



flowPIM 1

1200 V / 25 A

Topology features

- Kelvin Emitter for improved switching performance
- Open Emitter configuration
- Temperature sensor
- Converter+Brake+Inverter
- Tandem diode

Component features

- Easy paralleling
- Low turn-off losses
- Low collector emitter saturation voltage
- Positive temperature coefficient
- Short tail current
- Switching optimized for EMC

Housing features

- Base isolation: Al<sub>2</sub>O<sub>3</sub>
- Convex shaped substrate for superior thermal contact
- Thermo-mechanical push-and-pull force relief
- Solder pin

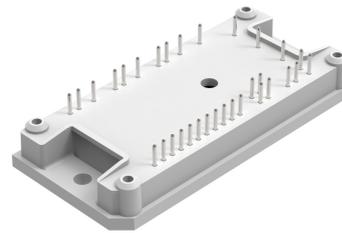
Target applications

- Embedded Drives
- HVAC
- Industrial Drives

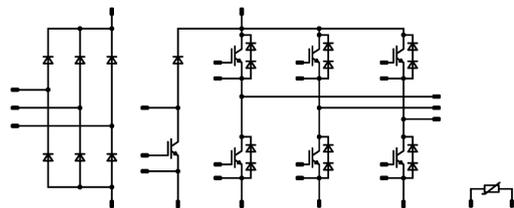
Types

- 10-FY12PMA025M702-P589A71

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)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	32	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	50	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	72	W
Gate-emitter voltage	$V_{GES}$		±20	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 800\text{ V}$ $T_j = 150\text{ °C}$	9,5	µs
Maximum junction temperature	$T_{jmax}$		175	°C

## Inverter Diode

Peak repetitive reverse voltage	$V_{RRM}$		1300	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	31	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	89	W
Maximum junction temperature	$T_{jmax}$		175	°C

## Brake Switch

Collector-emitter voltage	$V_{CES}$		1200	V
Collector current (DC current)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	32	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	50	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	72	W
Gate-emitter voltage	$V_{GES}$		±20	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 800\text{ V}$ $T_j = 150\text{ °C}$	9,5	µs
Maximum junction temperature	$T_{jmax}$		175	°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)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	21	A
Repetitive peak forward current	$I_{FRM}$	$I_p$ limited by $T_{jmax}$	30	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	42	W
Maximum junction temperature	$T_{jmax}$		175	°C

## Rectifier Diode

Peak repetitive reverse voltage	$V_{RRM}$		1600	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	47	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	$I^2t$		365	A <sup>2</sup> s
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	58	W
Maximum junction temperature	$T_{jmax}$		175	°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
Creepage distance			>12,7	mm
Clearance			7,91	mm
Comparative Tracking Index	CTI		≥ 200	

\*100 % tested in production



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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 Switch

##### Static

Gate-emitter threshold voltage	$V_{GE(th)}$		10	0,0025	25	5,4	6	6,6	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	15		25	25 125 150		1,64 1,89 1,95	2,1 <sup>(1)</sup>	V
Collector-emitter cut-off current	$I_{CES}$	0	1200		25			70	μA
Gate-emitter leakage current	$I_{GES}$	20	0		25			200	nA
Internal gate resistance	$r_g$						None		Ω
Input capacitance	$C_{ies}$						4800		pF
Output capacitance	$C_{oes}$	0	10		25		170		pF
Reverse transfer capacitance	$C_{res}$						57		pF
Gate charge	$Q_g$	$V_{CC} = 600$ V	0/15		25	25	180		nC

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 5,2$ W/mK (PTM)					1,31		K/W
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##### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 8$ Ω $R_{goff} = 8$ Ω	±15	600	25	25	85,39		ns
						125	84,87		
						150	84,54		
Rise time	$t_r$					25	13,77		
						125	15,96		
						150	16,88		
Turn-off delay time	$t_{d(off)}$					25	142,74		
						125	171,43		
		150	177,73						
Fall time	$t_f$	25	108,39						
		125	144,53						
		150	153,01						
Turn-on energy (per pulse)	$E_{on}$	$Q_{tFWD} = 0,653$ μC	25	0,689				mWs	
		$Q_{tFWD} = 1,39$ μC	125	1,17					
		$Q_{tFWD} = 1,62$ μC	150	1,34					
Turn-off energy (per pulse)	$E_{off}$		25	1,81				mWs	
			125	2,57					
			150	2,78					



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datasheet

### 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		
<b>Inverter Diode</b>										
<b>Static</b>										
Forward voltage	$V_F$			30	25 125 150		3,19 3,01 2,93	3,84 <sup>(1)</sup>		V
Reverse leakage current	$I_R$	$V_r = 1300$ V			25			1,6		μA
<b>Thermal</b>										
Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 5,2$ W/mK (PTM)					1,07			K/W
<b>Dynamic</b>										
Peak recovery current	$I_{RM}$	$di/dt=2359$ A/μs $di/dt=2128$ A/μs $di/dt=1760$ A/μs	±15	600	25	25		27		A
Reverse recovery time	$t_{rr}$					125		29,47		
						150		30,18		
						25		65,45		
Recovered charge	$Q_r$					125		116,32		
						150		132,65		
		25		0,653						
Reverse recovered energy	$E_{rec}$	125		1,39						
		150		1,62						
		25		0,235						
Peak rate of fall of recovery current	$(di_r/dt)_{max}$	125		0,489						
		150		0,571						
		25		1984,05						
						125		573,8		A/μs
						150		526,72		



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datasheet

### 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	$V_{GE(th)}$			10	0,0025	25	5,4	6	6,6	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		25	25 125 150		1,64 1,89 1,95	2,1 <sup>(1)</sup>	V
Collector-emitter cut-off current	$I_{CES}$		0	1200		25			70	μA
Gate-emitter leakage current	$I_{GES}$		20	0		25			200	nA
Internal gate resistance	$r_g$							None		Ω
Input capacitance	$C_{ies}$							4800		pF
Output capacitance	$C_{oes}$		0	10		25		170		pF
Reverse transfer capacitance	$C_{res}$							57		pF
Gate charge	$Q_g$	$V_{CC} = 600$ V	0/15		25	25		180		nC

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 5,2$ W/mK (PTM)						1,31		K/W
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##### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 16$ Ω $R_{goff} = 16$ Ω	0/15	700	25	25		70,6		ns			
						125		66,6					
						150		65					
Rise time	$t_r$								25		47,6		ns
									125		50,4		
									150		51,4		
Turn-off delay time	$t_{d(off)}$								25		262,2		ns
					125		290						
					150		296						
Fall time	$t_f$				25		101,1		ns				
					125		117,29						
					150		119,12						
Turn-on energy (per pulse)	$E_{on}$	$Q_{tFWD} = 1,92$ μC $Q_{tFWD} = 2,9$ μC $Q_{tFWD} = 3,15$ μC				25		2,6		mWs			
						125		3,11					
						150		3,24					
Turn-off energy (per pulse)	$E_{off}$					25		2,03		mWs			
						125		2,65					
						150		2,81					



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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		
<b>Brake Diode</b>										
<b>Static</b>										
Forward voltage	$V_F$			15	25 125 150		1,63 1,74 1,73	1,9 <sup>(1)</sup>		V
Reverse leakage current	$I_R$	$V_r = 1200$ V			25			30		μA
<b>Thermal</b>										
Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 5,2$ W/mK (PTM)					2,25			K/W
<b>Dynamic</b>										
Peak recovery current	$I_{RM}$	$di/dt=394$ A/μs $di/dt=319$ A/μs $di/dt=403$ A/μs	0/15	700	25	25		13,75		A
Reverse recovery time	$t_{rr}$					125		15,17		
						150		15,47		
						25		263,52		
Recovered charge	$Q_r$					125		374,58		
						150		413,14		
		25		1,92						
Reverse recovered energy	$E_{rec}$	125		2,9						
		150		3,15						
		25		0,778						
Peak rate of fall of recovery current	$(di_r/dt)_{max}$	125		1,28						
		150		1,41						
		25		111,02						
							85		A/μs	
							72,04			



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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		

#### Rectifier Diode

##### Static

Forward voltage	$V_F$				28	25 125 150		1,13 1,07 1,06	1,5 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_r = 1600$ V				25 150			50 1000	μA

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 5,2$ W/mK (PTM)						1,63		K/W
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#### Thermistor

##### Static

Rated resistance	$R$					25		22		kΩ
Deviation of R100	$\Delta_{R/R}$	$R_{100} = 1484$ Ω				100	-5		5	%
Power dissipation	$P$					25		130		mW
Power dissipation constant	$d$					25		1,5		mW/K
B-value	$B_{(25/50)}$	Tol. ±1 %						3962		K
B-value	$B_{(25/100)}$	Tol. ±1 %						4000		K
Vincotech Thermistor Reference									I	

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

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

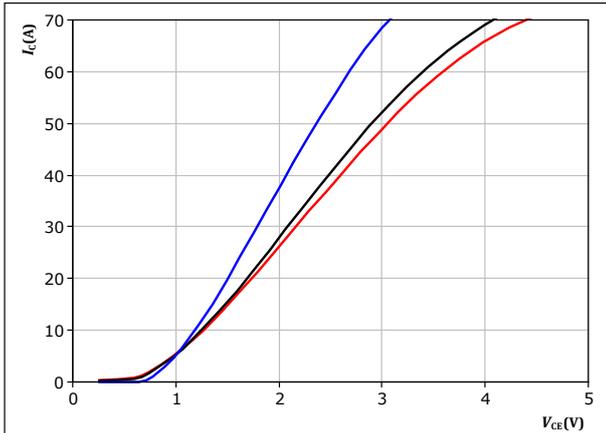


## Inverter Switch Characteristics

**figure 1.** IGBT

Typical output characteristics

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



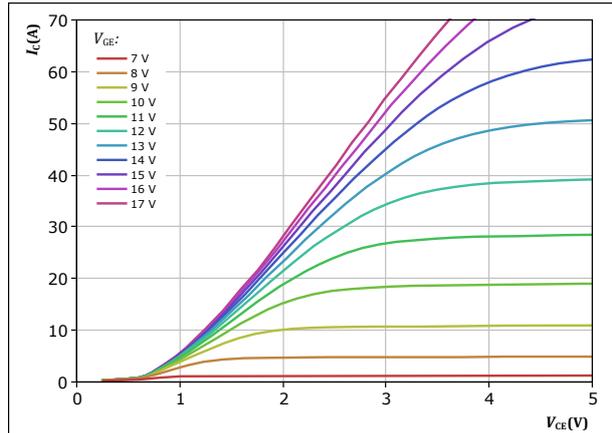
$t_p = 250 \mu s$   
 $V_{GE} = 15 V$

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

**figure 2.** IGBT

Typical output characteristics

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

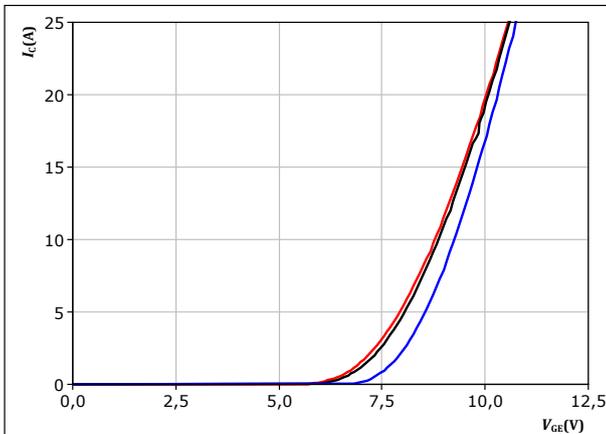


$t_p = 250 \mu s$   
 $T_j = 150 \text{ °C}$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

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



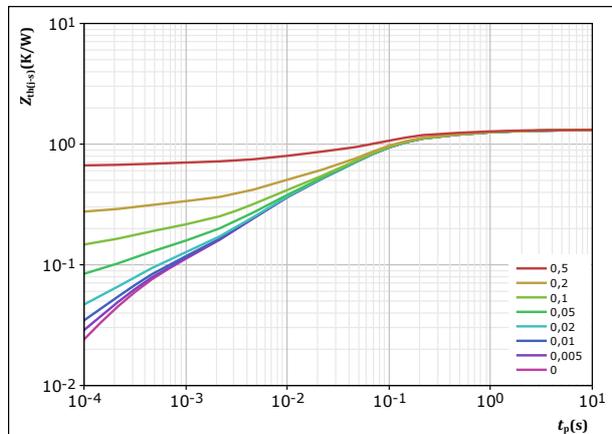
$t_p = 250 \mu s$   
 $V_{CE} = 10 V$

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

**figure 4.** IGBT

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,314 K/W$

IGBT thermal model values

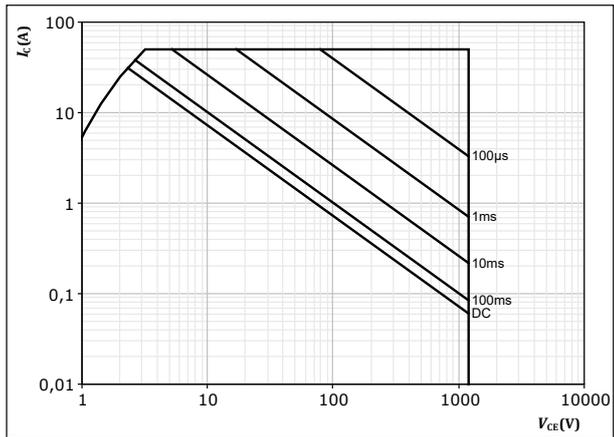
R (K/W)	$\tau$ (s)
4,80E-02	4,95E+00
2,14E-01	4,62E-01
7,66E-01	6,41E-02
2,24E-01	6,11E-03
6,85E-02	3,04E-04



## Inverter Switch Characteristics

figure 5. IGBT

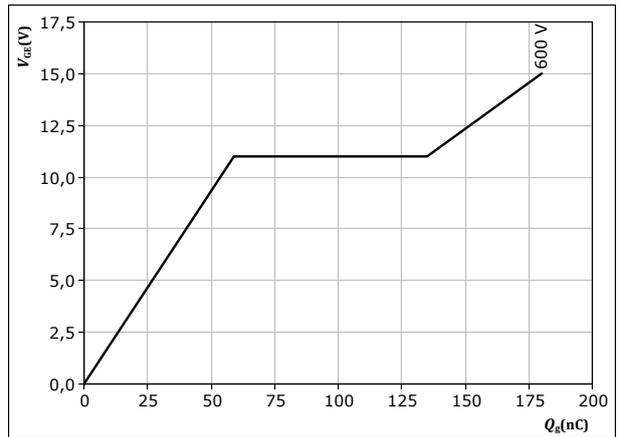
Safe operating area  
 $I_C = f(V_{CE})$



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

figure 6. IGBT

Gate voltage vs gate charge  
 $V_{GE} = f(Q_g)$



$I_C = 25 \text{ A}$   
 $T_j = 25 \text{ } ^\circ\text{C}$



### Inverter Diode Characteristics

figure 7. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

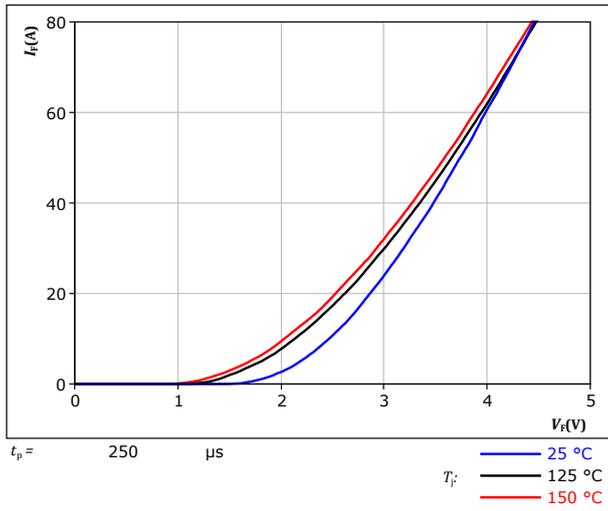
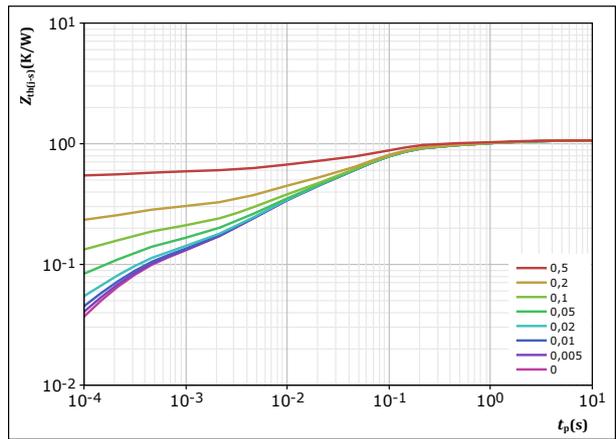


figure 8. FWD

Transient thermal impedance as a function of pulse width

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



$D =$	$t_p / T$	
$R_{th(j-s)} =$	1,066	K/W
FWD thermal model values		
$R$ (K/W)	$\tau$ (s)	
2,57E-02	6,85E+00	
1,35E-01	7,68E-01	
6,16E-01	6,78E-02	
2,02E-01	6,16E-03	
9,26E-02	2,29E-04	

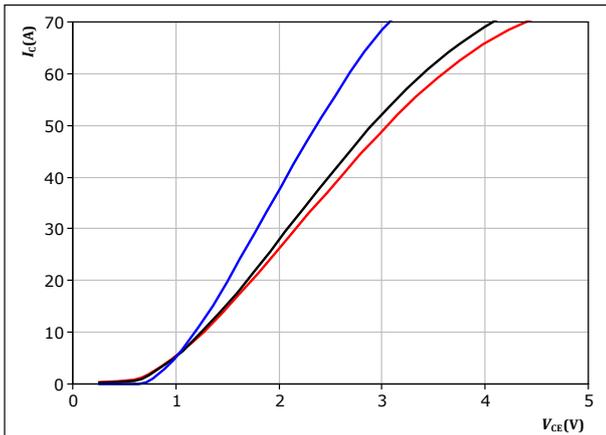


## Brake Switch Characteristics

figure 9. IGBT

Typical output characteristics

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



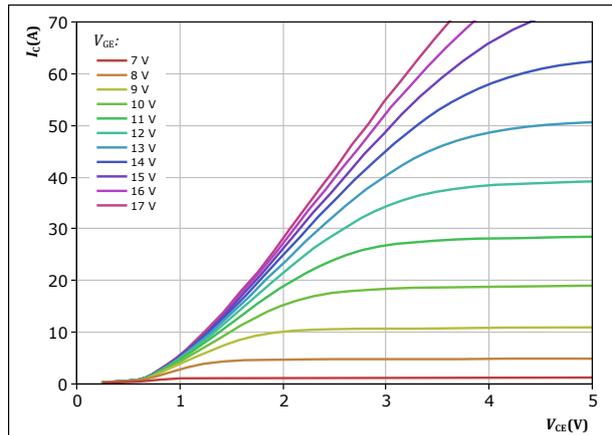
$t_p = 250\ \mu\text{s}$   
 $V_{GE} = 15\ \text{V}$

$T_j:$  — 25 °C  
— 125 °C  
— 150 °C

figure 10. IGBT

Typical output characteristics

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

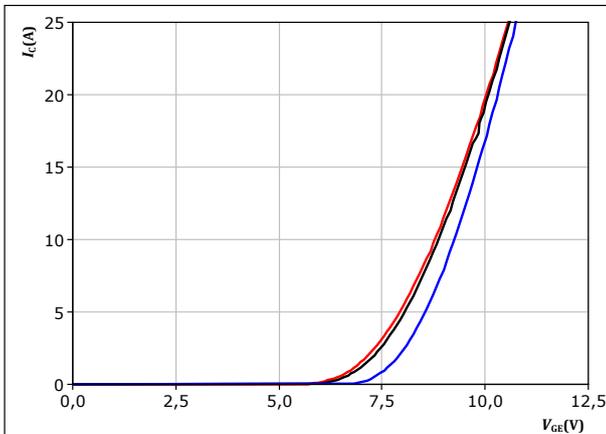


$t_p = 250\ \mu\text{s}$   
 $T_j = 150\text{ °C}$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

figure 11. IGBT

Typical transfer characteristics

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



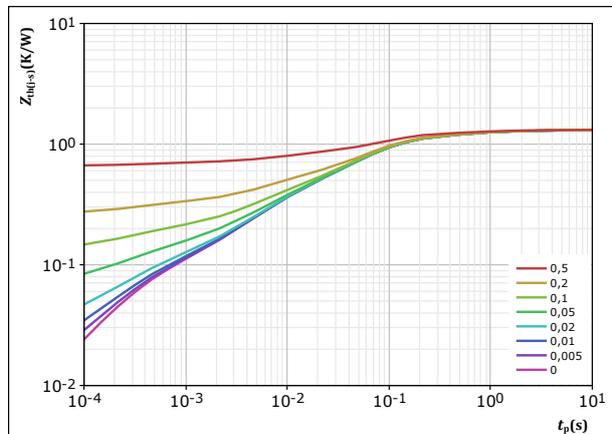
$t_p = 250\ \mu\text{s}$   
 $V_{CE} = 10\ \text{V}$

$T_j:$  — 25 °C  
— 125 °C  
— 150 °C

figure 12. IGBT

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,314\ \text{K/W}$

IGBT thermal model values

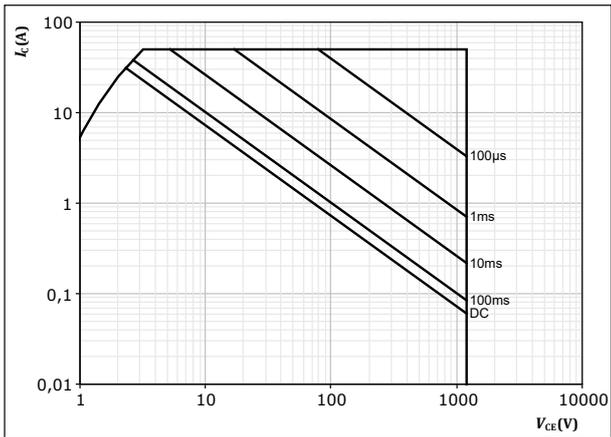
$R$ (K/W)	$\tau$ (s)
4,80E-02	4,95E+00
2,14E-01	4,62E-01
7,66E-01	6,41E-02
2,24E-01	6,11E-03
6,85E-02	3,04E-04



### Brake Switch Characteristics

figure 13. IGBT

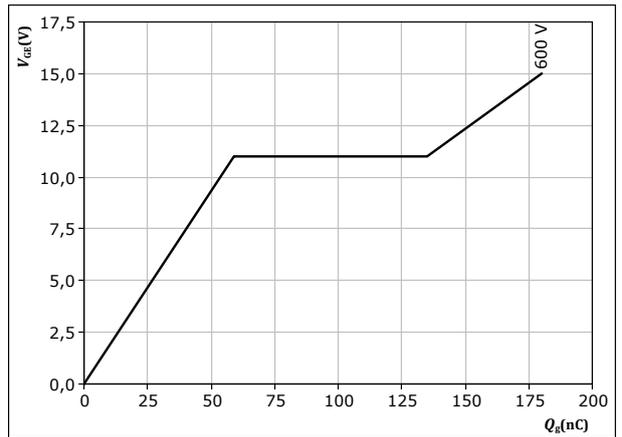
Safe operating area  
 $I_C = f(V_{CE})$



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

figure 14. IGBT

Gate voltage vs gate charge  
 $V_{GE} = f(Q_g)$



$I_C = 25 \text{ A}$   
 $T_j = 25 \text{ } ^\circ\text{C}$



## Brake Diode Characteristics

figure 15. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

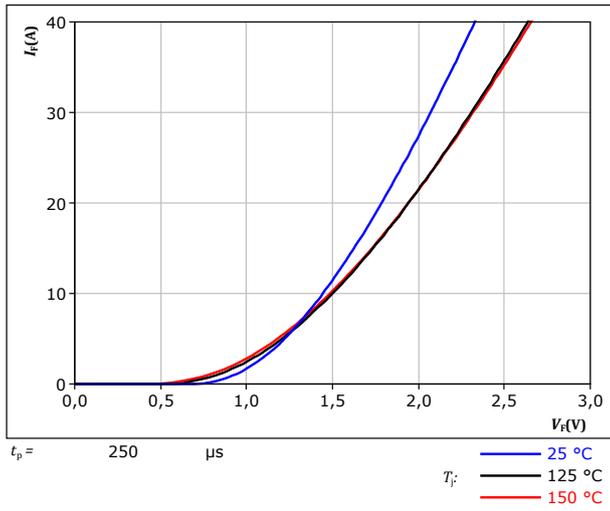
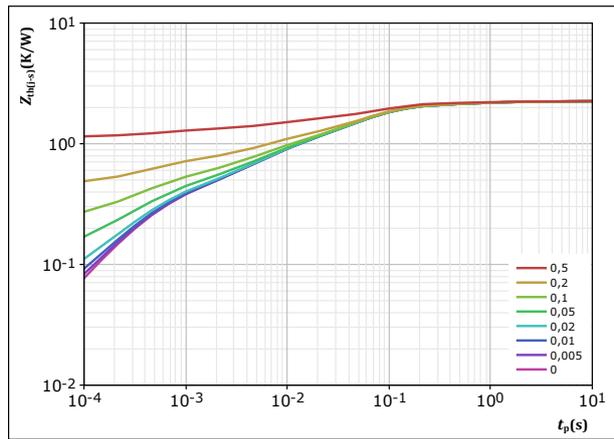


figure 16. FWD

Transient thermal impedance as a function of pulse width

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



$D =$	$t_p / T$	
$R_{th(j-s)} =$	2,253	K/W
FWD thermal model values		
$R$ (K/W)	$\tau$ (s)	
4,18E-02	6,42E+00	
1,99E-01	5,83E-01	
1,22E+00	5,90E-02	
4,91E-01	5,62E-03	
3,08E-01	4,15E-04	



## Rectifier Diode Characteristics

figure 17. Rectifier

Typical forward characteristics

$$I_F = f(V_F)$$

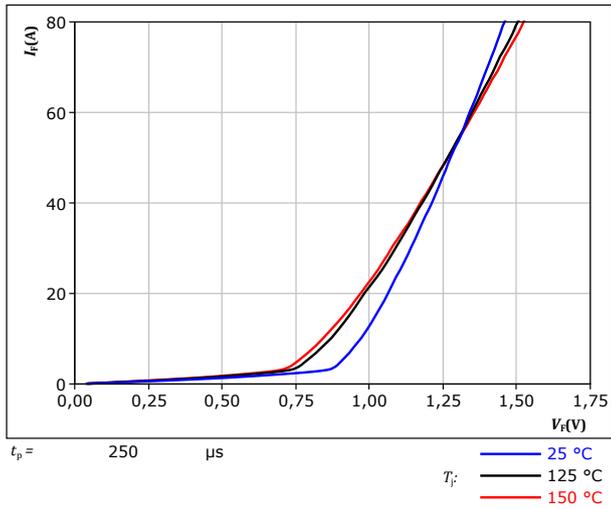
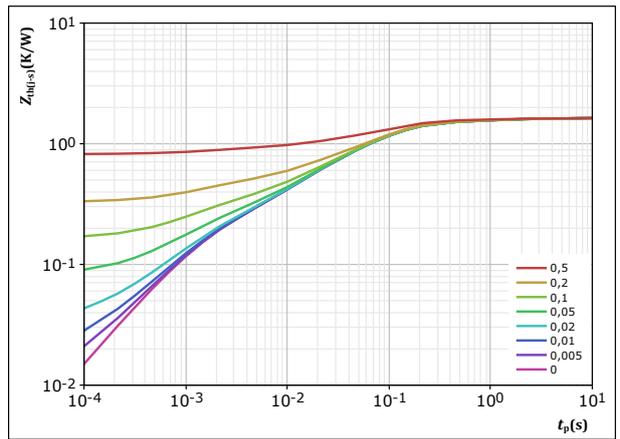


figure 18. Rectifier

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,632 \text{ K/W}$   
 Rectifier thermal model values

R (K/W)	$\tau$ (s)
4,65E-02	5,42E+00
1,44E-01	6,99E-01
9,83E-01	8,47E-02
3,07E-01	1,50E-02
1,57E-01	1,29E-03

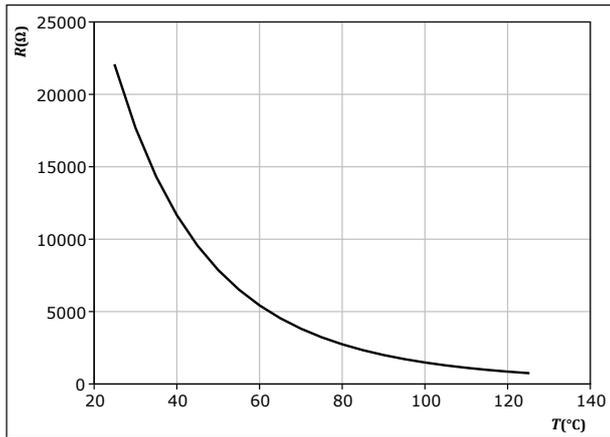


### Thermistor Characteristics

figure 19. Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$

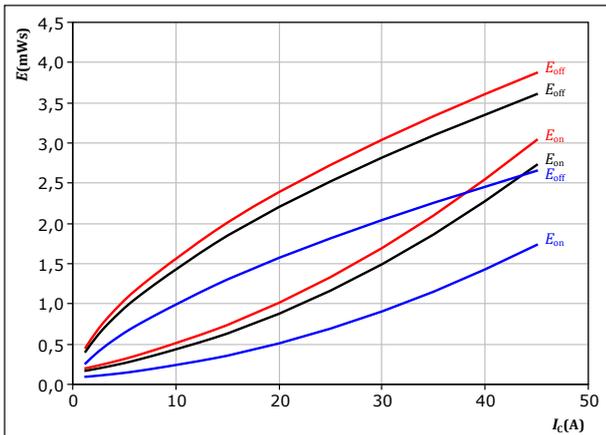




## Inverter Switching Characteristics

**figure 20.** IGBT

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

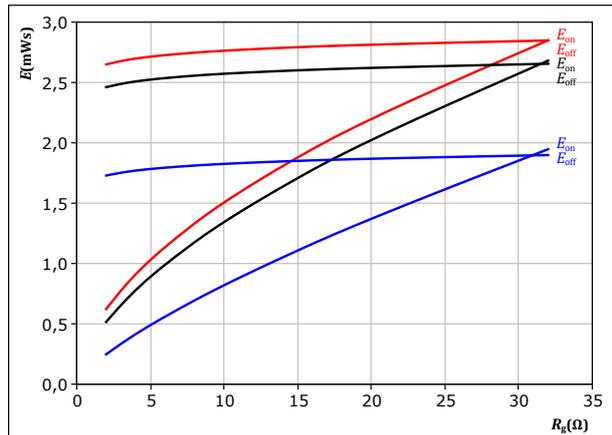


With an inductive load at

$V_{CE} =$	600	V	$T_j:$	25 °C
$V_{GE} =$	±15	V		125 °C
$R_{gon} =$	8	Ω		150 °C
$R_{goff} =$	8	Ω		

**figure 21.** IGBT

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

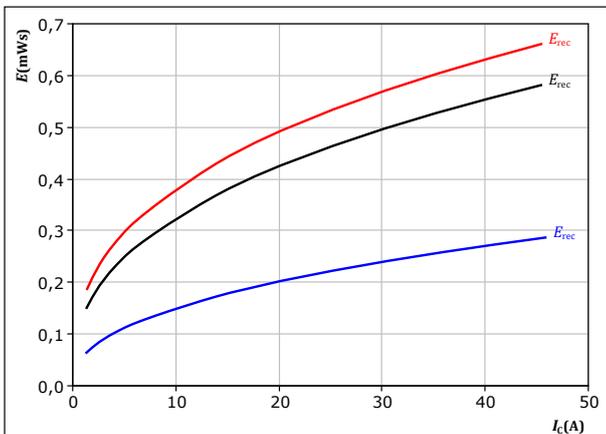


With an inductive load at

$V_{CE} =$	600	V	$T_j:$	25 °C
$V_{GE} =$	±15	V		125 °C
$I_c =$	25	A		150 °C

**figure 22.** FWD

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

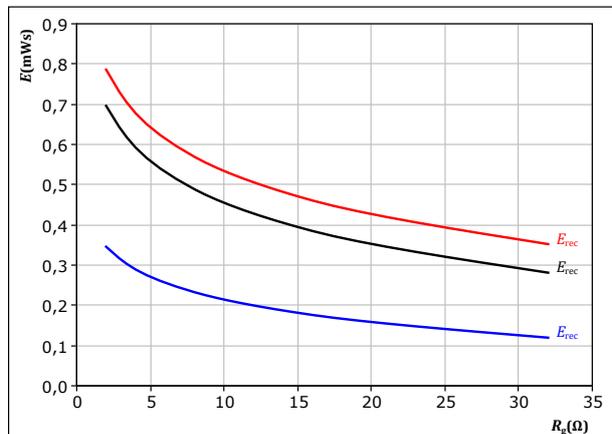


With an inductive load at

$V_{CE} =$	600	V	$T_j:$	25 °C
$V_{GE} =$	±15	V		125 °C
$R_{gon} =$	8	Ω		150 °C

**figure 23.** FWD

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



With an inductive load at

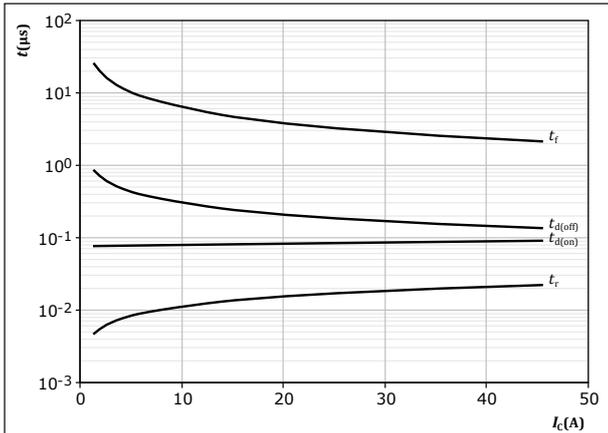
$V_{CE} =$	600	V	$T_j:$	25 °C
$V_{GE} =$	±15	V		125 °C
$I_c =$	25	A		150 °C



## Inverter Switching Characteristics

**figure 24.** IGBT

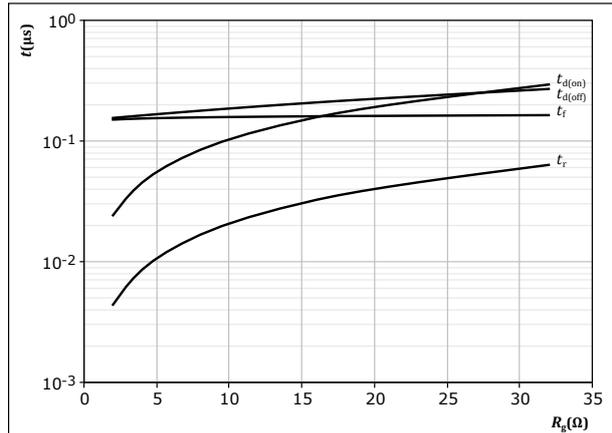
Typical switching times as a function of collector current  
 $t = f(I_c)$



With an inductive load at  
 $T_j = 150 \text{ }^\circ\text{C}$   
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 8 \text{ } \Omega$   
 $R_{goff} = 8 \text{ } \Omega$

**figure 25.** IGBT

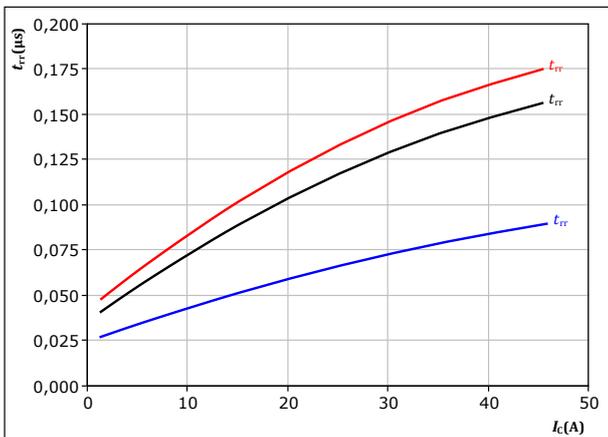
Typical switching times as a function of IGBT turn on gate resistor  
 $t = f(R_g)$



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

**figure 26.** FWD

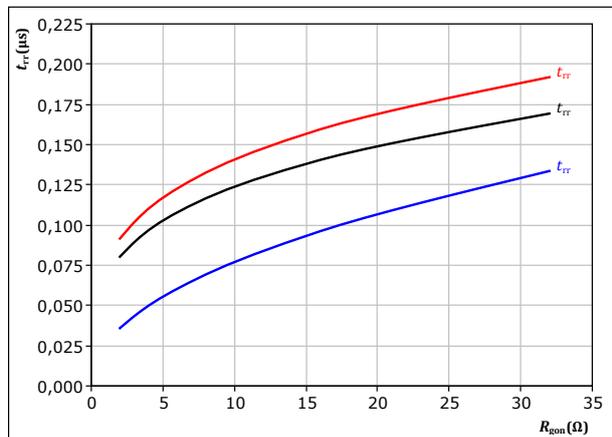
Typical reverse recovery time as a function of collector current  
 $t_{rr} = f(I_c)$



With an inductive load at  
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 8 \text{ } \Omega$   
 $T_j:$  — 25 °C  
— 125 °C  
— 150 °C

**figure 27.** FWD

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



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  
— 125 °C  
— 150 °C

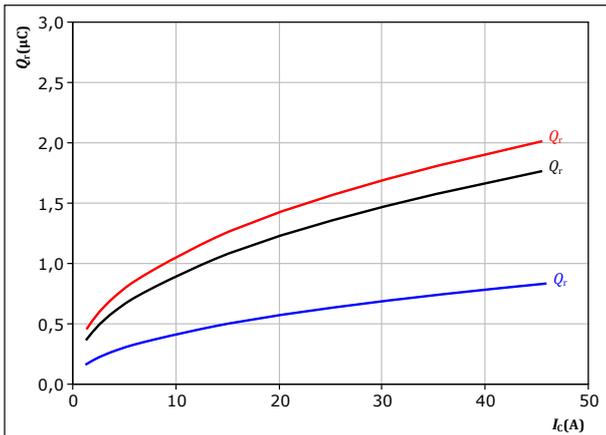


## Inverter Switching Characteristics

figure 28. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

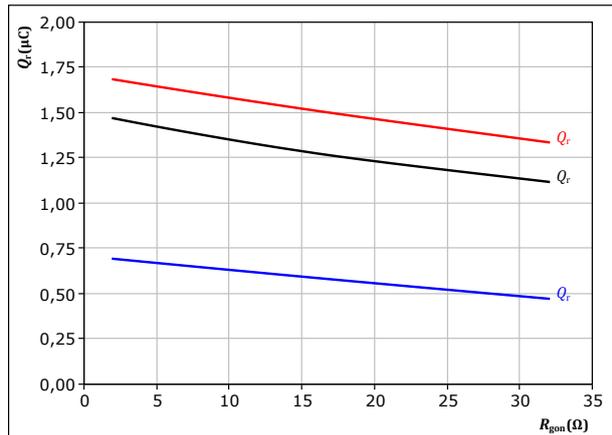
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 8 \ \Omega$

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

figure 29. FWD

Typical recovered charge as a function of IGBT turn on gate resistor

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



With an inductive load at

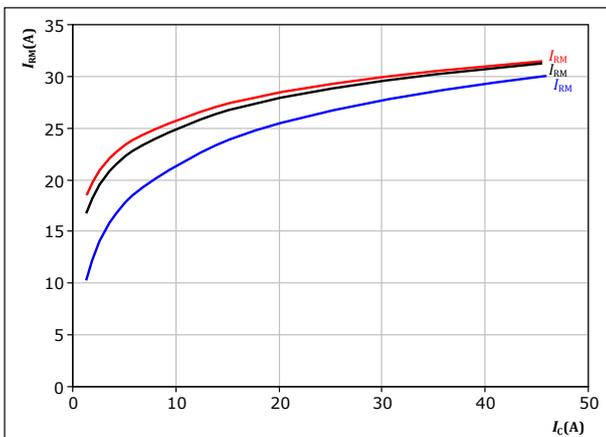
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 25 \text{ A}$

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

figure 30. FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

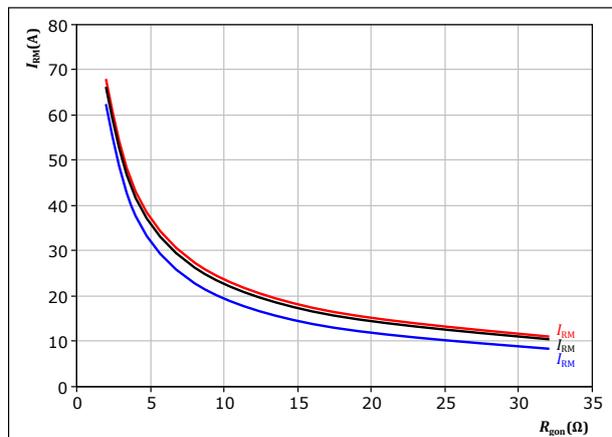
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 8 \ \Omega$

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

figure 31. FWD

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

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



With an inductive load at

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

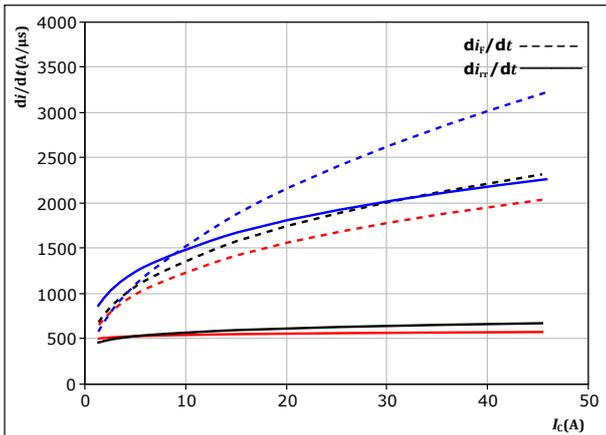
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C



## Inverter Switching Characteristics

**figure 32.** FWD

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



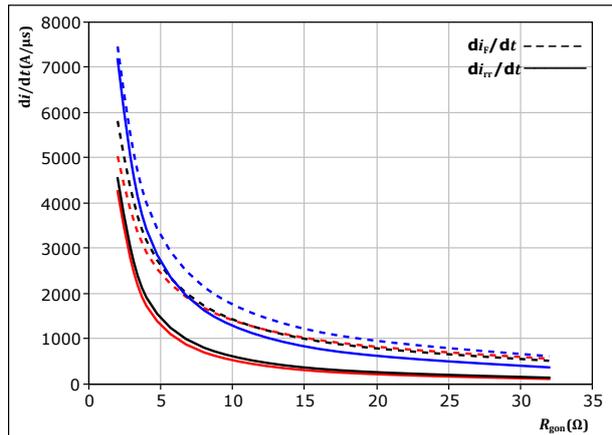
With an inductive load at

$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 8$   $\Omega$

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

**figure 33.** FWD

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



With an inductive load at

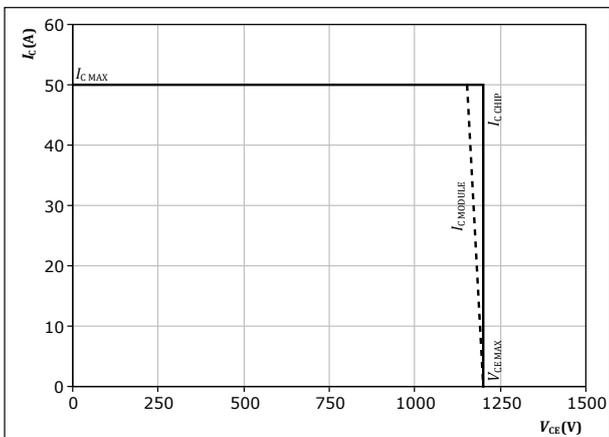
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 25$  A

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

**figure 34.** IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At  $T_j = 150$  °C  
 $R_{gon} = 8$   $\Omega$   
 $R_{goff} = 8$   $\Omega$

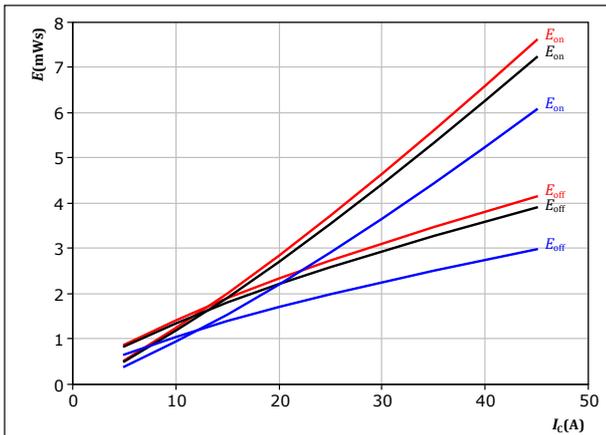


## Brake Switching Characteristics

figure 35. IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_c)$$



With an inductive load at

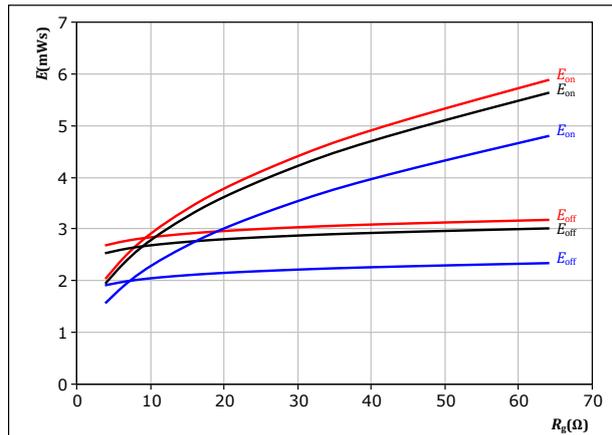
$V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $R_{gon} = 16 \ \Omega$   
 $R_{goff} = 16 \ \Omega$

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

figure 36. IGBT

Typical switching energy losses as a function of IGBT turn on gate resistor

$$E = f(R_g)$$



With an inductive load at

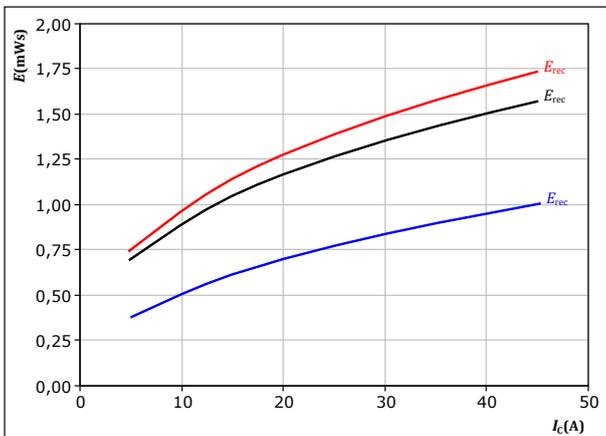
$V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $I_c = 25 \text{ A}$

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

figure 37. FWD

Typical reverse recovered energy loss as a function of collector current

$$E_{rec} = f(I_c)$$



With an inductive load at

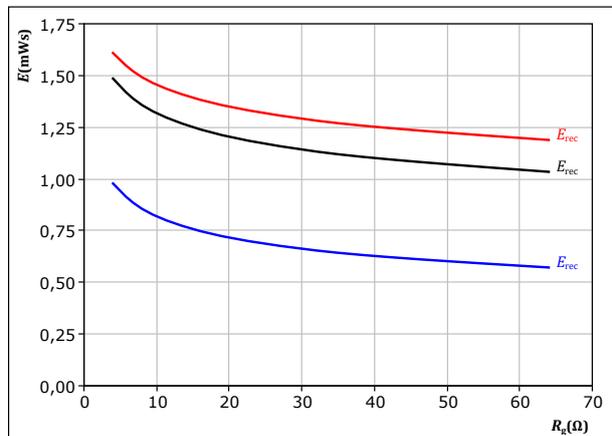
$V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $R_{gon} = 16 \ \Omega$

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

figure 38. FWD

Typical reverse recovered energy loss as a function of IGBT turn on gate resistor

$$E_{rec} = f(R_g)$$



With an inductive load at

$V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $I_c = 25 \text{ A}$

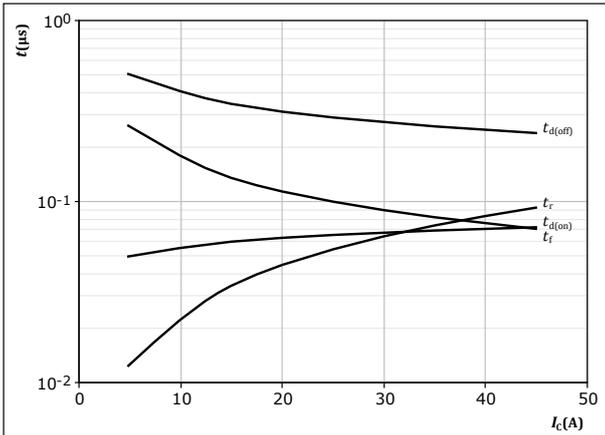
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C



## Brake Switching Characteristics

**figure 39.** IGBT

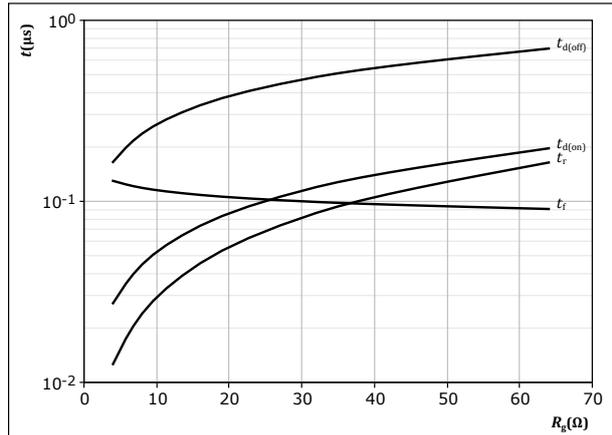
Typical switching times as a function of collector current  
 $t = f(I_c)$



With an inductive load at  
 $T_j = 150 \text{ } ^\circ\text{C}$   
 $V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $R_{gon} = 16 \text{ } \Omega$   
 $R_{goff} = 16 \text{ } \Omega$

**figure 40.** IGBT

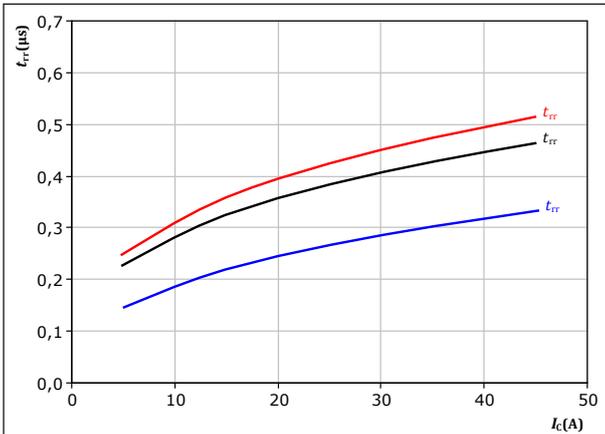
Typical switching times as a function of IGBT turn on gate resistor  
 $t = f(R_g)$



With an inductive load at  
 $T_j = 150 \text{ } ^\circ\text{C}$   
 $V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $I_c = 25 \text{ A}$

**figure 41.** FWD

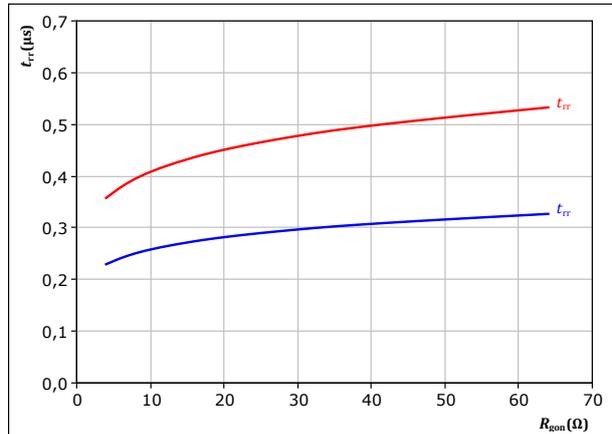
Typical reverse recovery time as a function of collector current  
 $t_{rr} = f(I_c)$



With an inductive load at  
 $V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $R_{gon} = 16 \text{ } \Omega$   
 $T_j:$  — 25 °C  
 — 125 °C  
 — 150 °C

**figure 42.** FWD

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



With an inductive load at  
 $V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $I_c = 25 \text{ A}$   
 $T_j:$  — 25 °C  
 — 150 °C

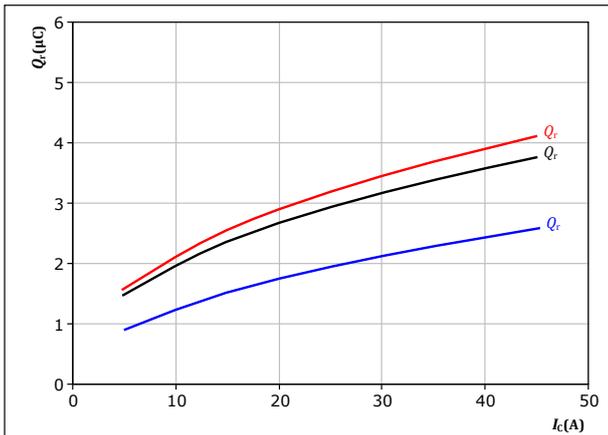


## Brake Switching Characteristics

**figure 43.** FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

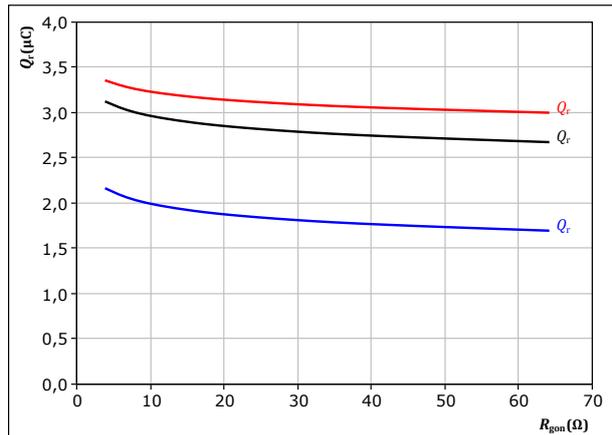
$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 16$  Ω

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

**figure 44.** FWD

Typical recovered charge as a function of IGBT turn on gate resistor

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



With an inductive load at

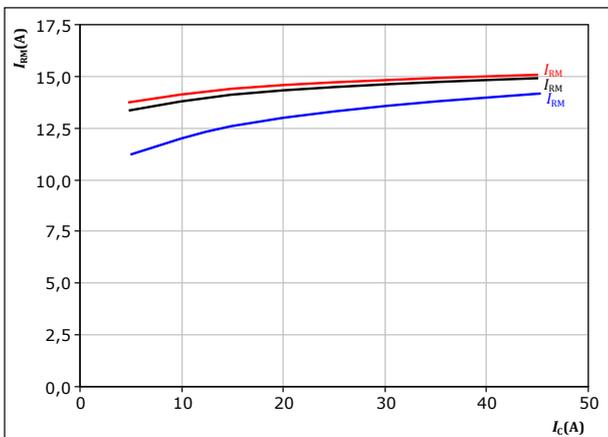
$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 25$  A

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

**figure 45.** FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

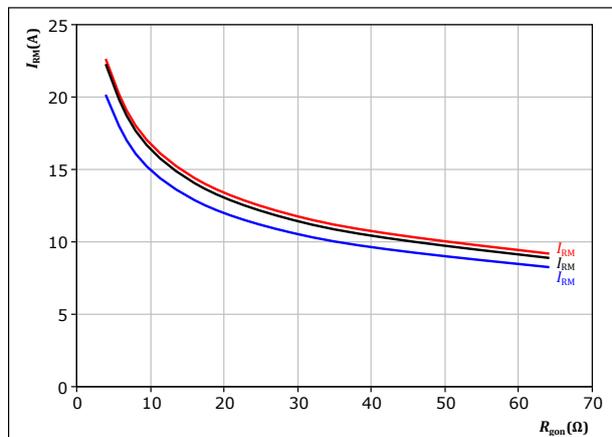
$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 16$  Ω

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

**figure 46.** FWD

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

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



With an inductive load at

$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 25$  A

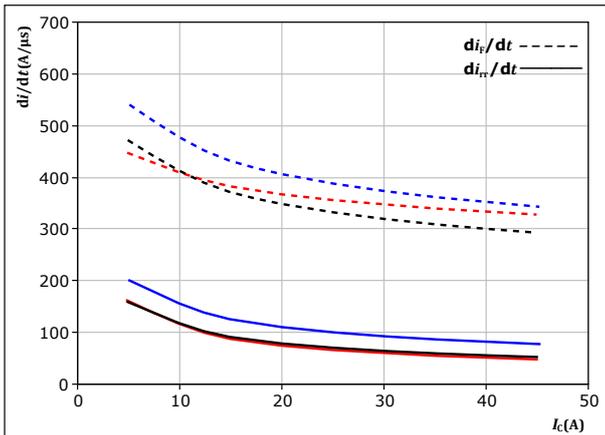
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C



## Brake Switching Characteristics

**figure 47.** FWD

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

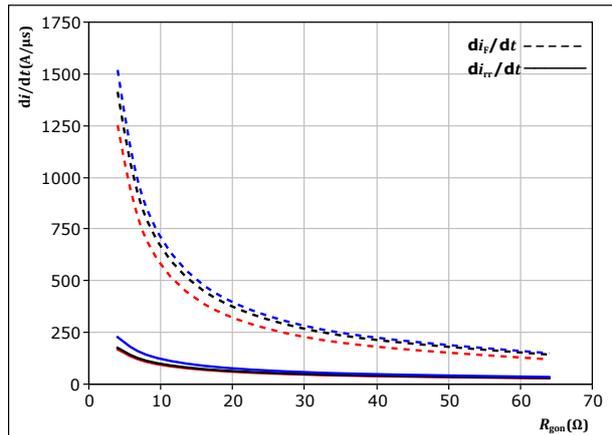


With an inductive load at

$V_{CE} = 700$ V	$T_j = 25$ °C
$V_{GE} = 0/15$ V	$T_j = 125$ °C
$R_{gon} = 16$ Ω	$T_j = 150$ °C

**figure 48.** FWD

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

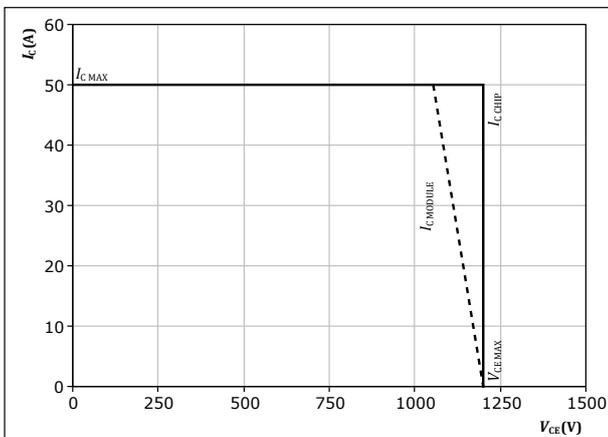


With an inductive load at

$V_{CE} = 700$ V	$T_j = 25$ °C
$V_{GE} = 0/15$ V	$T_j = 125$ °C
$I_c = 25$ A	$T_j = 150$ °C

**figure 49.** IGBT

Reverse bias safe operating area  
 $I_c = f(V_{CE})$



At  $T_j = 150$  °C  
 $R_{gon} = 16$  Ω  
 $R_{goff} = 16$  Ω



## Switching Definitions

figure 50. IGBT

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

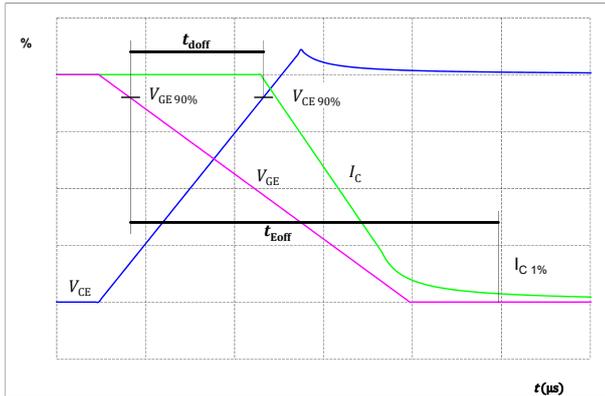


figure 51. IGBT

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

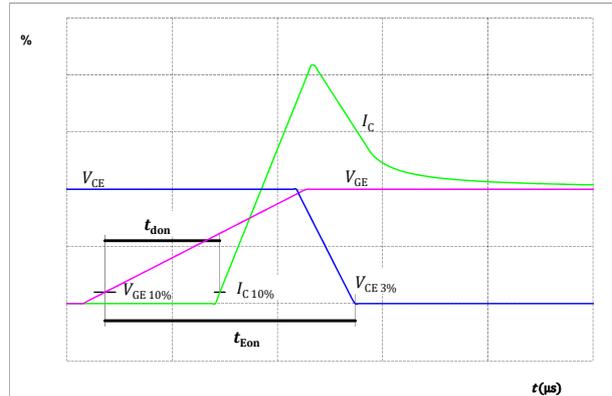


figure 52. IGBT

Turn-off Switching Waveforms & definition of  $t_f$

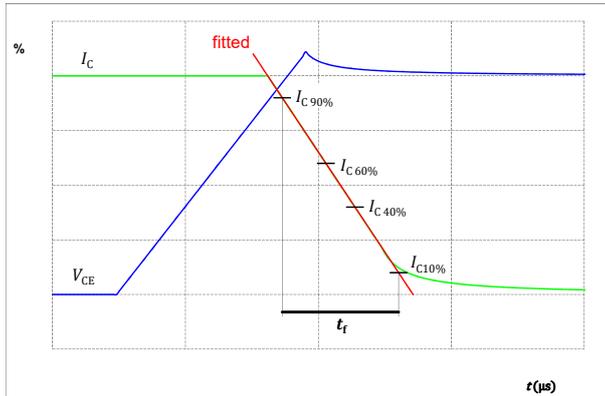
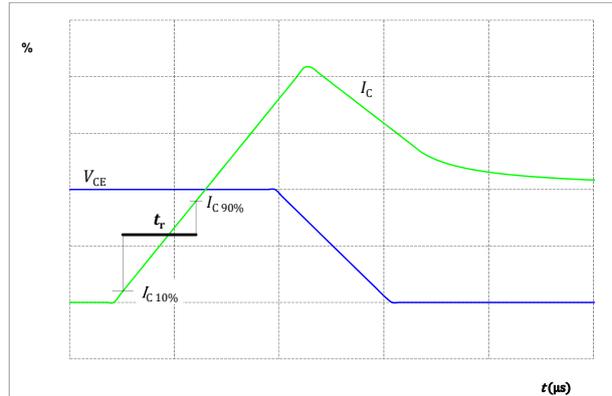


figure 53. IGBT

Turn-on Switching Waveforms & definition of  $t_r$





### Switching Definitions

figure 54. FWD

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

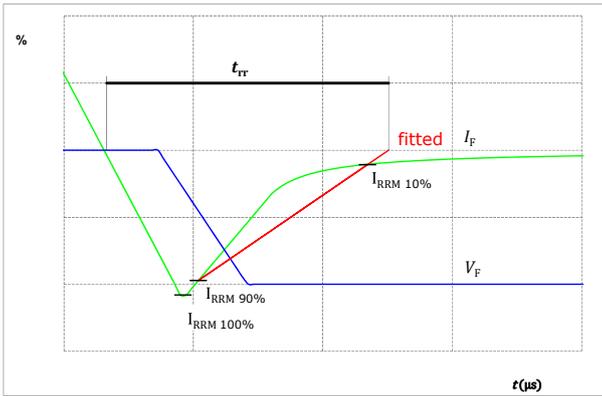
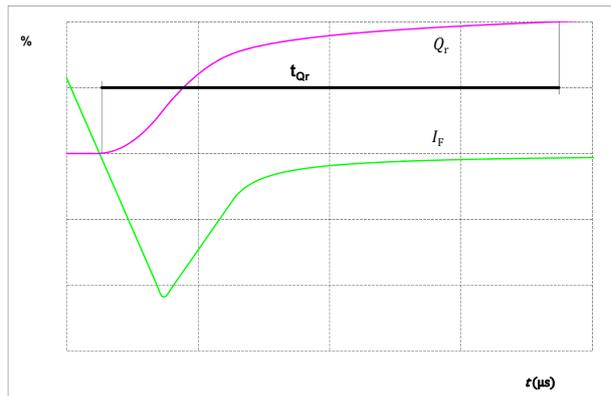


figure 55. FWD

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





Vincotech

Ordering Code	
<b>Version</b>	<b>Ordering Code</b>
Without thermal paste	10-FY12PMA025M702-P589A71
With thermal paste (5,2 W/mK, PTM6000HV)	10-FY12PMA025M702-P589A71-7/

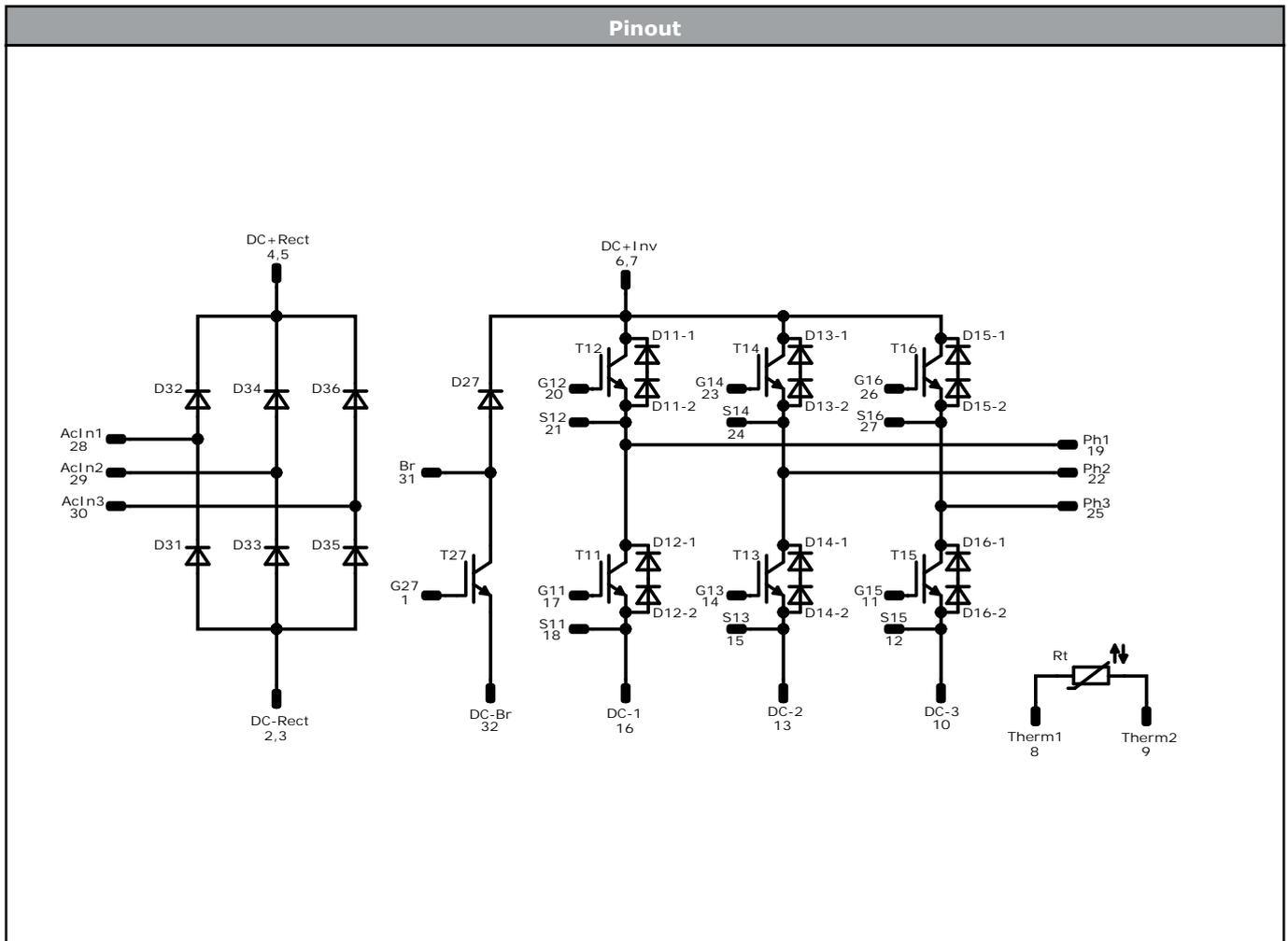
Marking						
	<b>Text</b>	<b>Name</b> NN-NNNNNNNNNNNNNN- TTTTTV	<b>Date code</b> WWYY	<b>UL &amp; VIN</b> UL VIN	<b>Lot</b> LLLLL	<b>Serial</b> SSSS
	<b>Datamatrix</b>	<b>Type&amp;Ver</b> TTTTTV	<b>Lot number</b> LLLLL	<b>Serial</b> SSSS	<b>Date code</b> WWYY	

Pin table [mm]				Outline	
Pin	X	Y	Function		
1	52,55	0	G27		
2	47,7	0	DC-Rect		
3	44,8	0	DC-Rect		
4	37,8	0	DC+Rect		
5	37,8	2,8	DC+Rect		
6	35	0	DC+Inv		
7	35	2,8	DC+Inv		
8	28	0	Therm1		
9	25,2	0	Therm2		
10	22,4	0	DC-3		
11	19,6	0	G15		
12	16,8	0	S15		
13	14	0	DC-2		
14	11,2	0	G13		
15	8,4	0	S13		
16	5,6	0	DC-1		
17	2,8	0	G11		
18	0	0	S11		
19	0	28,5	Ph1		
20	2,8	28,5	G12		
21	7,5	28,5	S12		
22	14,5	28,5	Ph2		
23	17,3	28,5	G14		
24	22	28,5	S14		
25	29	28,5	Ph3		
26	31,8	28,5	G16		
27	36,5	28,5	S16		
28	43,5	28,5	ACIn1		
29	52,55	25	ACIn2		
30	52,55	16,9	ACIn3		
31	52,55	8,6	Br		
32	52,55	2,8	DC-Br		

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
T11, T12, T13, T14, T15, T16	IGBT	1200 V	25 A	Inverter Switch	
D11-1, D11-2, D12-1, D12-2, D13-1, D13-2, D14-1, D14-2, D15-1, D15-2, D16-1, D16-2	FWD	1300 V	30 A	Inverter Diode	
T27	IGBT	1200 V	25 A	Brake Switch	
D27	FWD	1200 V	15 A	Brake Diode	
D31, D32, D33, D34, D35, D36	Rectifier	1600 V	28 A	Rectifier Diode	
Rt	Thermistor			Thermistor	



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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 UL 1557 recognized under E192116 up to a junction temperature under switching condition $T_{j,op}=175^{\circ}\text{C}$ and up to 3500VAC/1min isolation voltage. For more information see vincotech.com website.



Document No.:	Date:	Modification:	Pages
10-FY12PMA025M702-P589A71-D1-14	8 Jan. 2026	Initial Release	

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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in labelling can be reasonably expected to result in significant injury to the user.
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.