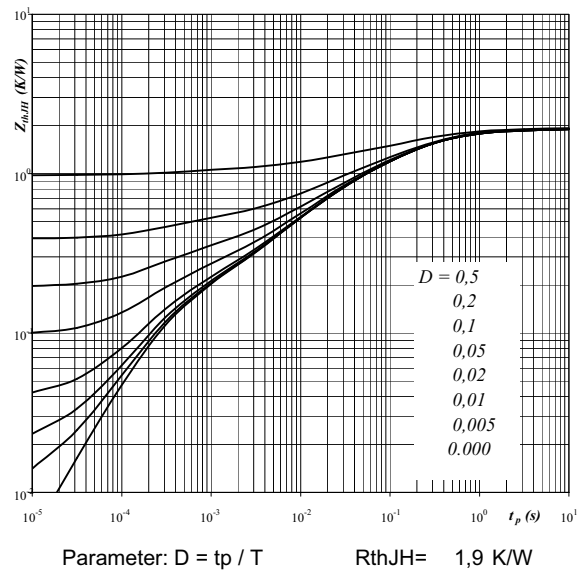
Figure 13. IGBT transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$



IGBT thermal model values

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

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)
0,05	1,0E+02
0,13	2,3E+00
0,48	3,7E-01
0,58	1,0E-01

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Output inverter

Figure 15. Power dissipation as a function of heatsink temperature

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

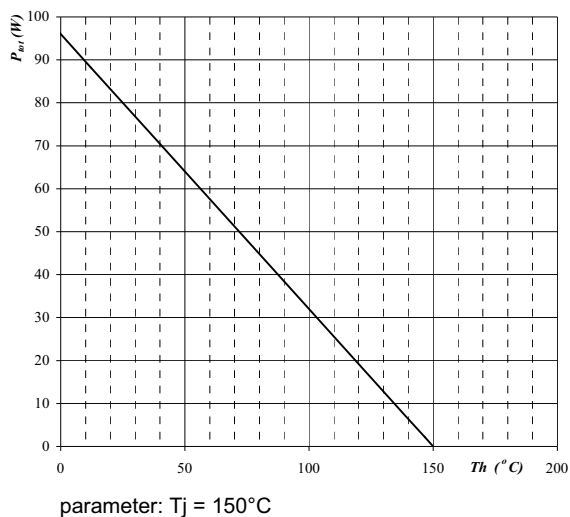


Figure 16. Collector current as a function of heatsink temperature

Output inverter IGBT
 $I_c = f(T_h)$

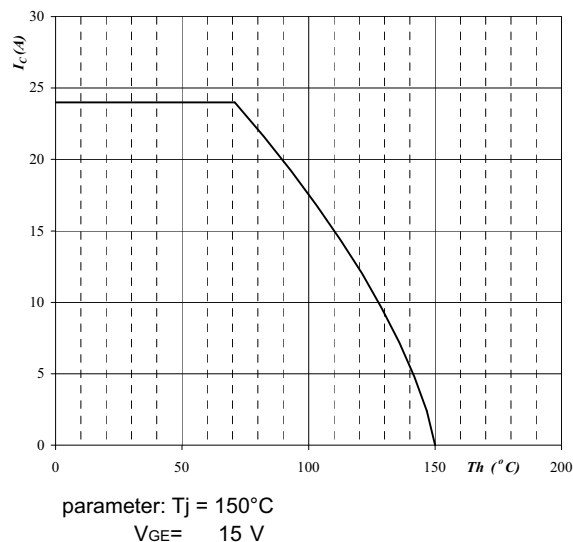


Figure 17. Power dissipation as a function of heatsink temperature

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

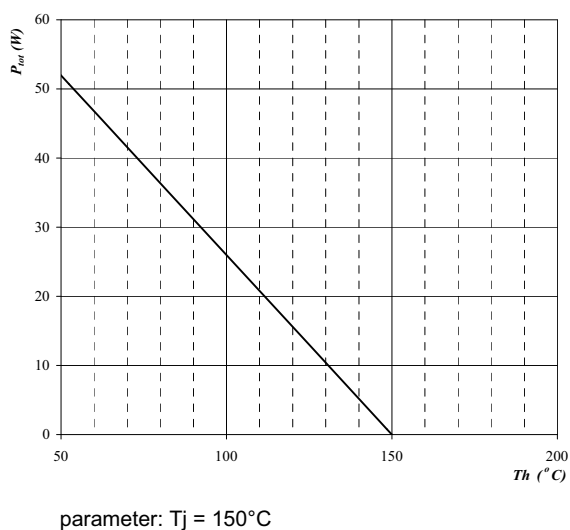
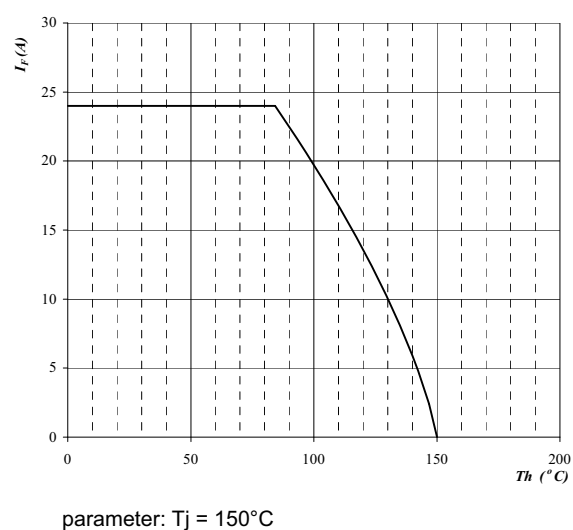


Figure 18. Forward current as a function of heatsink temperature

Output inverter FRED
 $I_F = f(T_h)$



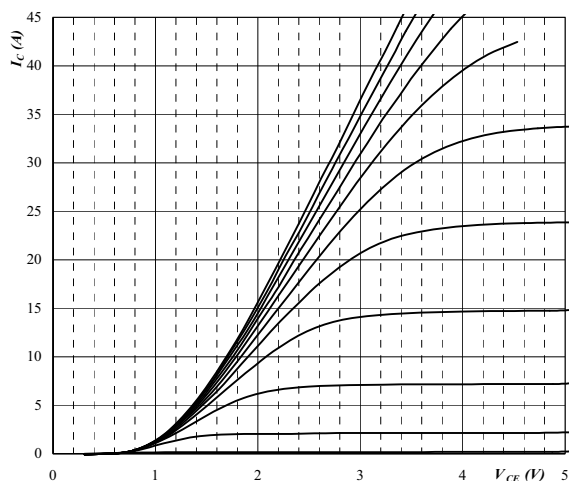
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Brake

Figure 19. Typical output characteristics

Brake IGBT

$I_c = f(V_{CE})$



parameter: $t_p = 250 \text{ ms}$

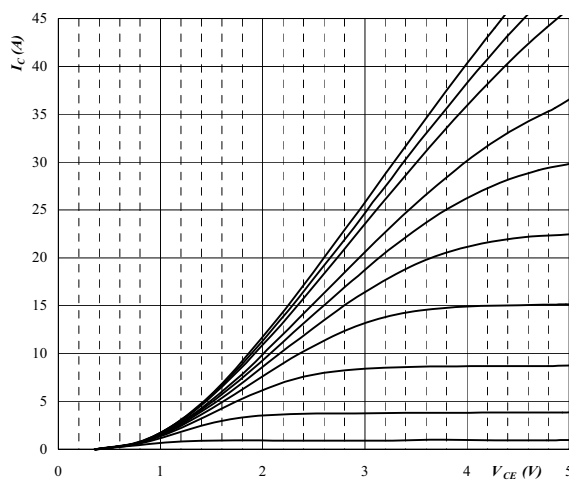
$T_j = 25 \text{ °C}$

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: $t_p = 250 \text{ ms}$

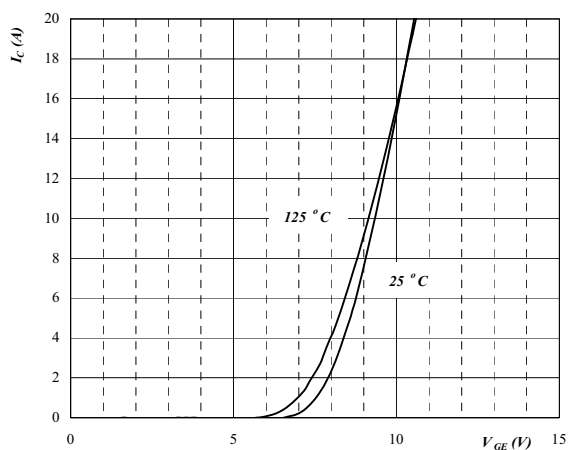
$T_j = 125 \text{ °C}$

V_{GE} parameter: from: 7 V to 17 V
in 1 V steps

Figure 21. Typical transfer characteristics

Brake IGBT

$I_c = f(V_{GE})$



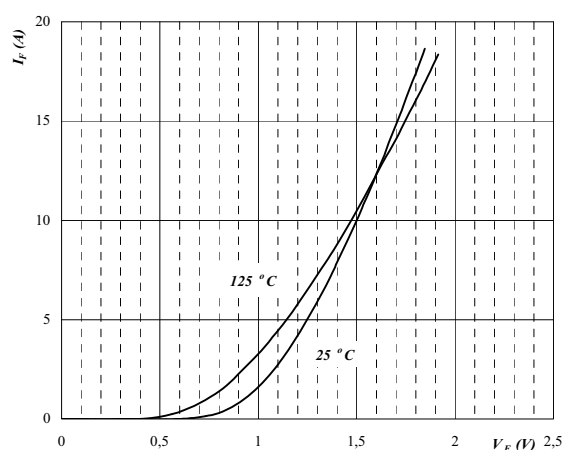
parameter: $t_p = 250 \text{ ms}$

$V_{CE} = 10 \text{ V}$

Figure 22. Typical diode forward current as a function of forward voltage

Brake FRED

$I_F = f(V_F)$



parameter: $t_p = 250 \text{ ms}$

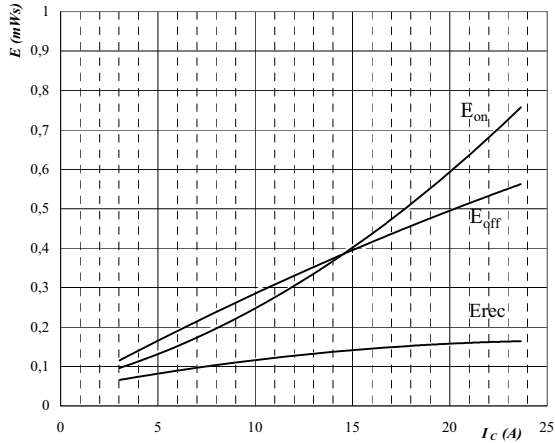
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Brake

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

Brake IGBT

$$E = f(I_C)$$



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

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

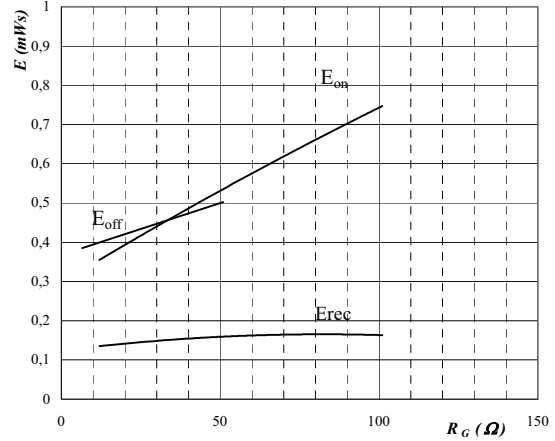
$$V_{GE} = 15 \text{ V}$$

$$R_{gon} = 2 \cdot R_{goff} = 23 \text{ Ohm}$$

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

Brake IGBT

$$E = f(R_G)$$



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

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

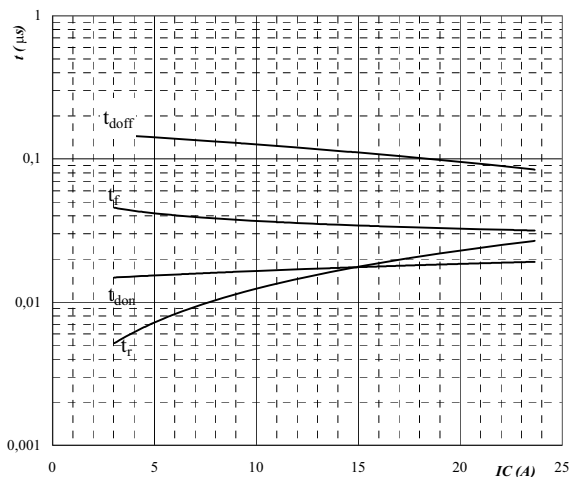
$$V_{GE} = 15 \text{ V}$$

$$I_C = 15 \text{ A}$$

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

Brake IGBT

$$t = f(I_C)$$



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

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

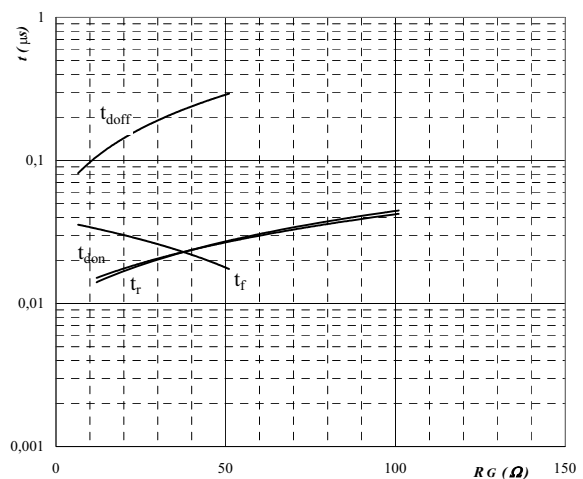
$$V_{GE} = 15 \text{ V}$$

$$R_{gon} = 2 \cdot R_{goff} = 23 \text{ Ohm}$$

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

Brake IGBT

$$t = f(R_G)$$



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

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

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

$$I_C = 15 \text{ A}$$

flowPIM® 1, 600V

Brake

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

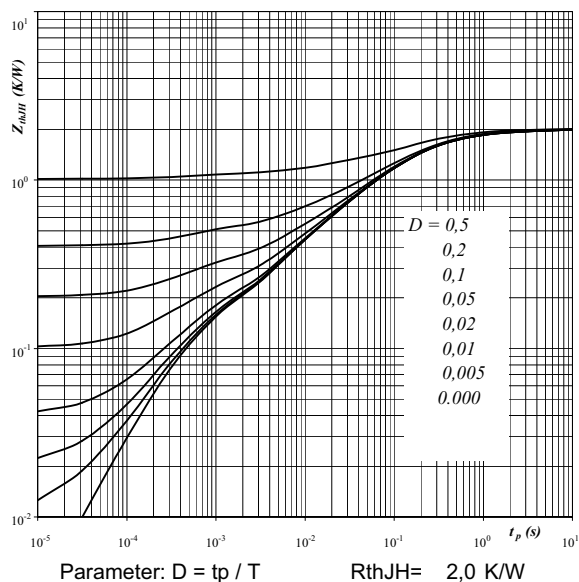


Figure 28. FRED transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$

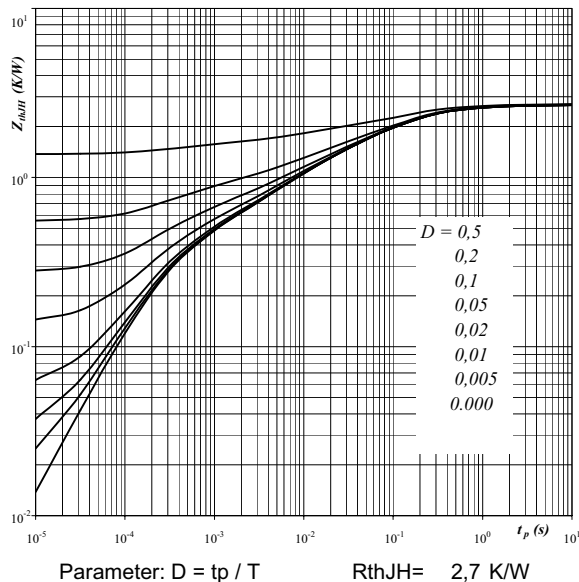


Figure 29. Power dissipation as a function of heatsink temperature
 Brake IGBT
 $P_{tot} = f(T_h)$

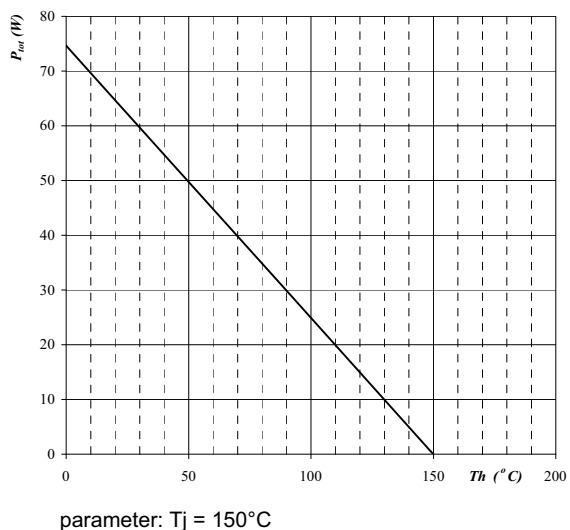
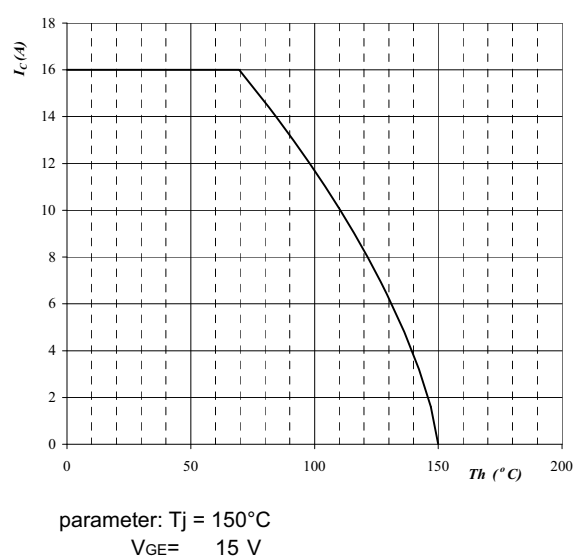


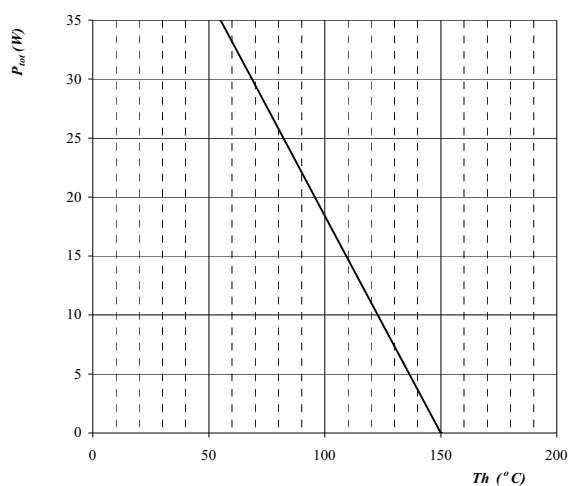
Figure 30. Collector current as a function of heatsink temperature
 Brake IGBT
 $I_c = f(T_h)$



flowPIM® 1, 600V

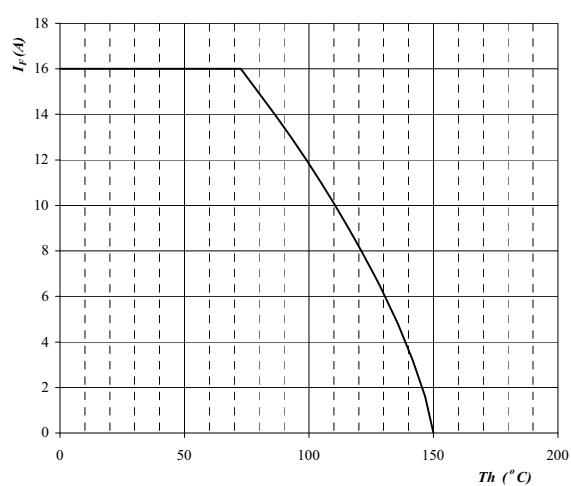
Brake

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 $I_F = f(V_F)$

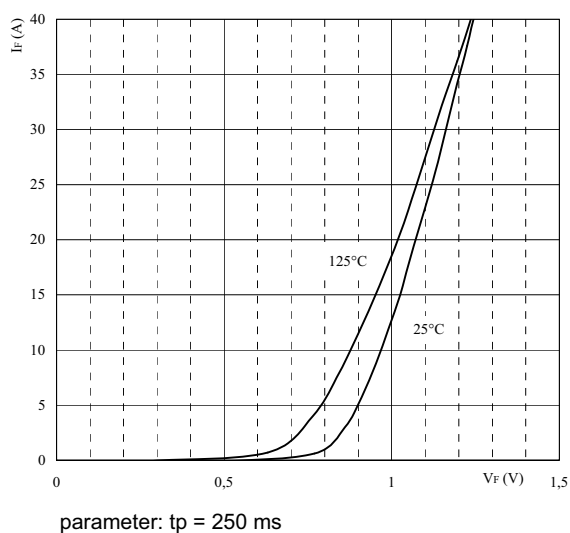


Figure 34. Diode transient thermal impedance as a function of pulse width
 $Z_{thJC} = f(t_p)$

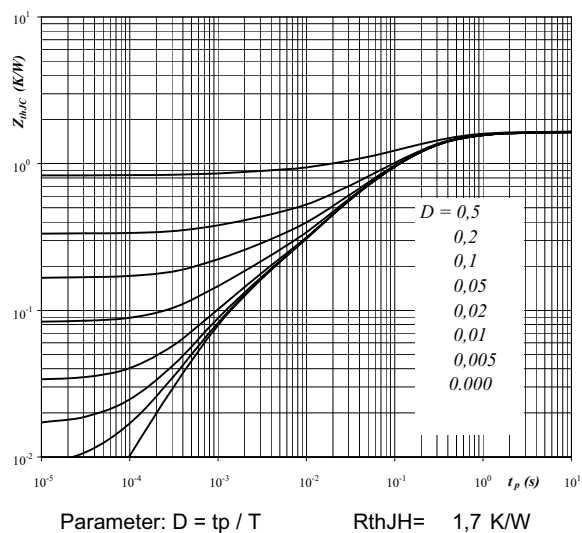


Figure 35. Power dissipation as a function of heatsink temperature
Rectifier diode $P_{tot} = f(T_h)$

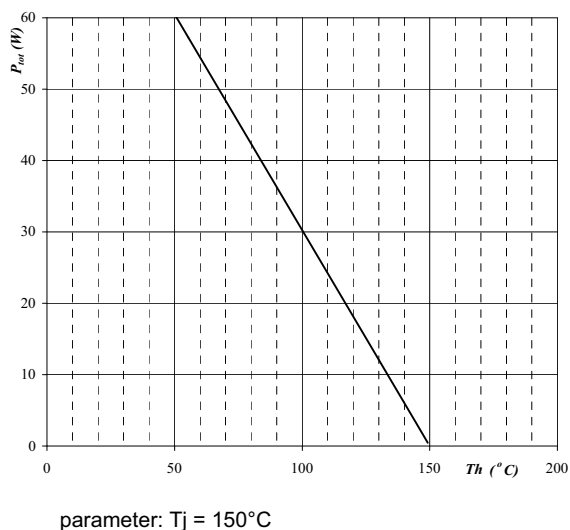
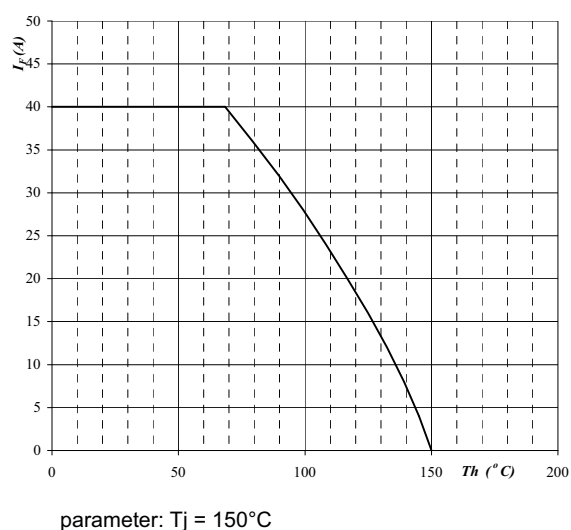


Figure 36. Forward current as a function of heatsink temperature
Rectifier diode $I_F = f(T_h)$



flowPIM® 1, 600V

Thermistor

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

$$R_T = f(T)$$

