



**flowPIM 1**

**1200 V / 25 A**

**Features**

- Power intelligent module with 3~ rectifier, optional BRC, Inverter
- IGBT4 technology for low conduction and switching losses
- Compact and low inductive design
- Built in NTC

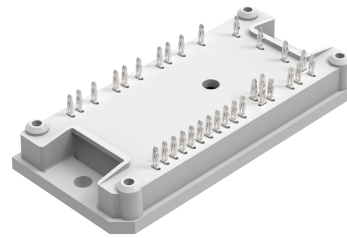
**Target applications**

- Embedded Drives

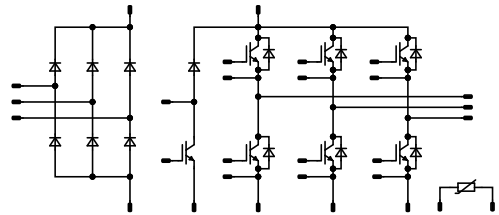
**Types**

- V23990-P589-A418Y-PM

**flow 1 12 mm housing**



**Schematic**





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## Maximum Ratings

$T_j = 25\text{ °C}$ , unless otherwise specified

Parameter	Symbol	Conditions	Value	Unit
<b>Inverter Switch</b>				
Collector-emitter voltage	$V_{CES}$		1200	V
Collector current (DC current)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	34	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	75	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	99	W
Gate-emitter voltage	$V_{GES}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 800\text{ V}$ $T_j = 150\text{ °C}$	10	$\mu\text{s}$
Maximum junction temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

<b>Inverter Diode</b>				
Peak repetitive reverse voltage	$V_{RRM}$		1200	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	29	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	50	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	60	W
Maximum junction temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

<b>Brake Switch</b>				
Collector-emitter voltage	$V_{CES}$		1200	V
Collector current (DC current)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	22	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	45	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	71	W
Gate-emitter voltage	$V_{GES}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 800\text{ V}$ $T_j = 150\text{ °C}$	10	$\mu\text{s}$
Maximum junction temperature	$T_{jmax}$		175	$^{\circ}\text{C}$



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## Maximum Ratings

$T_j = 25\text{ °C}$ , unless otherwise specified

Parameter	Symbol	Conditions	Value	Unit
<b>Brake Diode</b>				
Peak repetitive reverse voltage	$V_{RRM}$		1200	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	19	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	20	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	46	W
Maximum junction temperature	$T_{jmax}$		175	°C

## Rectifier Diode

Peak repetitive reverse voltage	$V_{RRM}$		1600	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	46	A
Surge (non-repetitive) forward current	$I_{FSM}$	Single Half Sine Wave, $t_p = 10\text{ ms}$ $T_j = 150\text{ °C}$	270	A
Surge current capability	$I^2t$		370	A <sup>2</sup> s
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	56	W
Maximum junction temperature	$T_{jmax}$		150	°C

## Module Properties

### Thermal Properties

Storage temperature	$T_{stg}$		-40...+125	°C
Operation temperature under switching condition	$T_{jop}$		-40...+( $T_{jmax} - 25$ )	°C

### Isolation Properties

Isolation voltage	$V_{isol}$	DC Test Voltage* $t_p = 2\text{ s}$	6000	V
Isolation voltage	$V_{isol}$	AC Voltage $t_p = 1\text{ min}$	2500	V
Creepage distance			>12,7	mm
Clearance			7,96	mm
Comparative Tracking Index	CTI		≥ 200	

\*100 % tested in production



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### Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
		$V_{GS}$ [V]	$V_{GE}$ [V]	$V_{DS}$ [V]	$I_D$ [A]	$I_F$ [A]	$T_j$ [°C]	Min	Typ	

#### Inverter Switch

##### Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00085	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		25	25 150	1,58	1,87 2,31	2,07 <sup>(1)</sup>	V
Collector-emitter cut-off current	$I_{CES}$		0	1200		25			2,4	μA
Gate-emitter leakage current	$I_{GES}$		20	0		25			120	nA
Internal gate resistance	$r_g$							None		Ω
Input capacitance	$C_{ies}$	$f = 1 \text{ Mhz}$	0	25		25		1450		pF
Reverse transfer capacitance	$C_{res}$							50		pF
Gate charge	$Q_g$		15		0	25		200		nC

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)						0,96		K/W
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##### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 32 \Omega$ $R_{goff} = 32 \Omega$	±15	600	25	25		126,2		ns
Rise time	$t_r$					150		126,4		ns
						25		21,4		ns
Turn-off delay time	$t_{d(off)}$					150		220,2		ns
						25		284		ns
Fall time	$t_f$					25		74,2		ns
						150		99,96		ns
Turn-on energy (per pulse)	$E_{on}$	$Q_{trFWD} = 2,5 \mu\text{C}$				25		1,64		mWs
		$Q_{trFWD} = 4,8 \mu\text{C}$				150		2,53		mWs
Turn-off energy (per pulse)	$E_{off}$					25		1,38		mWs
						150		2,17		mWs



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### Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
		$V_{GE}$ [V] $V_{GS}$ [V]	$V_{CE}$ [V] $V_{DS}$ [V] $V_F$ [V]	$I_C$ [A] $I_D$ [A] $I_F$ [A]	$T_j$ [°C]	Min	Typ	Max		

#### Inverter Diode

##### Static

Forward voltage	$V_F$				25	25 150	1,35	1,97 1,94	2,05 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_i = 1200$ V				25			5,2	μA

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,59		K/W
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##### Dynamic

Peak recovery current	$I_{RRM}$	$di/dt=1408$ A/μs $di/dt=1098$ A/μs	±15	600	25	25		32,16		A
						150		33,88		
Reverse recovery time	$t_{rr}$					25		265,26		
						150		435,54		
Recovered charge	$Q_r$					25		2,5		
						150		4,8		
Reverse recovered energy	$E_{rec}$	25		0,98						
		150		1,94						
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$	25		1722						
		150		579,94						



### Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
		$V_{GE}$ [V] $V_{GS}$ [V]	$V_{CE}$ [V] $V_{DS}$ [V] $V_F$ [V]	$I_C$ [A] $I_D$ [A] $I_F$ [A]	$T_j$ [°C]	Min	Typ	Max		

#### Brake Switch

##### Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0005	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		15	25 125	1,58	1,88 2,3	2,07 <sup>(1)</sup>	V
Collector-emitter cut-off current	$I_{CES}$		0	1200		25			2	μA
Gate-emitter leakage current	$I_{GES}$		20	0		25			120	nA
Internal gate resistance	$r_g$							None		Ω
Input capacitance	$C_{ies}$	$f = 1 \text{ Mhz}$	0	25		25		890		pF
Reverse transfer capacitance	$C_{res}$							30		pF
Gate charge	$Q_g$		20		0	25		120		nC

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)						1,35		K/W
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##### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 32 \Omega$ $R_{goff} = 32 \Omega$	$\pm 15$	600	15	25		86,8		ns
						125		86,6		
						150		88		
Rise time	$t_r$					25		24,2		
						125		27,8		
						150		28,6		
Turn-off delay time	$t_{d(off)}$					25		193,6		
		125		256						
		150		257,8						
Fall time	$t_f$	25		76,6						
		125		102,03						
		150		110,95						
Turn-on energy (per pulse)	$E_{on}$	$Q_{fwd} = 1,38 \mu\text{C}$ $Q_{fwd} = 2,27 \mu\text{C}$ $Q_{fwd} = 2,53 \mu\text{C}$				25		0,95		mWs
						125		1,29		
						150		1,38		
Turn-off energy (per pulse)	$E_{off}$					25		0,824		mWs
						125		1,17		
						150		1,27		



### Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
		$V_{GE}$ [V] $V_{GS}$ [V]	$V_{CE}$ [V] $V_{DS}$ [V] $V_F$ [V]	$I_C$ [A] $I_D$ [A] $I_F$ [A]	$T_j$ [°C]	Min	Typ	Max		

#### Brake Diode

##### Static

Forward voltage	$V_F$				10	25 150	1,35	1,85 1,77	2,05 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_i = 1200$ V				25			2,7	μA

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						2,07		K/W
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##### Dynamic

Peak recovery current	$I_{RRM}$	$di/dt=611$ A/μs $di/dt=482$ A/μs $di/dt=484$ A/μs	±15	600	15	25		10,02		A
Reverse recovery time	$t_{rr}$					125		11,64		
						150		12,03		
						25		323,77		
Recovered charge	$Q_r$					125		488,88		
						150		537,51		
		25		1,38						
Reverse recovered energy	$E_{rec}$	125		2,27						
		150		2,53						
		25		0,581						
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$	125		0,965						
		150		1,08						
		25		45,97						
						125		45,75		A/μs
						150		44,44		



### Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
		$V_{GE}$ [V] $V_{GS}$ [V]	$V_{CE}$ [V] $V_{DS}$ [V] $V_F$ [V]	$I_C$ [A] $I_D$ [A] $I_F$ [A]	$T_j$ [°C]	Min	Typ	Max		

#### Rectifier Diode

##### Static

Forward voltage	$V_F$				13	25 125		0,988 0,899	1,21 <sup>(1)</sup> 1,1 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_i = 1600$ V				25			50	μA

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,25		K/W
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#### Thermistor

##### Static

Rated resistance	$R$					25		22		kΩ
Deviation of $R_{100}$	$\Delta_{R/R}$	$R_{100} = 1486$ Ω				100	-12		14	%
Power dissipation	$P$							200		mW
Power dissipation constant	$d$					25		2		mW/K
B-value	$B_{(25/50)}$	Tol. ±3 %						3950		K
B-value	$B_{(25/100)}$	Tol. ±3 %						3998		K
Vincotech Thermistor Reference									B	

<sup>(1)</sup> Value at chip level

<sup>(2)</sup> Only valid with pre-applied Vincotech thermal interface material.



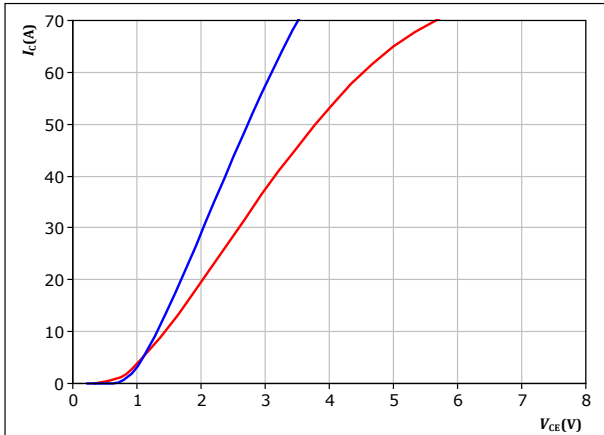


## Inverter Switch Characteristics

**figure 1.** IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

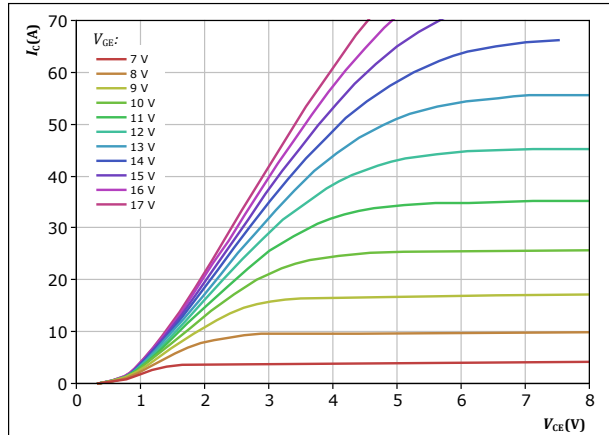


$t_p = 250 \mu s$   
 $V_{GE} = 15 V$   
 $T_j: 25^\circ C$  (blue),  $150^\circ C$  (red)

**figure 2.** IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

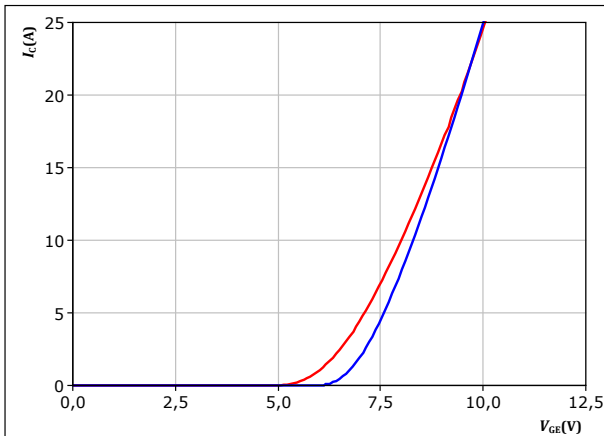


$t_p = 250 \mu s$   
 $T_j = 150^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

$$I_C = f(V_{GE})$$

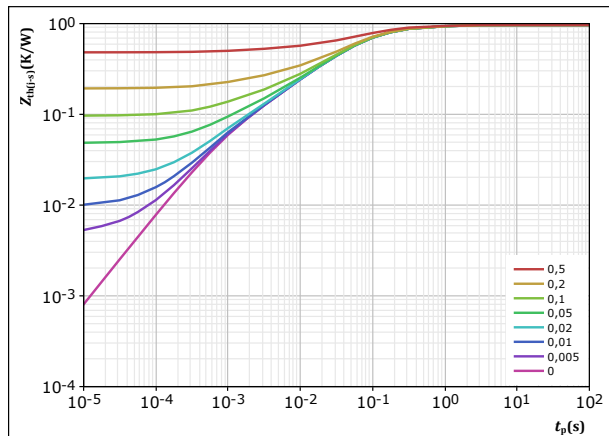


$t_p = 250 \mu s$   
 $V_{CE} = 10 V$   
 $T_j: 25^\circ C$  (blue),  $150^\circ C$  (red)

**figure 4.** IGBT

Transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



$D = t_p / T$   
 $R_{th(j-s)} = 0,964 K/W$   
IGBT thermal model values

R (K/W)	$\tau$ (s)
9,34E-02	8,35E-01
3,42E-01	1,19E-01
3,61E-01	4,14E-02
1,15E-01	7,70E-03
5,33E-02	9,80E-04

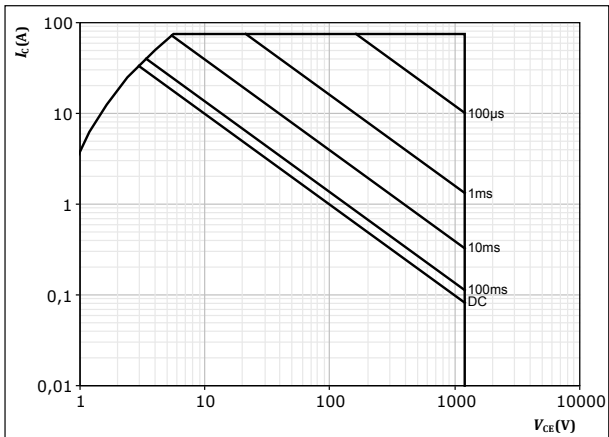


### Inverter Switch Characteristics

figure 5. IGBT

Safe operating area

$$I_C = f(V_{CE})$$



$D =$  single pulse  
 $T_s = 80 \text{ } ^\circ\text{C}$   
 $V_{GE} = 15 \text{ V}$   
 $T_j = T_{jmax}$

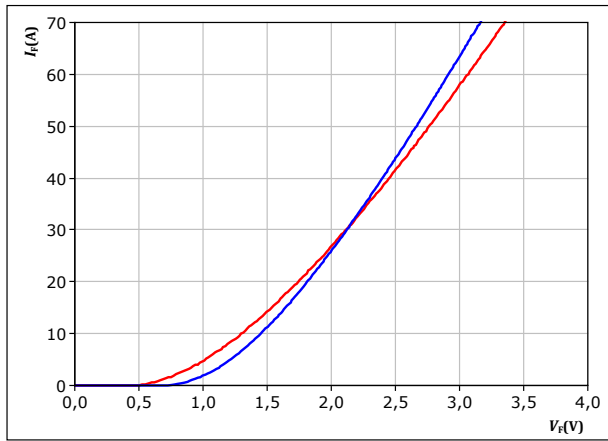


## Inverter Diode Characteristics

figure 6. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

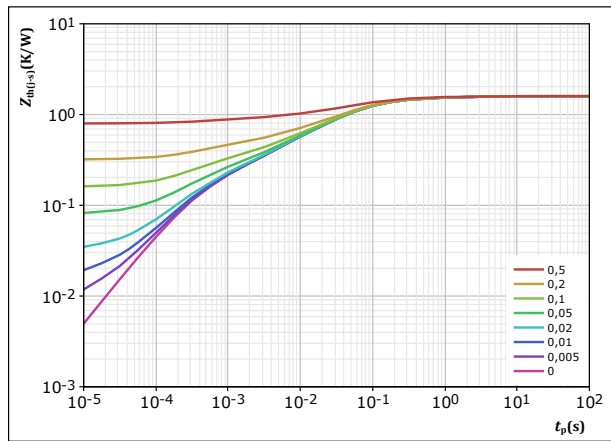


$t_p = 250 \mu s$   
 $T_j$ : — 25 °C  
 — 150 °C

figure 7. FWD

Transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



$D = t_p / T$   
 $R_{th(j-s)} = 1,594 \text{ K/W}$   
 FWD thermal model values

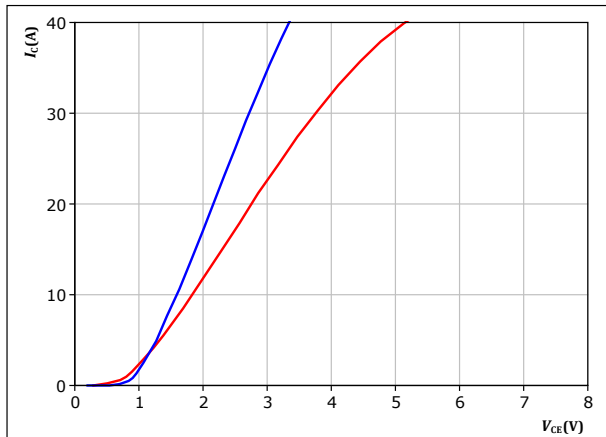
$R$ (K/W)	$\tau$ (s)
7,80E-02	2,61E+00
3,11E-01	2,04E-01
6,92E-01	4,64E-02
2,79E-01	8,74E-03
9,99E-02	1,79E-03
1,35E-01	3,39E-04



### Brake Switch Characteristics

**figure 8.** IGBT

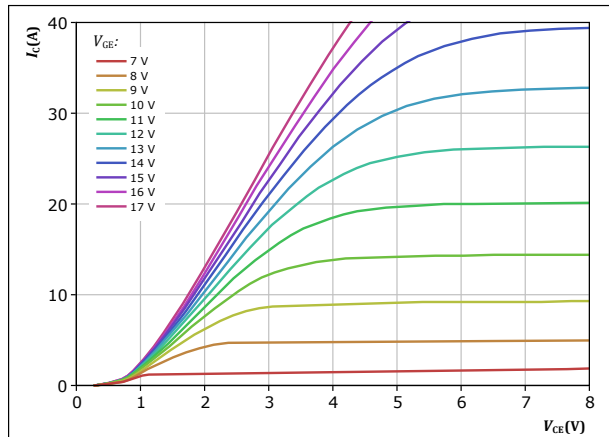
Typical output characteristics  
 $I_C = f(V_{CE})$



$t_p = 250 \mu s$   
 $V_{GE} = 15 V$   
 $T_j$ : — 25 °C  
— 125 °C

**figure 9.** IGBT

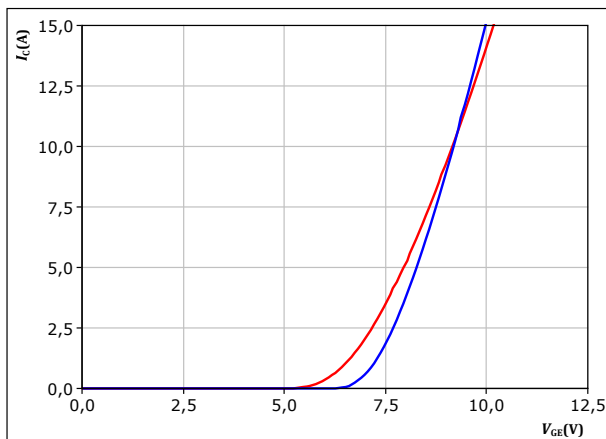
Typical output characteristics  
 $I_C = f(V_{CE})$



$t_p = 250 \mu s$   
 $T_j = 125 \text{ °C}$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 10.** IGBT

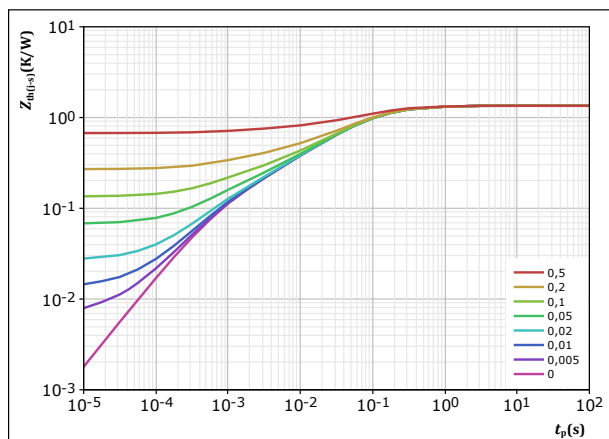
Typical transfer characteristics  
 $I_C = f(V_{GE})$



$t_p = 250 \mu s$   
 $V_{CE} = 10 V$   
 $T_j$ : — 25 °C  
— 125 °C

**figure 11.** IGBT

Transient thermal impedance as a function of pulse width  
 $Z_{th(j-s)} = f(t_p)$



$D = t_p / T$   
 $R_{th(j-s)} = 1,347 \text{ K/W}$

IGBT thermal model values

R (K/W)	$\tau$ (s)
1,62E-01	5,85E-01
6,34E-01	9,42E-02
2,82E-01	2,85E-02
1,64E-01	6,73E-03
8,75E-02	9,43E-04
1,75E-02	3,79E-04

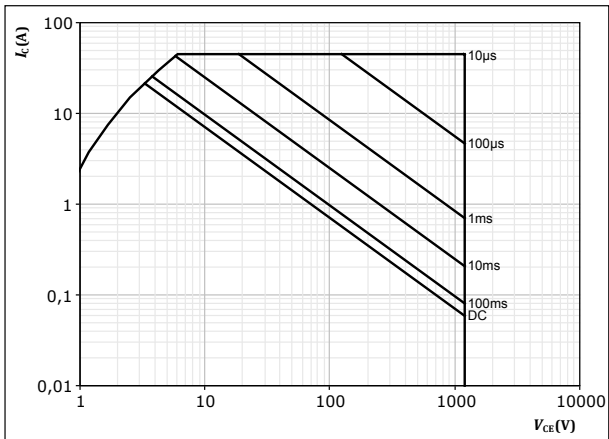


### Brake Switch Characteristics

figure 12. IGBT

Safe operating area

$$I_C = f(V_{CE})$$



$D =$  single pulse  
 $T_s = 80$  °C  
 $V_{GE} = 15$  V  
 $T_j = T_{jmax}$



### Brake Diode Characteristics

figure 13. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

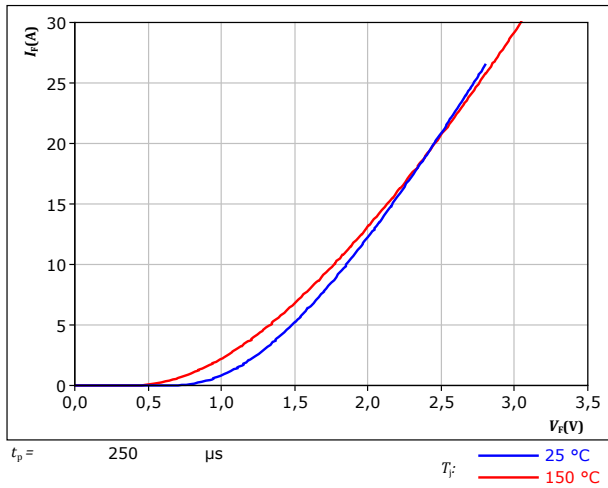
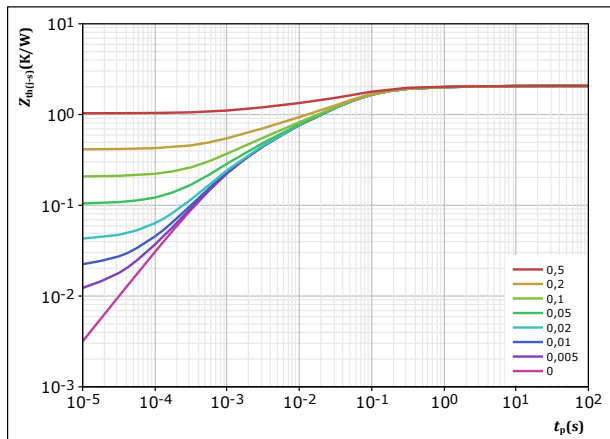


figure 14. FWD

Transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



$D = t_p / T$

$R_{th(j-s)} = 2,066 \text{ K/W}$

FWD thermal model values

$R \text{ (K/W)}$	$\tau \text{ (s)}$
5,09E-02	4,26E+00
1,55E-01	5,03E-01
7,75E-01	7,89E-02
5,33E-01	2,68E-02
3,54E-01	5,03E-03
1,97E-01	9,09E-04



## Rectifier Diode Characteristics

figure 15. Rectifier

Typical forward characteristics

$$I_F = f(V_F)$$

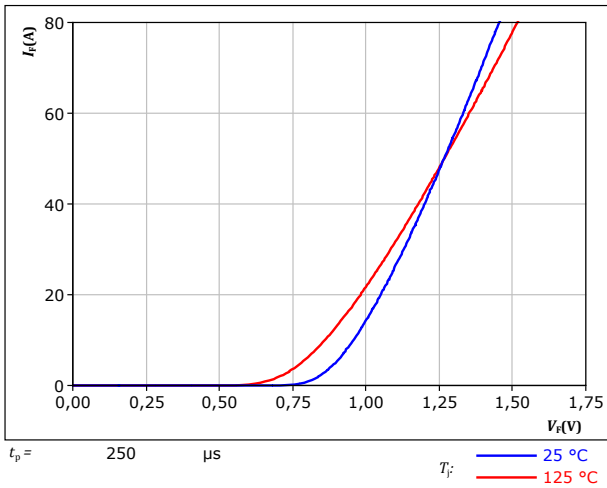
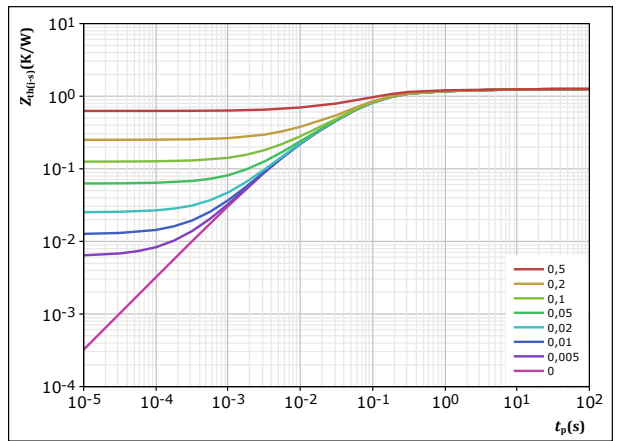


figure 16. Rectifier

Transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



$D = t_p / T$

$R_{th(j-s)} = 1,254 \text{ K/W}$

Rectifier thermal model values

$R \text{ (K/W)}$	$\tau \text{ (s)}$
8,00E-02	5,22E+00
1,56E-01	4,18E-01
6,95E-01	8,82E-02
2,23E-01	3,07E-02
9,97E-02	5,99E-03

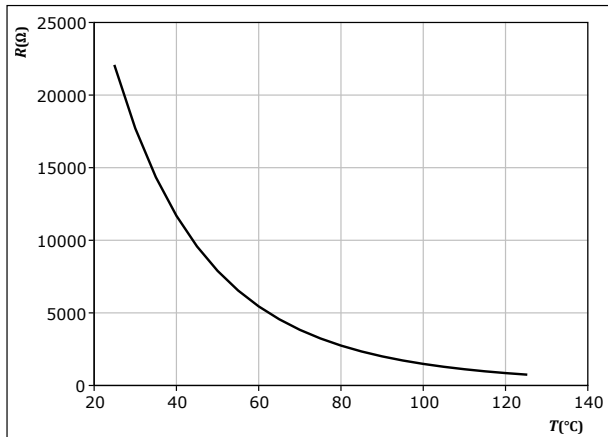


## Thermistor Characteristics

figure 17. Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$



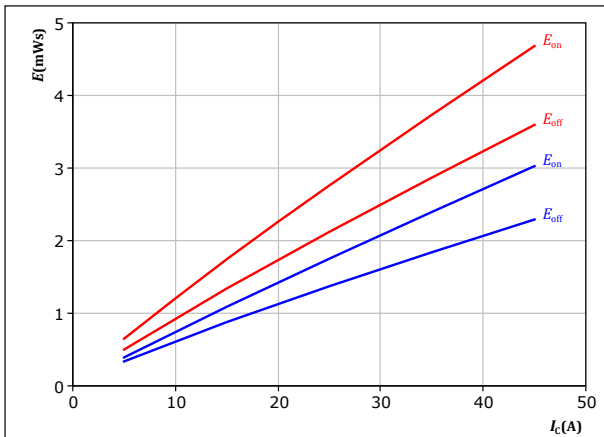




## Inverter Switching Characteristics

**figure 18.** IGBT

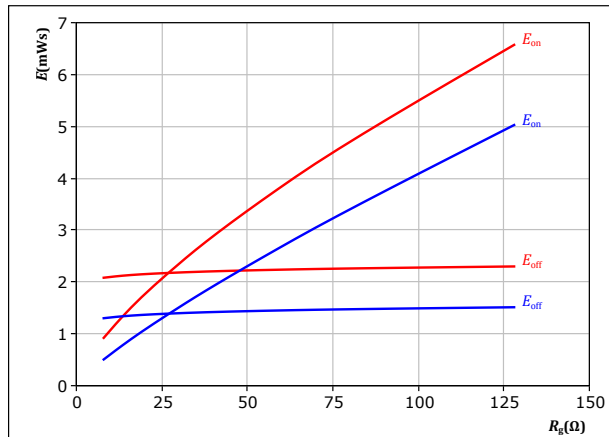
Typical switching energy losses as a function of collector current  
 $E = f(I_c)$



With an inductive load at  
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{g\text{on}} = 32 \text{ } \Omega$   
 $R_{g\text{off}} = 32 \text{ } \Omega$   
 $T_j$ : — 25 °C  
— 150 °C

**figure 19.** IGBT

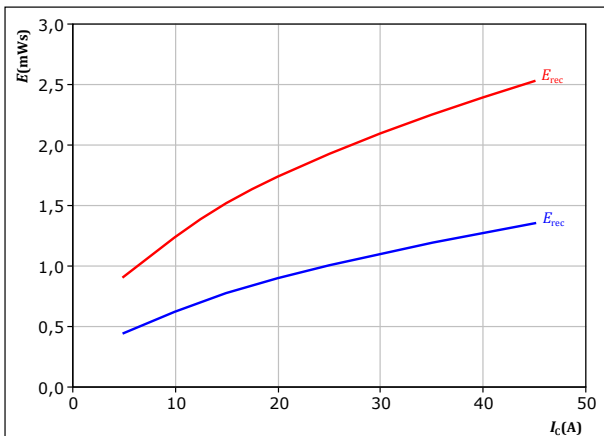
Typical switching energy losses as a function of gate resistor  
 $E = f(R_g)$



With an inductive load at  
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 25 \text{ A}$   
 $T_j$ : — 25 °C  
— 150 °C

**figure 20.** FWD

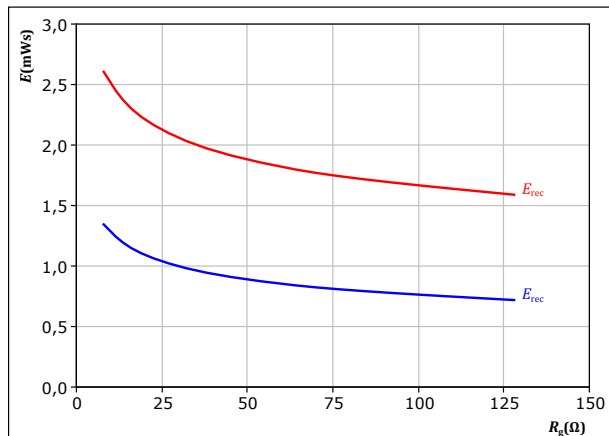
Typical reverse recovered energy loss as a function of collector current  
 $E_{rec} = f(I_c)$



With an inductive load at  
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{g\text{on}} = 32 \text{ } \Omega$   
 $T_j$ : — 25 °C  
— 150 °C

**figure 21.** FWD

Typical reverse recovered energy loss as a function of gate resistor  
 $E_{rec} = f(R_g)$



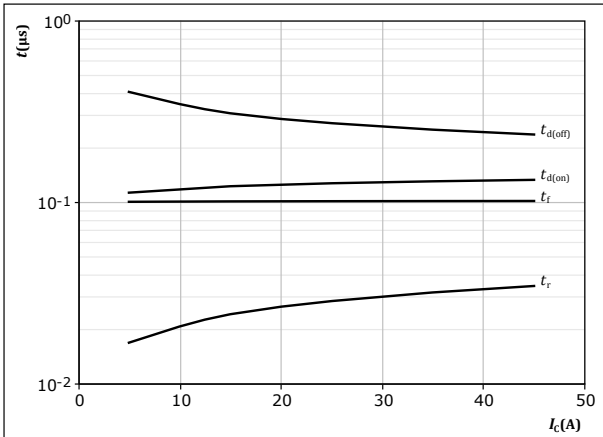
With an inductive load at  
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 25 \text{ A}$   
 $T_j$ : — 25 °C  
— 150 °C



## Inverter Switching Characteristics

**figure 22.** IGBT

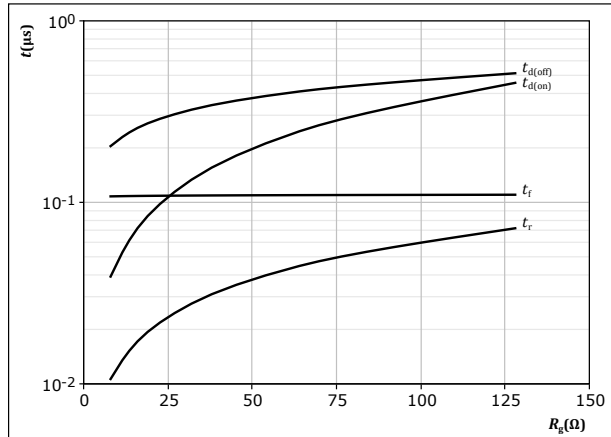
Typical switching times as a function of collector current  
 $t = f(I_c)$



With an inductive load at  
 $T_j = 150$  °C  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{g(on)} = 32$  Ω  
 $R_{g(off)} = 32$  Ω

**figure 23.** IGBT

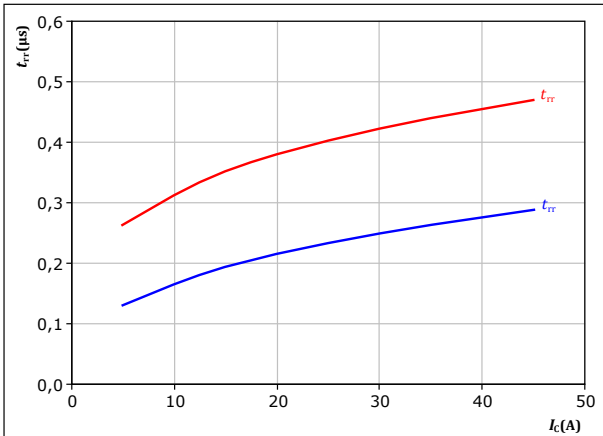
Typical switching times as a function of gate resistor  
 $t = f(R_g)$



With an inductive load at  
 $T_j = 150$  °C  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 25$  A

**figure 24.** FWD

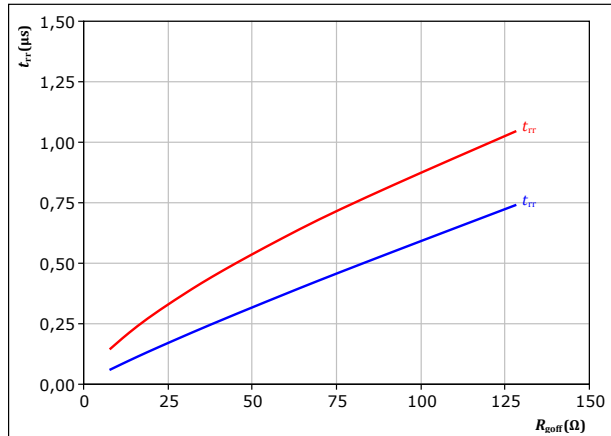
Typical reverse recovery time as a function of collector current  
 $t_{rr} = f(I_c)$



With an inductive load at  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{g(on)} = 32$  Ω  
 $T_j$ : — 25 °C  
— 150 °C

**figure 25.** FWD

Typical reverse recovery time as a function of IGBT turn off gate resistor  
 $t_{rr} = f(R_{g(off)})$



With an inductive load at  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 25$  A  
 $T_j$ : — 25 °C  
— 150 °C

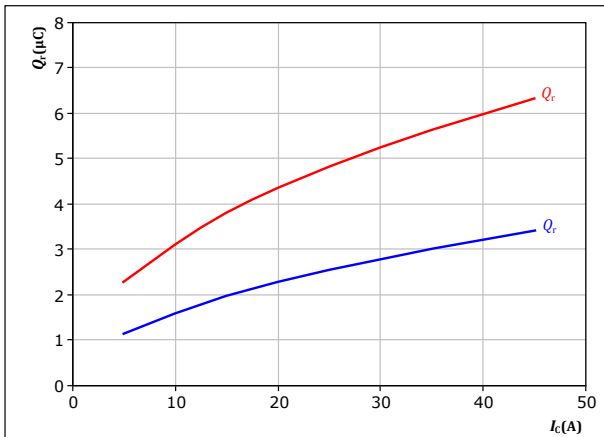


## Inverter Switching Characteristics

**figure 26.** FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

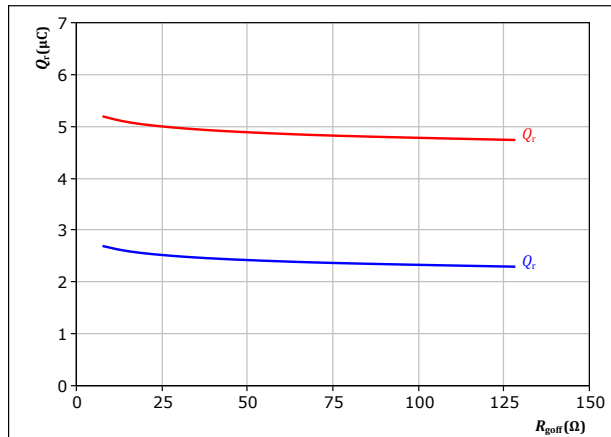
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{goff} = 32$  Ω

$T_j$ : — 25 °C  
— 150 °C

**figure 27.** FWD

Typical recovered charge as a function of turn off gate resistor

$$Q_r = f(R_{goff})$$



With an inductive load at

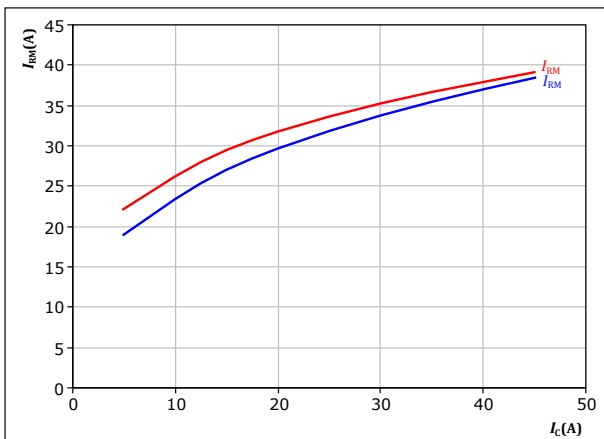
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 25$  A

$T_j$ : — 25 °C  
— 150 °C

**figure 28.** FWD

Typical peak reverse recovery current as a function of collector current

$$I_{RM} = f(I_c)$$



With an inductive load at

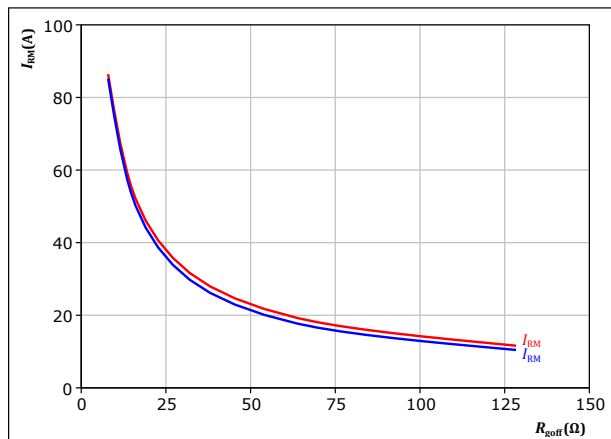
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{goff} = 32$  Ω

$T_j$ : — 25 °C  
— 150 °C

**figure 29.** FWD

Typical peak reverse recovery current as a function of turn off gate resistor

$$I_{RM} = f(R_{goff})$$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 25$  A

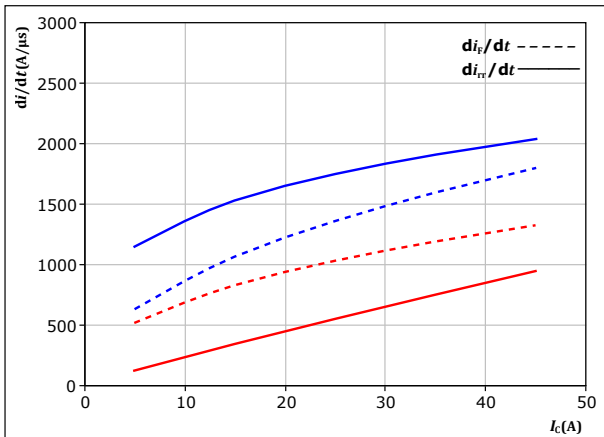
$T_j$ : — 25 °C  
— 150 °C



## Inverter Switching Characteristics

**figure 30.** FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_{rr}/dt = f(I_C)$



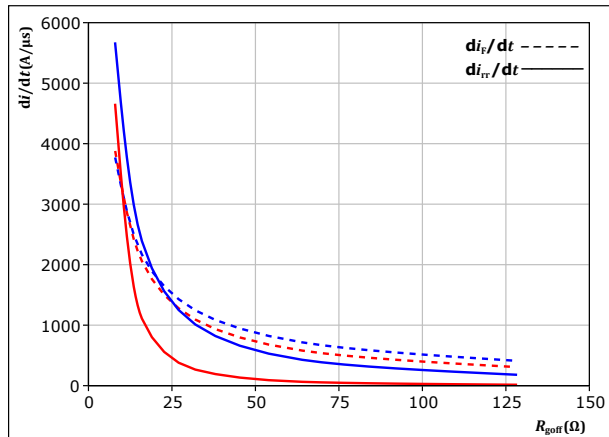
With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{goff} = 32 \ \Omega$

$T_j$ : — 25 °C  
 — 150 °C

**figure 31.** FWD

Typical rate of fall of forward and reverse recovery current as a function of turn off gate resistor  
 $di_f/dt, di_{rr}/dt = f(R_{goff})$



With an inductive load at

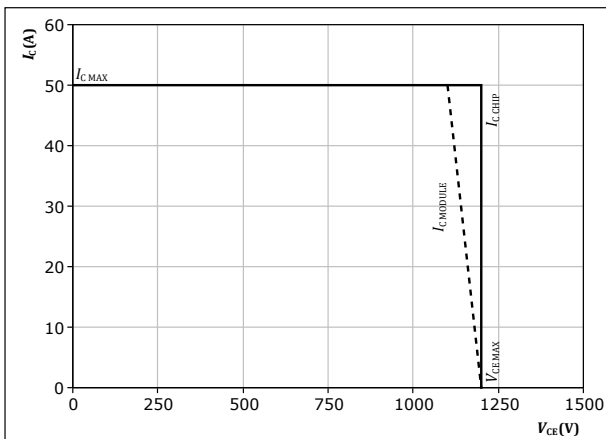
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 25 \text{ A}$

$T_j$ : — 25 °C  
 — 150 °C

**figure 32.** IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



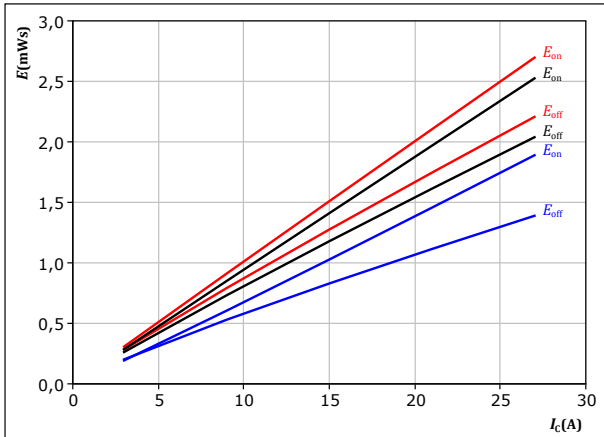
At  $T_j = 150 \text{ °C}$   
 $R_{goff} = 32 \ \Omega$   
 $R_{goff} = 32 \ \Omega$



## Brake Switching Characteristics

**figure 33.** IGBT

Typical switching energy losses as a function of collector current  
 $E = f(I_c)$



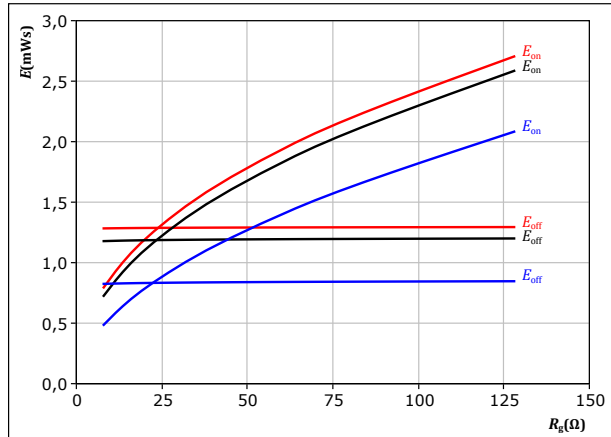
With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$   $\Omega$   
 $R_{goff} = 32$   $\Omega$

$T_j$ : — 25 °C  
 — 125 °C  
 — 150 °C

**figure 34.** IGBT

Typical switching energy losses as a function of gate resistor  
 $E = f(R_g)$



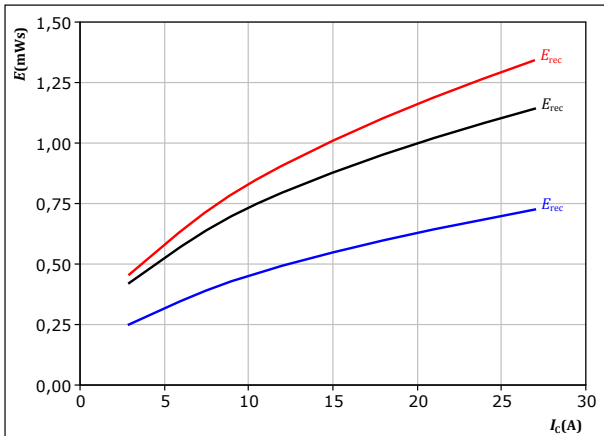
With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 15$  A

$T_j$ : — 25 °C  
 — 125 °C  
 — 150 °C

**figure 35.** FWD

Typical reverse recovered energy loss as a function of collector current  
 $E_{rec} = f(I_c)$



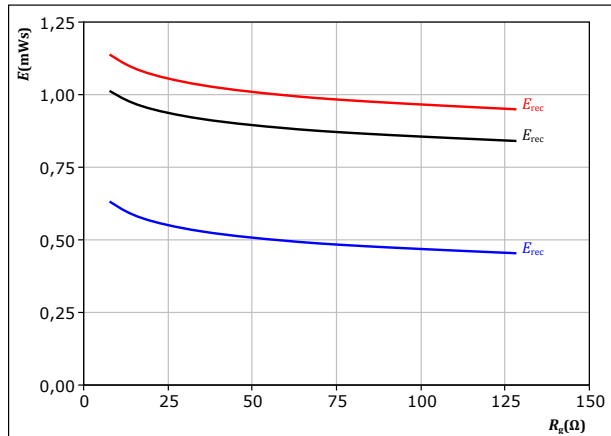
With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$   $\Omega$

$T_j$ : — 25 °C  
 — 125 °C  
 — 150 °C

**figure 36.** FWD

Typical reverse recovered energy loss as a function of gate resistor  
 $E_{rec} = f(R_g)$



With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 15$  A

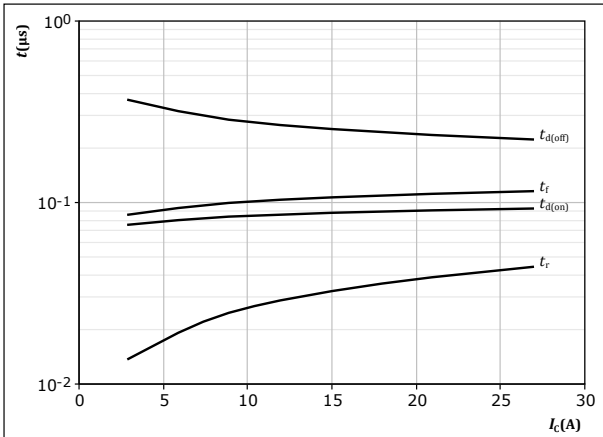
$T_j$ : — 25 °C  
 — 125 °C  
 — 150 °C



## Brake Switching Characteristics

**figure 37.** IGBT

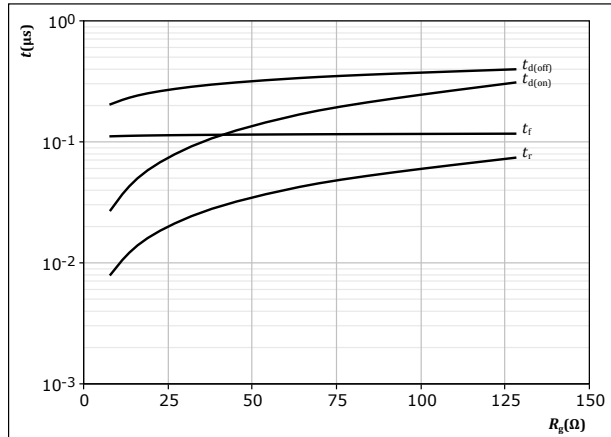
Typical switching times as a function of collector current  
 $t = f(I_c)$



With an inductive load at  
 $T_j = 150 \text{ }^\circ\text{C}$   
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{g(on)} = 32 \text{ } \Omega$   
 $R_{g(off)} = 32 \text{ } \Omega$

**figure 38.** IGBT

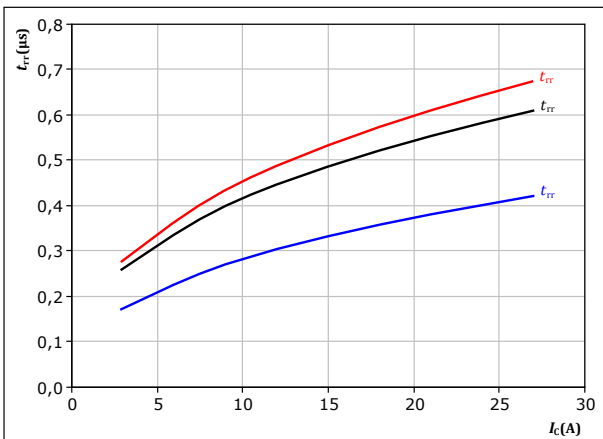
Typical switching times as a function of gate resistor  
 $t = f(R_g)$



With an inductive load at  
 $T_j = 150 \text{ }^\circ\text{C}$   
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 15 \text{ A}$

**figure 39.** FWD

Typical reverse recovery time as a function of collector current  
 $t_{rr} = f(I_c)$

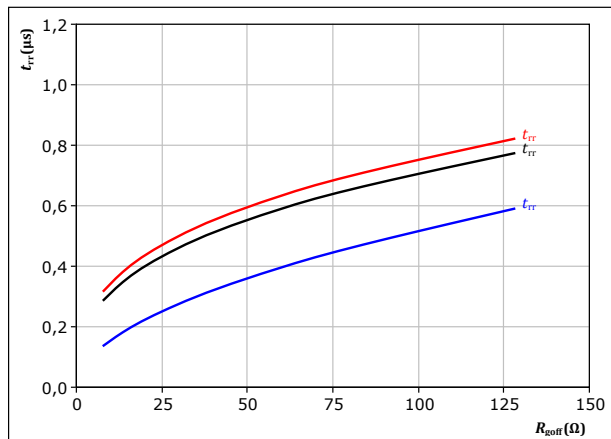


With an inductive load at  
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{g(on)} = 32 \text{ } \Omega$

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

**figure 40.** FWD

Typical reverse recovery time as a function of IGBT turn off gate resistor  
 $t_{rr} = f(R_{g(off)})$



With an inductive load at  
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 15 \text{ A}$

$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

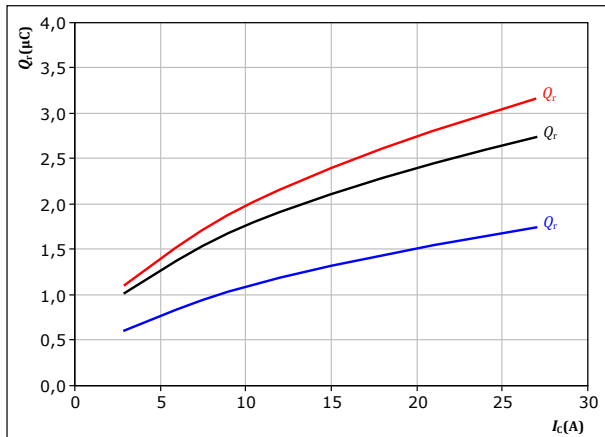


## Brake Switching Characteristics

figure 41. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



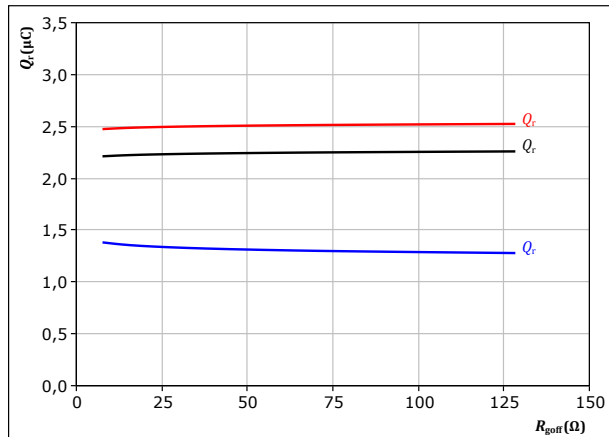
With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{goff} = 32$  Ω  
 $T_j$ : 25 °C (blue), 125 °C (black), 150 °C (red)

figure 42. FWD

Typical recovered charge as a function of turn off gate resistor

$$Q_r = f(R_{goff})$$



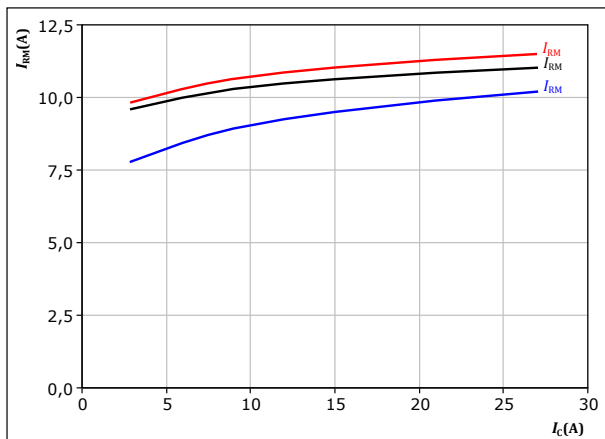
With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 15$  A  
 $T_j$ : 25 °C (blue), 125 °C (black), 150 °C (red)

figure 43. FWD

Typical peak reverse recovery current as a function of collector current

$$I_{RM} = f(I_c)$$



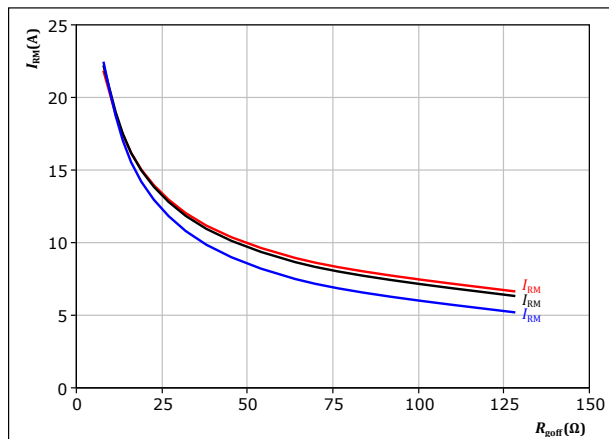
With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{goff} = 32$  Ω  
 $T_j$ : 25 °C (blue), 125 °C (black), 150 °C (red)

figure 44. FWD

Typical peak reverse recovery current as a function of turn off gate resistor

$$I_{RM} = f(R_{goff})$$



With an inductive load at

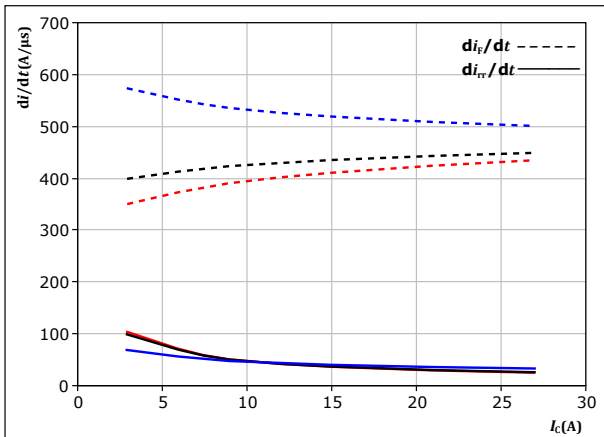
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 15$  A  
 $T_j$ : 25 °C (blue), 125 °C (black), 150 °C (red)



## Brake Switching Characteristics

**figure 45.** FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_r/dt = f(I_c)$



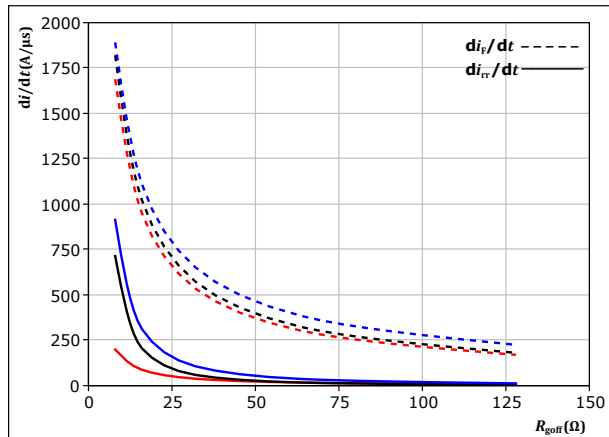
With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{goff} = 32 \ \Omega$

$T_j = 25 \text{ }^\circ\text{C}$   
 $125 \text{ }^\circ\text{C}$   
 $150 \text{ }^\circ\text{C}$

**figure 46.** FWD

Typical rate of fall of forward and reverse recovery current as a function of turn off gate resistor  
 $di_f/dt, di_r/dt = f(R_{goff})$



With an inductive load at

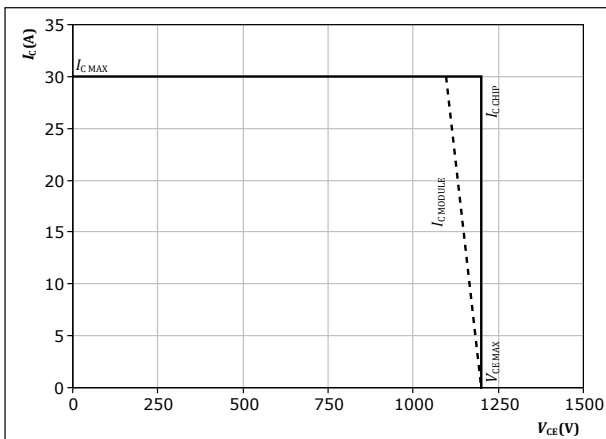
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 15 \text{ A}$

$T_j = 25 \text{ }^\circ\text{C}$   
 $125 \text{ }^\circ\text{C}$   
 $150 \text{ }^\circ\text{C}$

**figure 47.** IGBT

Reverse bias safe operating area

$I_c = f(V_{CE})$



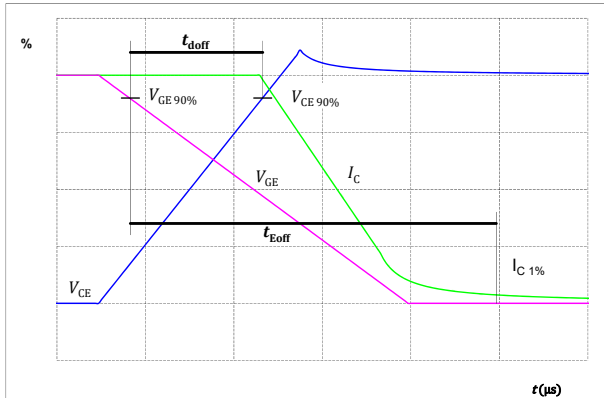
At  $T_j = 150 \text{ }^\circ\text{C}$   
 $R_{goff} = 32 \ \Omega$   
 $R_{goff} = 32 \ \Omega$



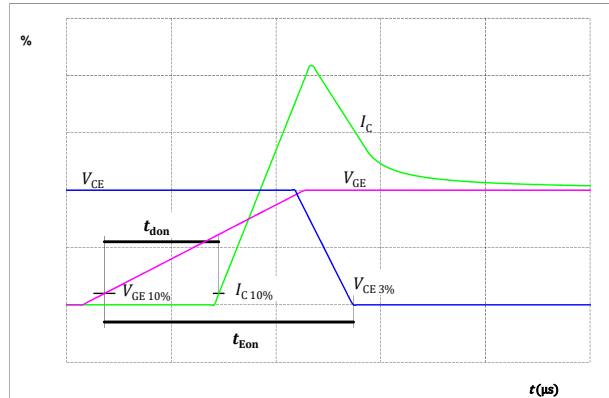


## Switching Definitions

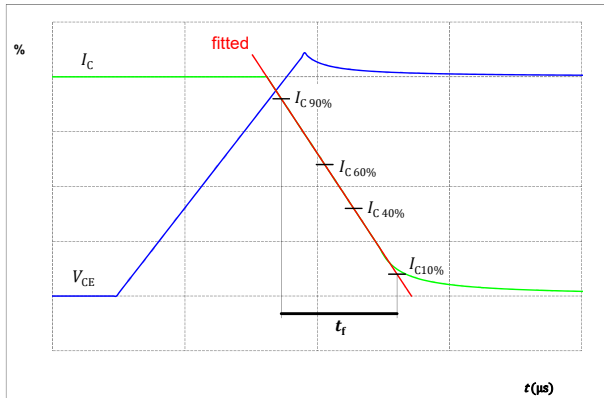
**figure 48.** IGBT  
Turn-off Switching Waveforms & definition of  $t_{doff}$ ,  $t_{Eoff}$  ( $t_{Eoff}$  = integrating time for  $E_{off}$ )



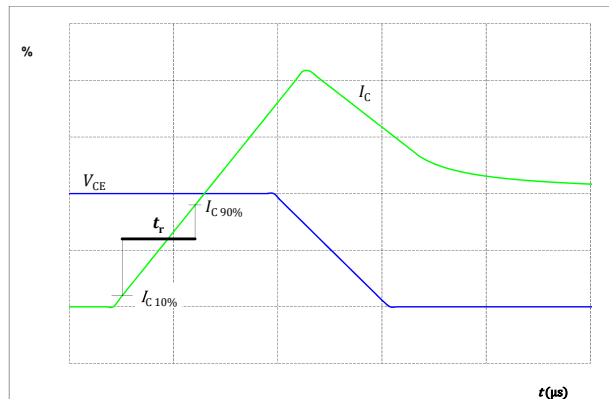
**figure 49.** IGBT  
Turn-on Switching Waveforms & definition of  $t_{don}$ ,  $t_{Eon}$  ( $t_{Eon}$  = integrating time for  $E_{on}$ )



**figure 50.** IGBT  
Turn-off Switching Waveforms & definition of  $t_f$



**figure 51.** IGBT  
Turn-on Switching Waveforms & definition of  $t_r$





### Switching Definitions

figure 52. FWD

Turn-off Switching Waveforms & definition of  $t_{rr}$

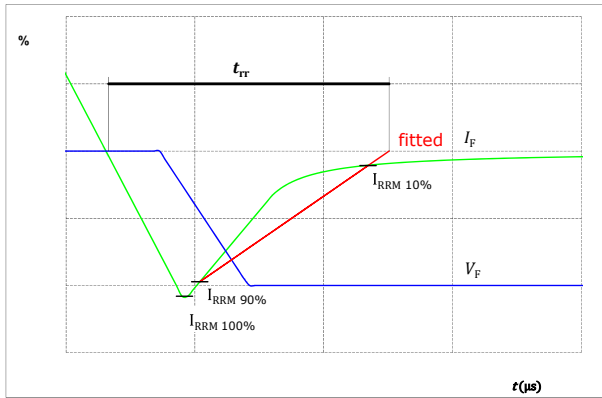
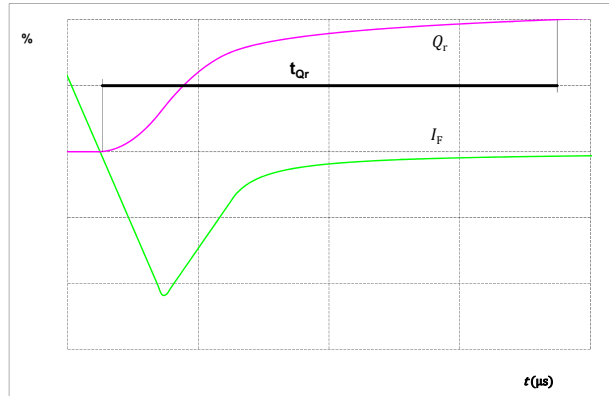


figure 53. FWD

Turn-on Switching Waveforms & definition of  $t_{Qr}$  ( $t_{Qr}$  = integrating time for  $Q_r$ )





Ordering Code	
<b>Version</b>	<b>Ordering Code</b>
Without thermal paste	V23990-P589-A418Y-PM
With thermal paste (5,2 W/mK, PTM6000HV)	V23990-P589-A418Y-/7/-PM
With thermal paste (3,4 W/mK, PSX-P7)	V23990-P589-A418Y-/3/-PM

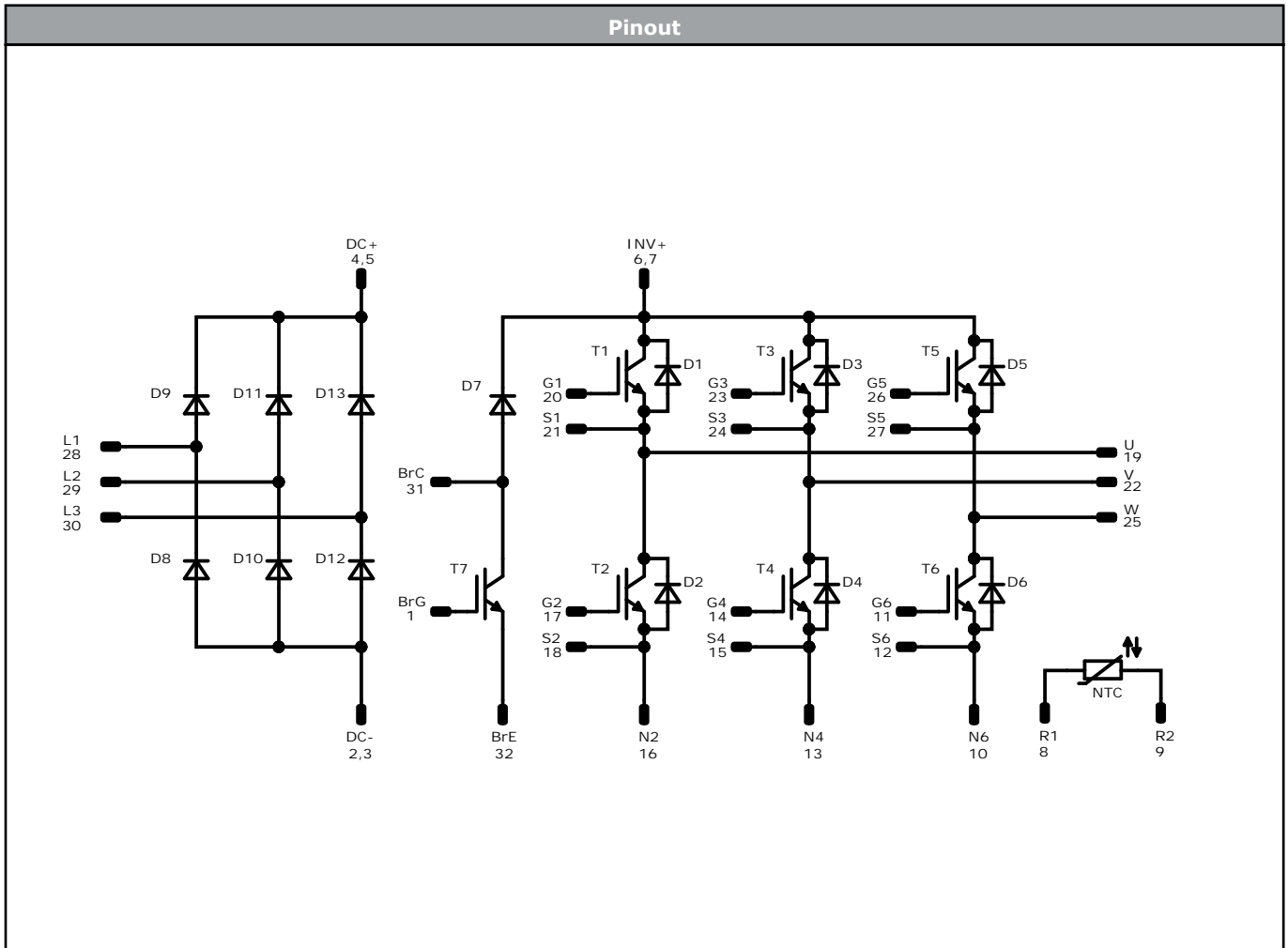
Marking							
	<b>Text</b>	<b>VIN</b>	<b>Date code</b>	<b>Type&amp;Ver</b>	<b>UL</b>	<b>Lot</b>	<b>Serial</b>
		VIN	WWYY	TTTTTUVV	UL	LLLLL	SSSS
	<b>Datamatrix</b>	<b>Type&amp;Ver</b>	<b>Lot number</b>	<b>Serial</b>	<b>Date code</b>		
		TTTTTUVV	LLLLL	SSSS	WWYY		

Pin table [mm]			
Pin	X	Y	Function
1	52,55	0	BrG
2	47,7	0	DC-
3	44,8	0	DC-
4	37,8	0	DC-
5	37,8	2,8	DC+
6	35	0	Inv+
7	35	2,8	Inv+
8	28	0	R1
9	25,2	0	R2
10	22,4	0	N6
11	19,6	0	G6
12	16,8	0	S6
13	14	0	N4
14	11,2	0	G4
15	8,4	0	S4
16	5,6	0	N2
17	2,8	0	G2
18	0	0	S2
19	0	28,5	U
20	2,8	28,5	G1
21	7,5	28,5	S1
22	14,5	28,5	V
23	17,3	28,5	G3
24	22	28,5	S3
25	29	28,5	W
26	31,8	28,5	G5
27	36,5	28,5	S5
28	43,5	28,5	L1
29	52,55	25	L2
30	52,55	16,9	L3
31	52,55	8,6	BrC
32	52,55	2,8	BrE

Tolerance of pinpositions: ±0,5mm at the end of pins  
Dimension of coordinate axis is only offset without tolerance



Vincotech



Identification					
ID	Component	Voltage	Current	Function	Comment
T2, T1, T4, T3, T6, T5	IGBT	1200 V	25 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	1200 V	25 A	Inverter Diode	
T7	IGBT	1200 V	15 A	Brake Switch	
D7	FWD	1200 V	10 A	Brake Diode	
D8, D9, D10, D11, D12, D13	Rectifier	1600 V	35 A	Rectifier Diode	
NTC	Thermistor			Thermistor	




Packaging instruction				
Standard packaging quantity (SPQ) 100	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for <i>flow 1</i> packages see vincotech.com website.

Package data
Package data for <i>flow 1</i> packages see vincotech.com website.

Vincotech thermistor reference
See Vincotech thermistor reference table at vincotech.com website.

UL recognition and file number
This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website. 

Document No.:	Date:	Modification:	Pages
V23990-P589-A418Y-PM-D6-14	22 Sep. 2021	Maximum ratings of Rectifier is updated Clearance is updated Rectifier and Inverter Switch characteristic values are updated The thermal characteristic of Inverter Switch is updated The thermistor characteristics are updated Separated datasheet New datasheet format module is unchanged	

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.