



flowPIM 1

600 V / 50 A

### Topology features

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

### Component features

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

### Housing features

- Base isolation:  $\text{Al}_2\text{O}_3$
- Convex shaped substrate for superior thermal contact
- Thermo-mechanical push-and-pull force relief
- Solder pin

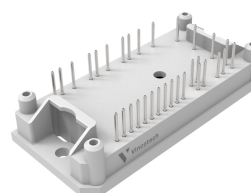
### Target applications

- Industrial drives
- Embedded drives

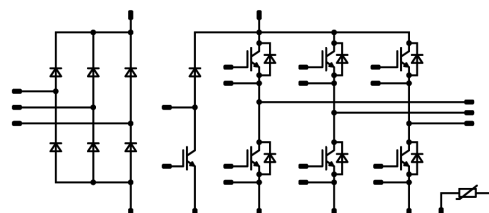
### Types

- V23990-P586-A20-PM

### flow 1 17 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	$V_{CES}$		600	V
Collector current (DC current)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	44	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	150	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	90	W
Gate-emitter voltage	$V_{GES}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 360\text{ V}$ $T_j = 150\text{ °C}$	6	$\mu s$
Maximum junction temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

## Inverter Diode

Peak repetitive reverse voltage	$V_{RRM}$		600	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	39	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	100	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	68	W
Maximum junction temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

## Brake Switch

Collector-emitter voltage	$V_{CES}$		600	V
Collector current (DC current)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	33	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	90	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	64	W
Gate-emitter voltage	$V_{GES}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 360\text{ V}$ $T_j = 150\text{ °C}$	6	$\mu s$
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	$V_{RRM}$		600	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	22	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	40	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	37	W
Maximum junction temperature	$T_{jmax}$		175	°C

## Rectifier Diode

Peak repetitive reverse voltage	$V_{RRM}$		1600	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	44	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* $t_p = 2\text{ s}$	4000	V
Isolation voltage	$V_{isol}$	AC Voltage $t_p = 1\text{ min}$	2500	V
Creepage distance			min 12,7	mm
Clearance			min 12,7	mm
Comparative Tracking Index	CTI		≥ 600	

\*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	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0008	25	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CEsat}$		15		50	25 125	1,05	1,76 2,07	1,85 <sup>(1)</sup>	V
Collector-emitter cut-off current	$I_{CES}$		0	600		25			2,6	µA
Gate-emitter leakage current	$I_{GES}$		20	0		25			600	nA
Internal gate resistance	$r_g$							None		Ω
Input capacitance	$C_{ies}$	$f = 1 \text{ Mhz}$	0	25	25			3140		pF
Output capacitance	$C_{oes}$							200		pF
Reverse transfer capacitance	$C_{res}$							93		pF

#### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)						1,06		K/W
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#### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 16 \text{ } \Omega$ $R_{goff} = 16 \text{ } \Omega$	$\pm 15$	350	50	25 125 150		187,32 185,79 186,12		ns
Rise time	$t_r$					25 125 150		29,43 33,19 33,33		ns
Turn-off delay time	$t_{d(off)}$					25 125 150		230,26 252,25 257,76		ns
Fall time	$t_f$					25 125 150		46,24 81,64 91,61		ns
Turn-on energy (per pulse)	$E_{on}$					25 125 150		1,23 1,61 1,7		mWs
Turn-off energy (per pulse)	$E_{off}$					25 125 150		1,18 1,53 1,62		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	$V_F$				50	25 125	1,2	1,85 1,94	1,9 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_r = 600$ V				25			27	μA

#### Thermal

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

Peak recovery current	$I_{RRM}$	$di/dt=2130$ A/μs $di/dt=2041$ A/μs $di/dt=1746$ A/μs	$\pm 15$	350	50	25 125 150		32,06 41,26 44,23		A
Reverse recovery time	$t_{rr}$					25 125 150		161,66 221,71 240,15		ns
Recovered charge	$Q_r$					25 125 150		1,4 3,14 3,63		μC
Reverse recovered energy	$E_{rec}$					25 125 150		0,301 0,695 0,81		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					25 125 150		2514,84 1010,64 981,58		A/μs



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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	

### Brake Switch

#### Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00043	25	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CEsat}$		15		30	25 125	1,1	1,55 1,75	1,9 <sup>(1)</sup>	V
Collector-emitter cut-off current	$I_{CES}$		0	600		25			1,6	µA
Gate-emitter leakage current	$I_{GES}$		20	0		25			300	nA
Internal gate resistance	$r_g$							None		Ω
Input capacitance	$C_{ies}$	$f = 1 \text{ Mhz}$	0	25		25		1630		pF
Output capacitance	$C_{oes}$							108		pF
Reverse transfer capacitance	$C_{res}$							50		pF

#### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)						1,49		K/W
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#### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 8 \Omega$ $R_{goff} = 8 \Omega$	0/15	400	30	25 125 150		20,2 19,58 19,11		ns
Rise time	$t_r$					25 125 150		27,61 28,44 28,57		ns
Turn-off delay time	$t_{d(off)}$					25 125 150		182,75 204,09 210,02		ns
Fall time	$t_f$					25 125 150		62,53 76,57 85,53		ns
Turn-on energy (per pulse)	$E_{on}$					25 125 150		0,701 0,931 0,996		mWs
Turn-off energy (per pulse)	$E_{off}$					25 125 150		0,744 0,994 1,06		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	

### Brake Diode

#### Static

Forward voltage	$V_F$				20	25 125	1,25	1,74 1,67	1,95 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_r = 600$ V				25			27	μA

#### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						2,6		K/W
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#### Dynamic

Peak recovery current	$I_{RRM}$	$di/dt=860$ A/μs $di/dt=861$ A/μs $di/dt=949$ A/μs	0/15	400	30	25 125 150		10,28 13,34 14,49		A
Reverse recovery time	$t_{rr}$					25 125 150		167,93 242,98 263,64		ns
Recovered charge	$Q_r$					25 125 150		0,703 1,52 1,77		μC
Reverse recovered energy	$E_{rec}$					25 125 150		0,195 0,429 0,505		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					25 125 150		44,97 88,68 94,34		A/μs



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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	$V_F$				13	25 125		0,995 0,927	1,21 <sup>(1)</sup> 1,1 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_r = 1600$ 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 $R_{100}$	$\Delta_{R/R}$	$R_{100} = 1484$ 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. $\pm 1$ %						3962		K
B-value	$B_{(25/100)}$	Tol. $\pm 1$ %						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.



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V23990-P586-A20-PM  
datasheet

## Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

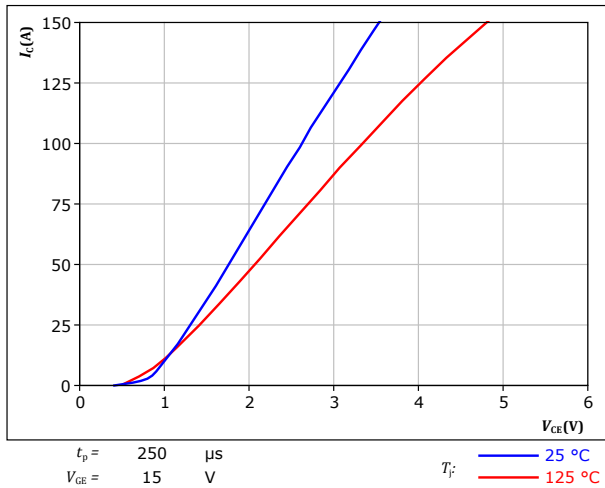


figure 2. IGBT

Typical output characteristics

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

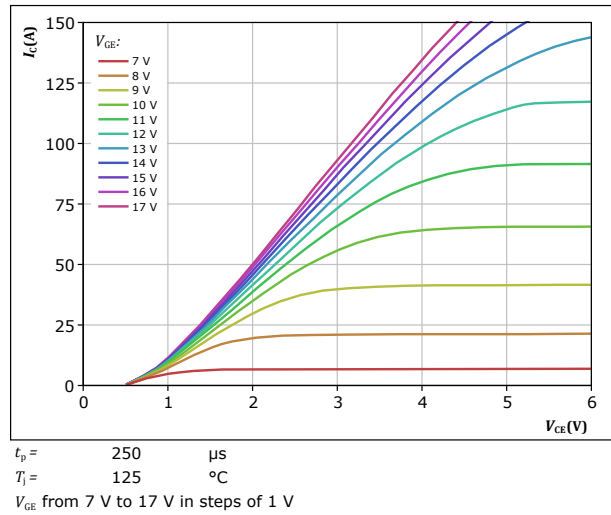


figure 3. IGBT

Typical transfer characteristics

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

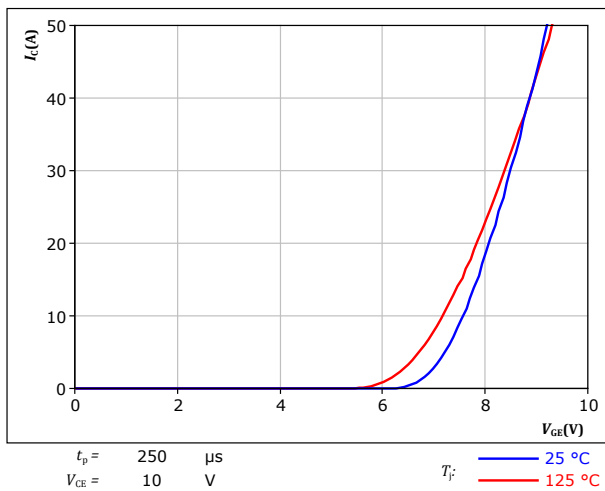
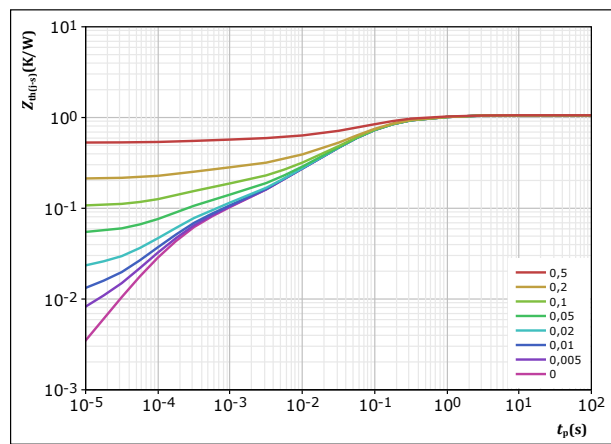


figure 4. IGBT

Transient thermal impedance as a function of pulse width

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



IGBT thermal model values	
$R$ (K/W)	$\tau$ (s)
1,11E-01	1,12E+00
3,60E-01	1,48E-01
3,77E-01	4,74E-02
1,24E-01	7,68E-03
4,58E-02	6,49E-04
4,19E-02	1,61E-04



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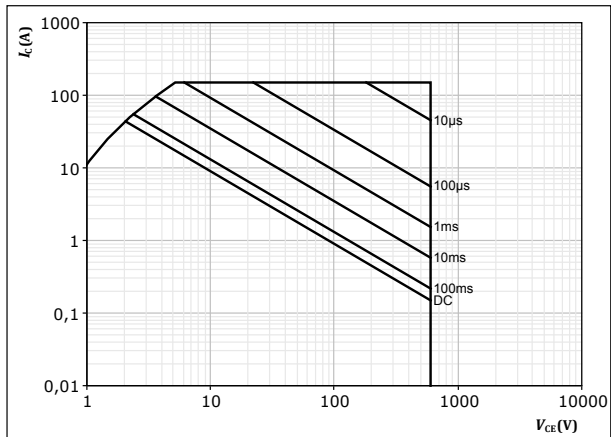
## Inverter Switch Characteristics

figure 5.

IGBT

Safe operating area

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



$D =$  single pulse

$T_s = 80$  °C

$V_{GE} = 15$  V

$T_j = T_{jmax}$



## Inverter Diode Characteristics

figure 6.

FWD

Typical forward characteristics

$$I_F = f(V_F)$$

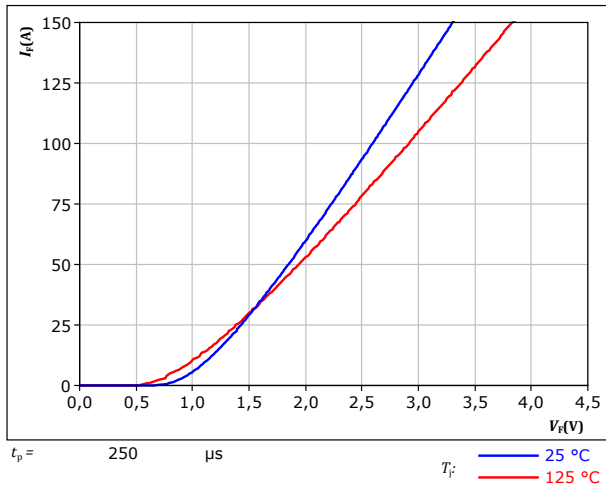
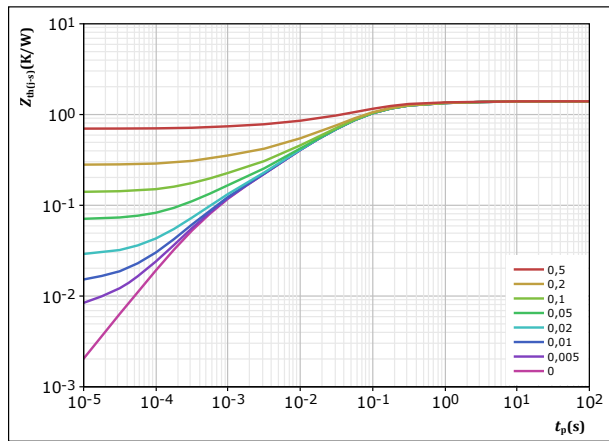


figure 7.

FWD

Transient thermal impedance as a function of pulse width

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



$D =$	$t_p / T$	
$R_{th(j-s)} =$	1,399	K/W
FWD thermal model values		
$R$ (K/W)	$\tau$ (s)	
6,76E-02	3,05E+00	
1,79E-01	3,50E-01	
6,70E-01	7,08E-02	
2,72E-01	1,81E-02	
1,35E-01	4,13E-03	
7,56E-02	5,11E-04	



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datasheet

## Brake Switch Characteristics

figure 8. IGBT

Typical output characteristics

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

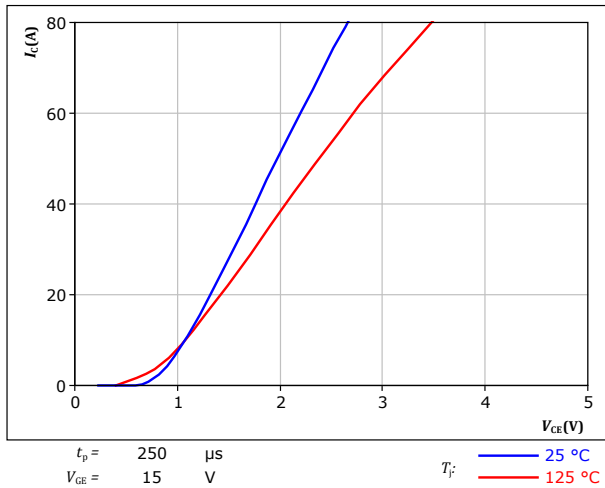


figure 9. IGBT

Typical output characteristics

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

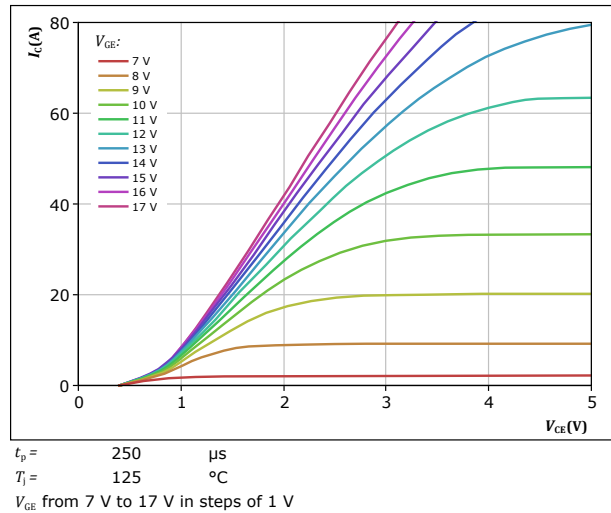


figure 10. IGBT

Typical transfer characteristics

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

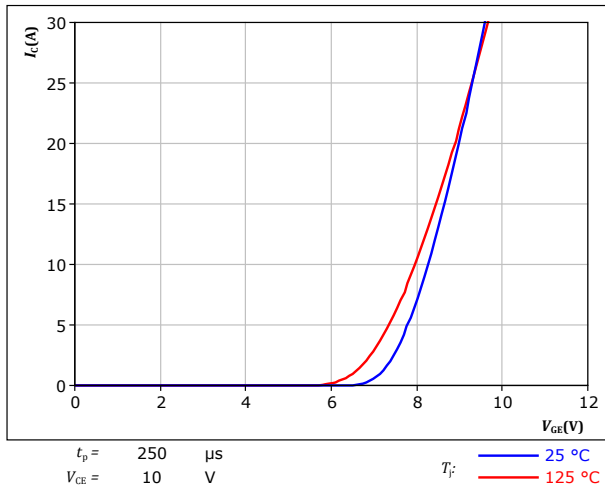
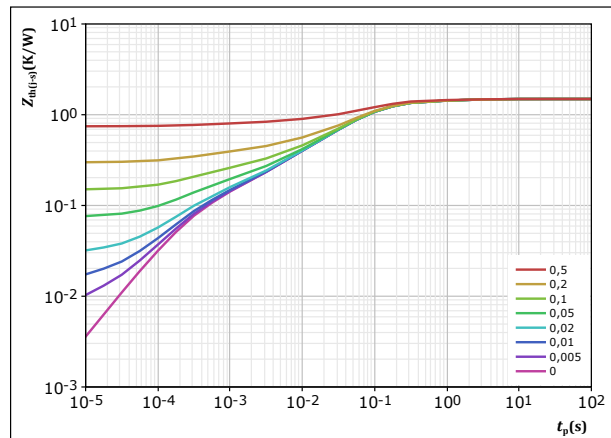


figure 11. IGBT

Transient thermal impedance as a function of pulse width

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



IGBT thermal model values	
$R$ (K/W)	$\tau$ (s)
7,25E-02	2,15E+00
1,02E-01	4,82E-01
6,96E-01	9,49E-02
3,56E-01	3,40E-02
1,42E-01	5,95E-03
4,77E-02	1,04E-03
7,51E-02	2,72E-04





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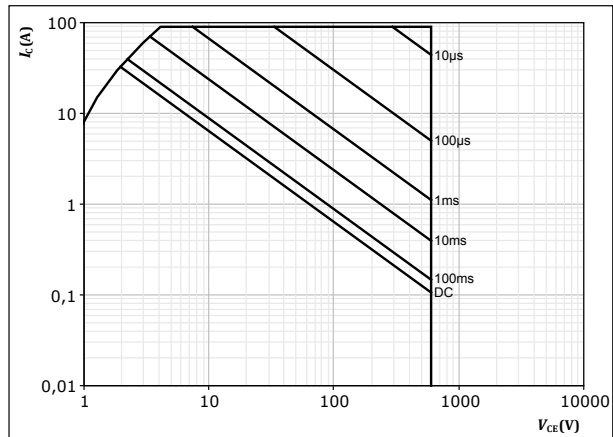
## Brake Switch Characteristics

figure 12.

IGBT

Safe operating area

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



D = single pulse

T<sub>s</sub> = 80 °C

V<sub>GE</sub> = 15 V

T<sub>j</sub> = T<sub>jmax</sub>



## Brake Diode Characteristics

figure 13.

FWD

Typical forward characteristics

$$I_F = f(V_F)$$

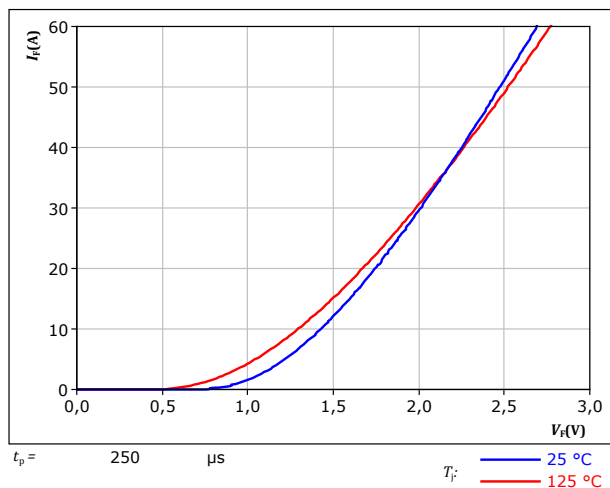
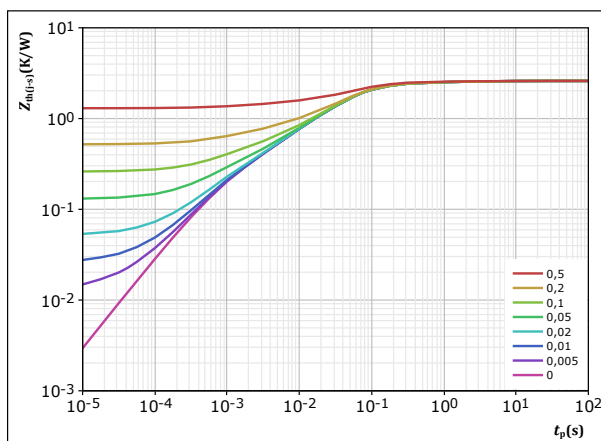


figure 14.

FWD

Transient thermal impedance as a function of pulse width

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



$D =$	$t_p / T$	
$R_{th(j-s)} =$	2,598	K/W
FWD thermal model values		
$R$ (K/W)	$\tau$ (s)	
6,56E-02	4,59E+00	
1,58E-01	5,68E-01	
8,97E-01	8,41E-02	
1,05E+00	3,28E-02	
2,75E-01	4,96E-03	
1,51E-01	7,65E-04	



## Rectifier Diode Characteristics

figure 15.

Rectifier

Typical forward characteristics

$$I_F = f(V_F)$$

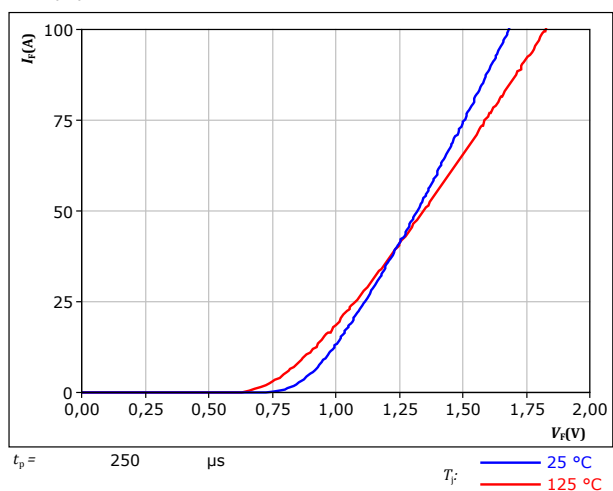
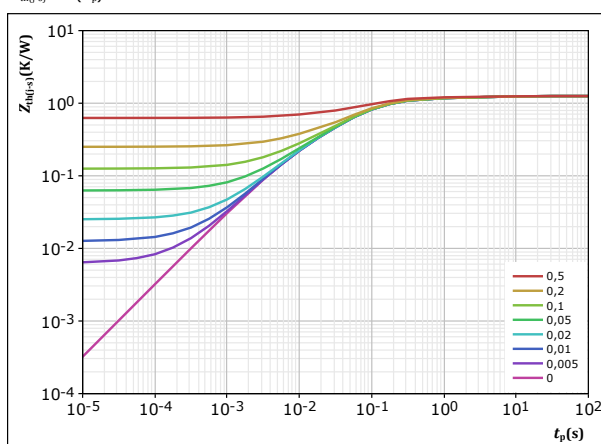


figure 16.

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	K/W
Rectifier thermal model values		
$R$ (K/W)	$\tau$ (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	



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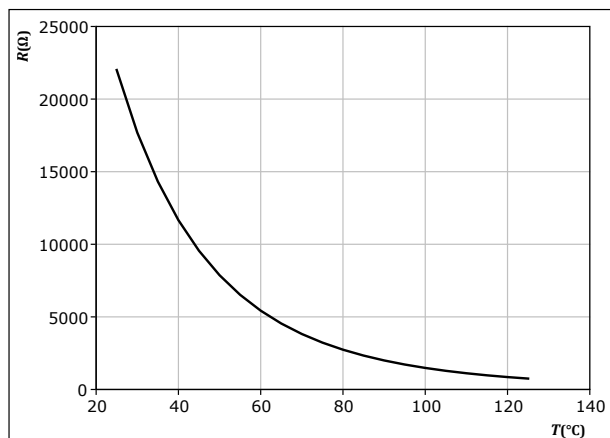
## Thermistor Characteristics

figure 17.

Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$





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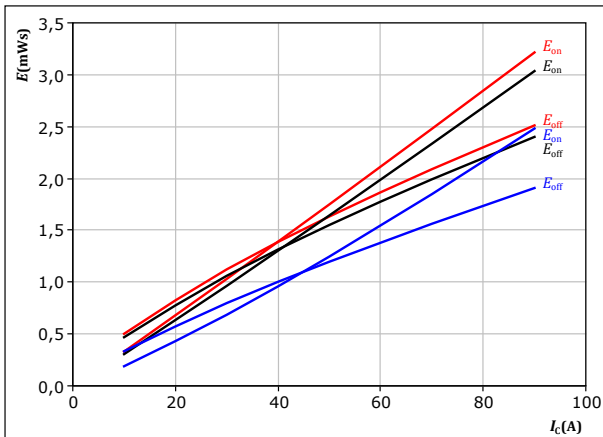
V23990-P586-A20-PM  
datasheet

## 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

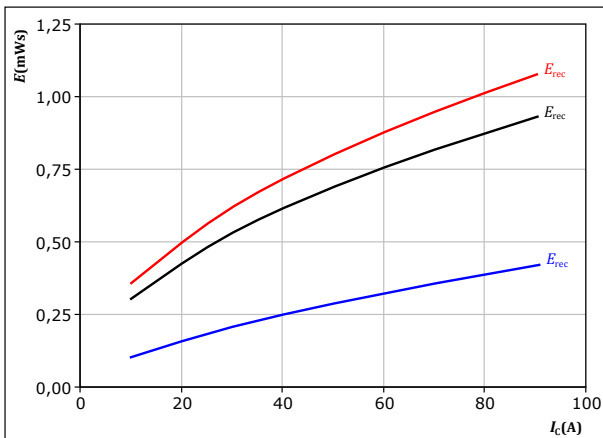
$V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 16 \text{ } \Omega$   
 $R_{goff} = 16 \text{ } \Omega$

$T_j$ :  
— 25 °C  
— 125 °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

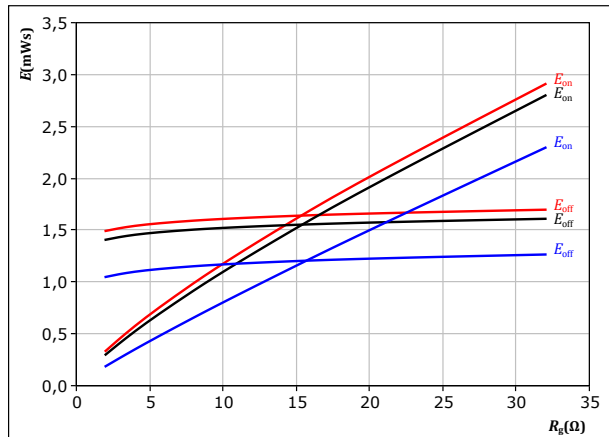
$V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 16 \text{ } \Omega$

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

figure 19. IGBT

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

$$E = f(R_g)$$



With an inductive load at

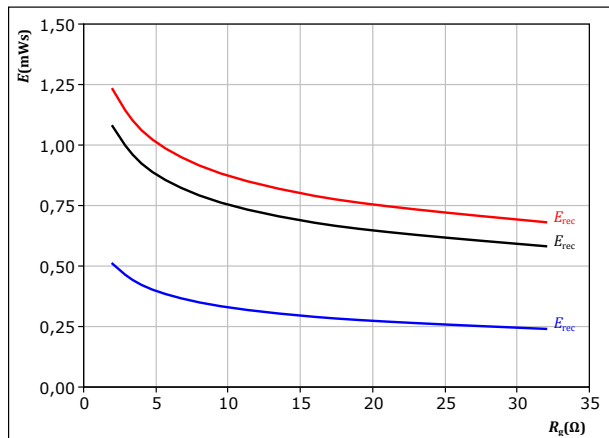
$V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 50 \text{ A}$

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

figure 21. 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

$V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 50 \text{ A}$

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



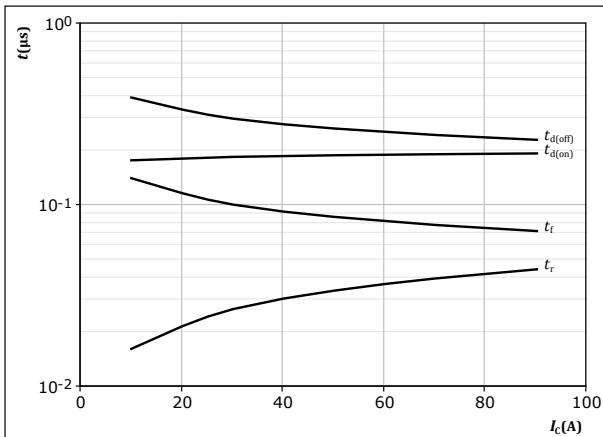
## Inverter Switching Characteristics

figure 22.

IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



With an inductive load at

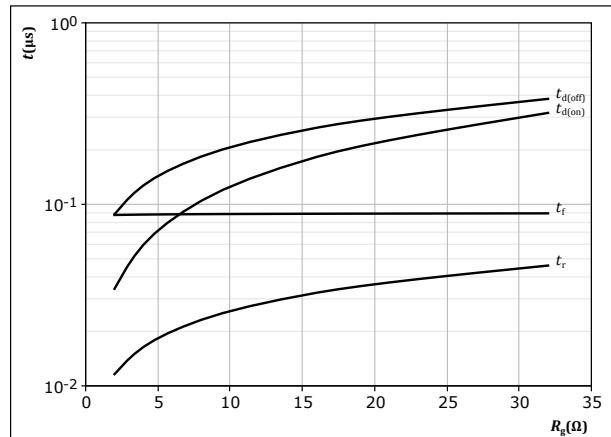
$T_j =$	150	°C
$V_{CE} =$	350	V
$V_{GE} =$	±15	V
$R_{gon} =$	16	Ω
$R_{goff} =$	16	Ω

figure 23.

IGBT

Typical switching times as a function of IGBT turn on gate resistor

$$t = f(R_g)$$



With an inductive load at

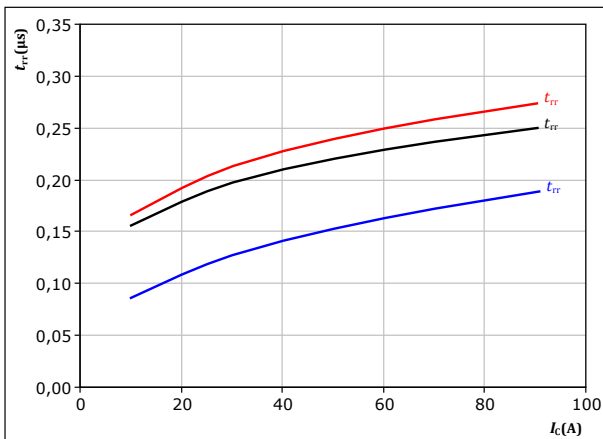
$T_j =$	150	°C
$V_{CE} =$	350	V
$V_{GE} =$	±15	V
$I_C =$	50	A

figure 24.

FWD

Typical reverse recovery time as a function of collector current

$$t_{rr} = f(I_C)$$



With an inductive load at

$V_{CE} =$	350	V
$V_{GE} =$	±15	V
$R_{gon} =$	16	Ω

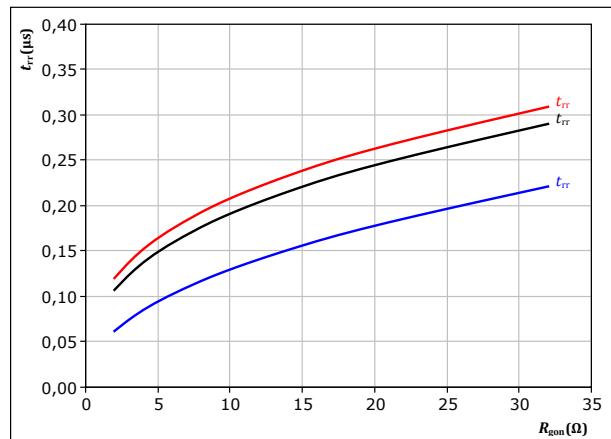
$T_j:$	25 °C
	125 °C
	150 °C

figure 25.

FWD

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

$$t_{rr} = f(R_{gon})$$



With an inductive load at

$V_{CE} =$	350	V
$V_{GE} =$	±15	V
$I_C =$	50	A

$T_j:$	25 °C
	125 °C
	150 °C



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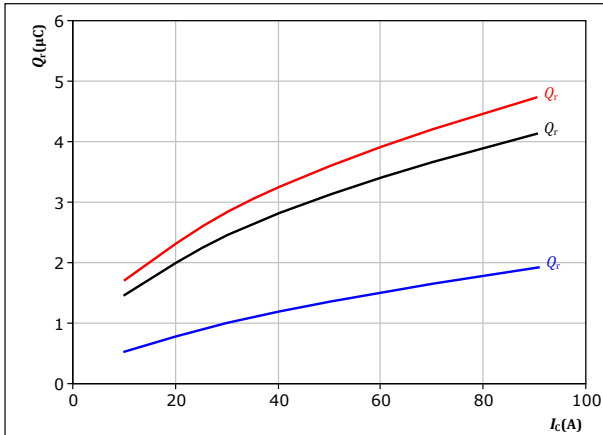
## Inverter Switching Characteristics

figure 26.

FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

$V_{CE} = 350$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 16$  Ω

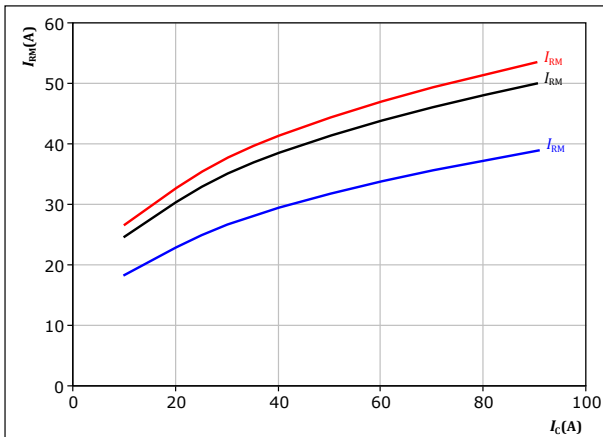
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 28.

FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

$V_{CE} = 350$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 16$  Ω

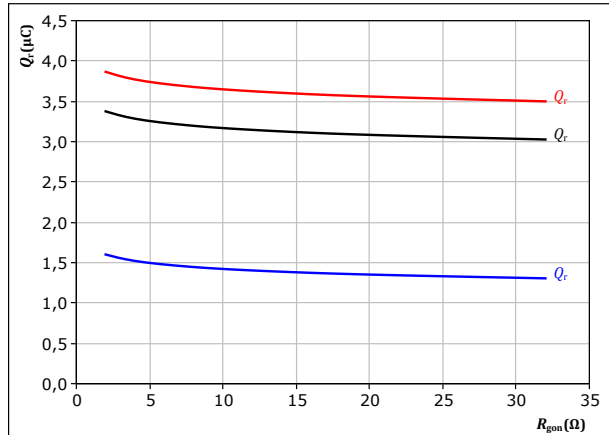
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 27.

FWD

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

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



With an inductive load at

$V_{CE} = 350$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 50$  A

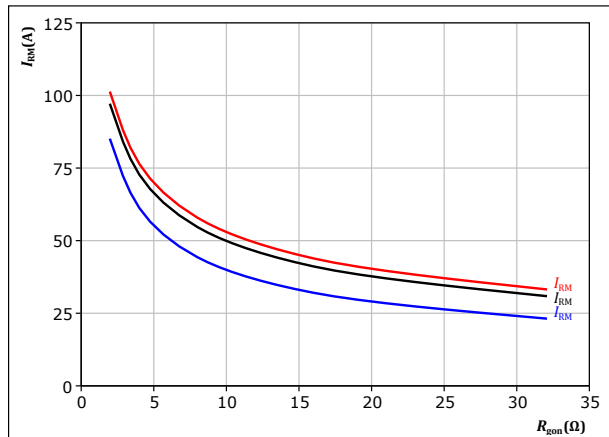
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 29.

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

$V_{CE} = 350$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 50$  A

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



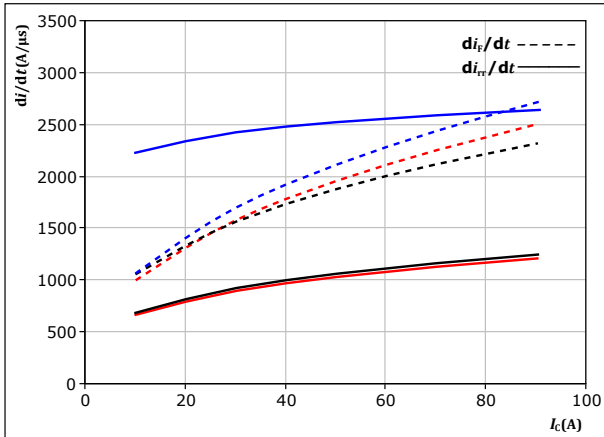
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## Inverter Switching Characteristics

figure 30. FWD

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



With an inductive load at

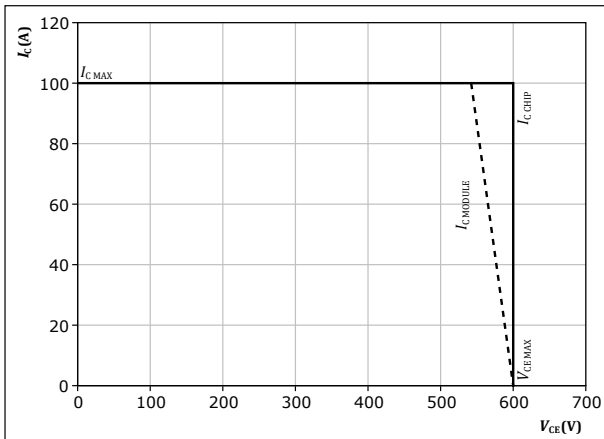
$V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 16 \text{ } \Omega$

$T_j$ : 25 °C  
125 °C  
150 °C

figure 32. IGBT

Reverse bias safe operating area

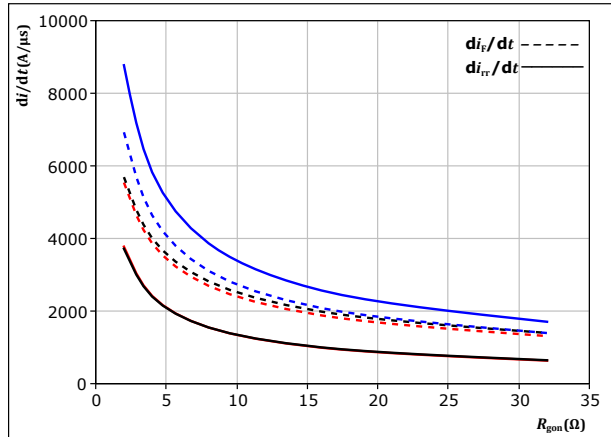
$I_C = f(V_{CE})$



At  $T_j = 150 \text{ } ^\circ\text{C}$   
 $R_{gon} = 16 \text{ } \Omega$   
 $R_{goff} = 16 \text{ } \Omega$

figure 31. 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

$V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 50 \text{ A}$

$T_j$ : 25 °C  
125 °C  
150 °C





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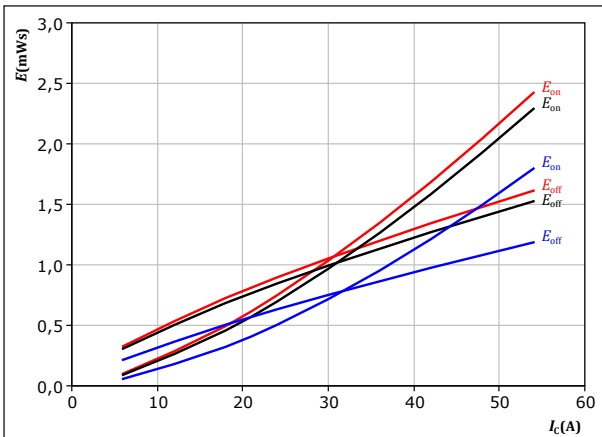
## Brake Switching Characteristics

figure 33.

IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_c)$$



With an inductive load at

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 8$   $\Omega$   
 $R_{goff} = 8$   $\Omega$

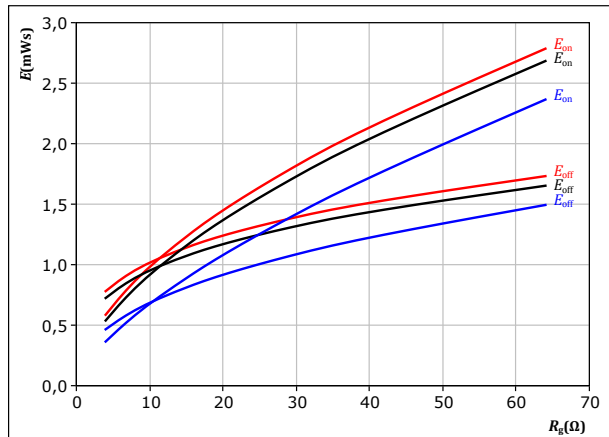
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 34.

IGBT

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

$$E = f(R_g)$$



With an inductive load at

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 30$  A

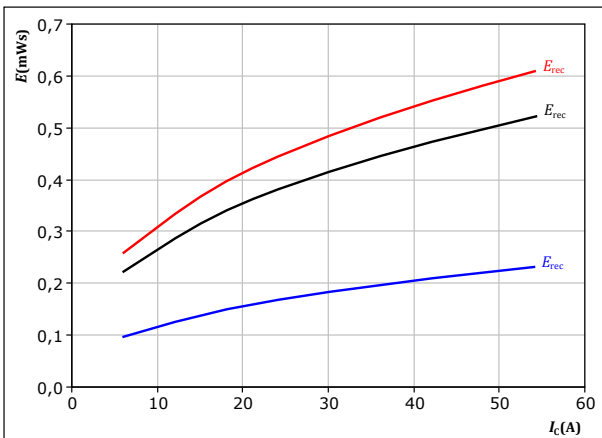
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 35.

FWD

Typical reverse recovered energy loss as a function of collector current

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



With an inductive load at

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 8$   $\Omega$

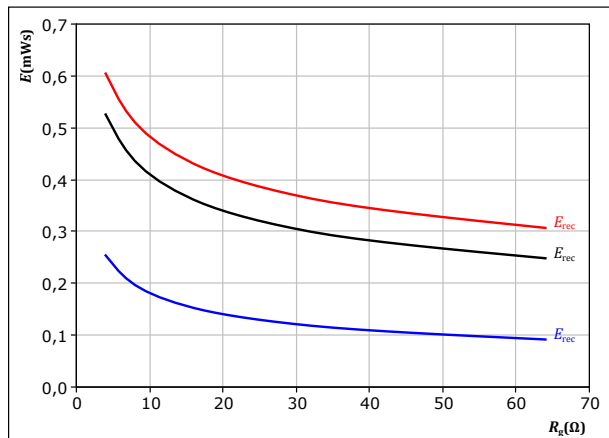
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 36.

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

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 30$  A

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



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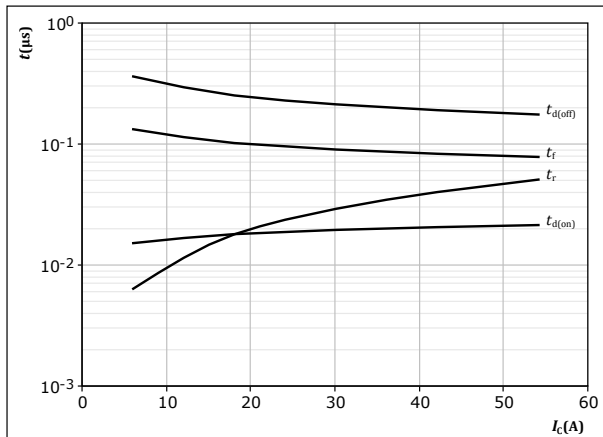
V23990-P586-A20-PM  
datasheet

## Brake Switching Characteristics

figure 37.

IGBT

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



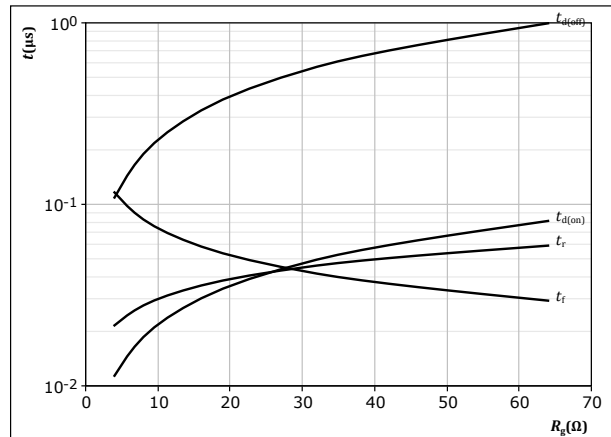
With an inductive load at

$T_j = 150$  °C  
 $V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 8$   $\Omega$   
 $R_{goff} = 8$   $\Omega$

figure 38.

IGBT

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



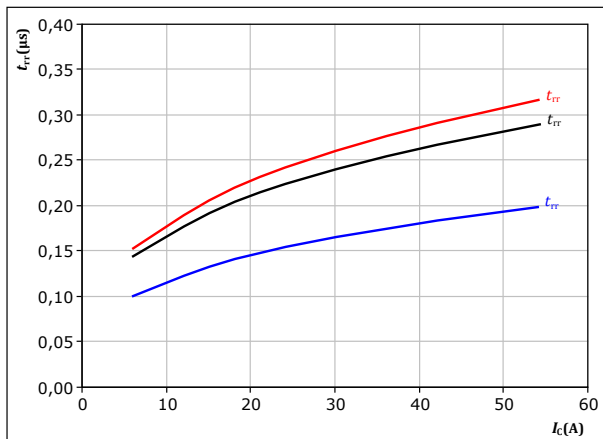
With an inductive load at

$T_j = 150$  °C  
 $V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $I_C = 30$  A

figure 39.

FWD

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



With an inductive load at

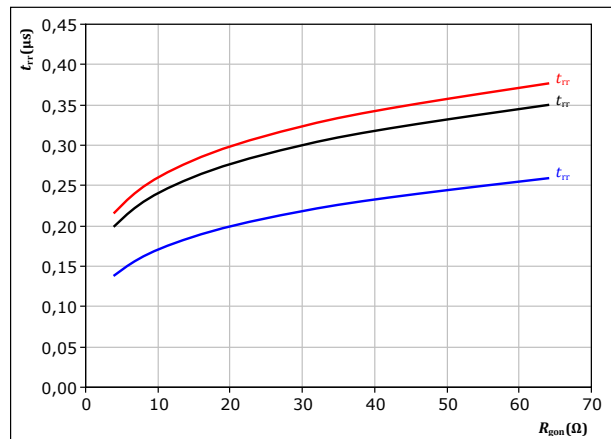
$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 8$   $\Omega$

$T_j$ : 25 °C  
125 °C  
150 °C

figure 40.

FWD

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



With an inductive load at

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $I_C = 30$  A

$T_j$ : 25 °C  
125 °C  
150 °C



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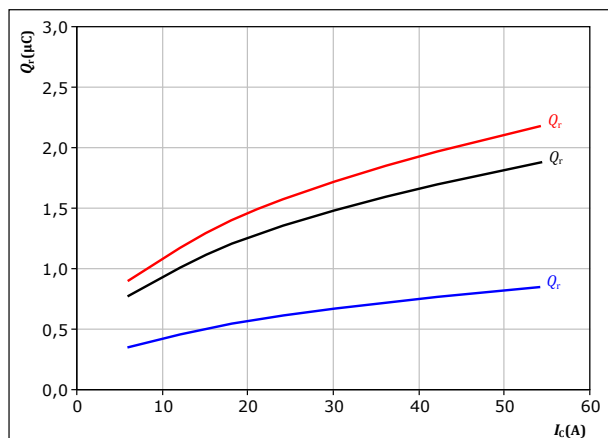
## Brake Switching Characteristics

figure 41.

FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 8$  Ω

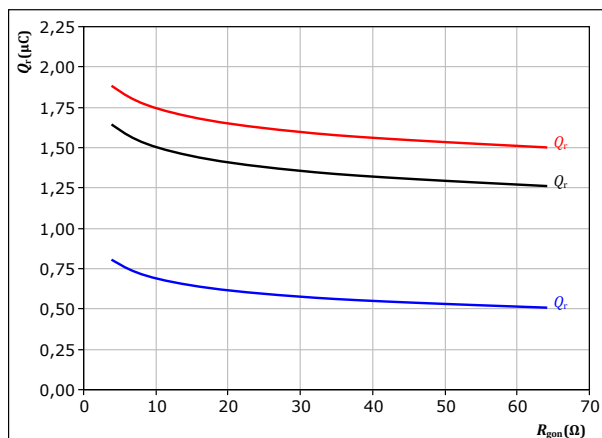
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 42.

FWD

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

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



With an inductive load at

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 30$  A

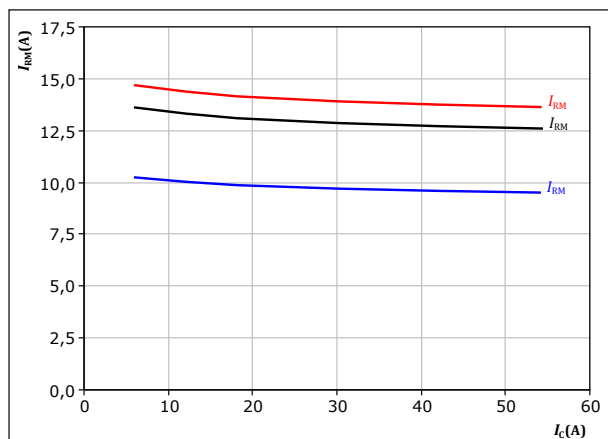
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 43.

FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 8$  Ω

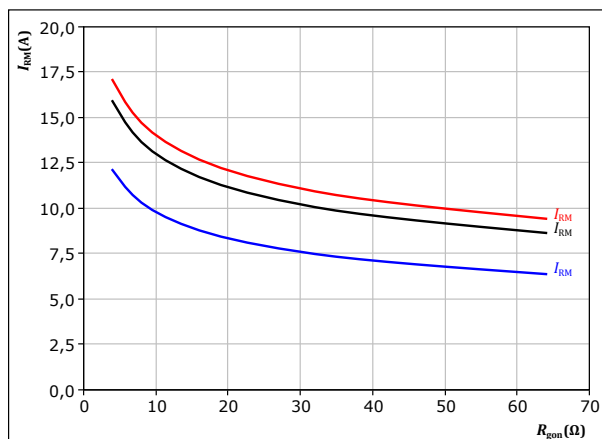
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 44.

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

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 30$  A

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



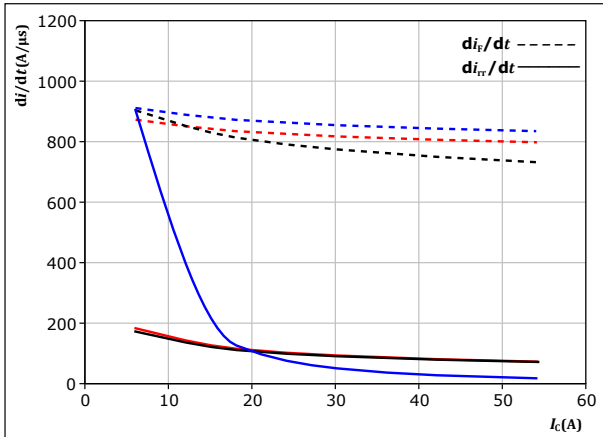
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## Brake Switching Characteristics

figure 45. FWD

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



With an inductive load at

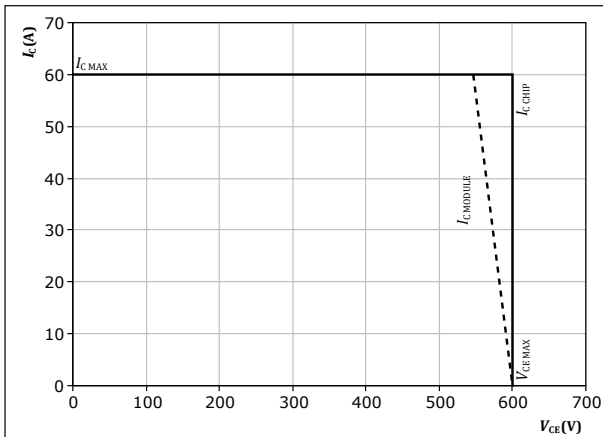
$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 8$   $\Omega$

$T_j$ : 25 °C  
125 °C  
150 °C

figure 47. IGBT

Reverse bias safe operating area

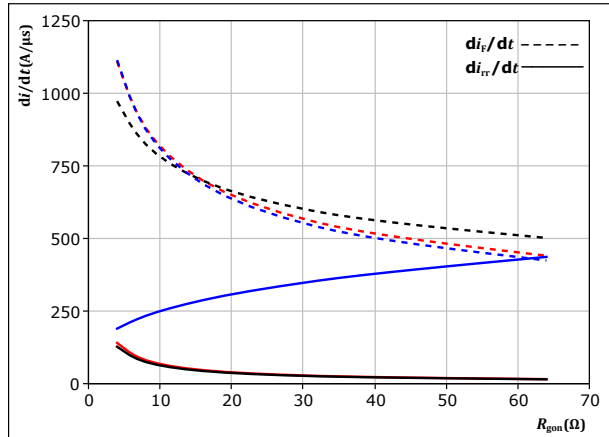
$I_C = f(V_{CE})$



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

figure 46. 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

$V_{CE} = 400$  V  
 $V_{GE} = 0/15$  V  
 $I_C = 30$  A

$T_j$ : 25 °C  
125 °C  
150 °C



## 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  $E_{on}$ )



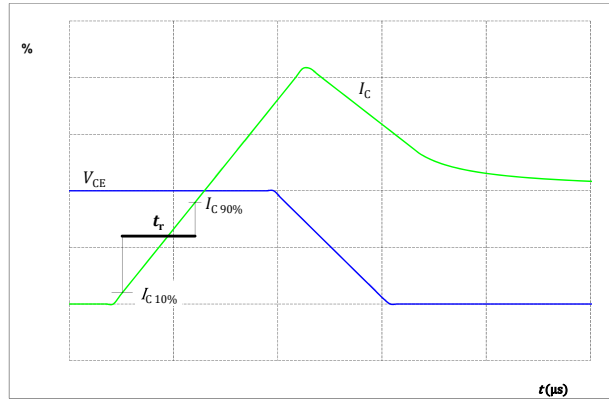
figure 50. IGBT

Turn-off Switching Waveforms & definition of  $t_f$



figure 51. IGBT

Turn-on Switching Waveforms & definition of  $t_r$





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## 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  $Q_r$ )





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# V23990-P586-A20-PM

datasheet

Ordering Code	
Version	Ordering Code
Without thermal paste	V23990-P586-A20-PM
With thermal paste (5,2 W/mK, PTM6000HV)	V23990-P586-A20-/7/-PM
With thermal paste (3,4 W/mK, PSX-P7)	V23990-P586-A20-/3/-PM

Marking							
	Text	VIN	Date code	Type&Ver	UL	Lot	Serial
		VIN	WWYY	TTTTTTVV	UL	LLLL	SSSS
	Datamatrix	Type&Ver	Lot number	Serial	Date code		
		TTTTTTVV	LLLL	SSSS	WWYY		

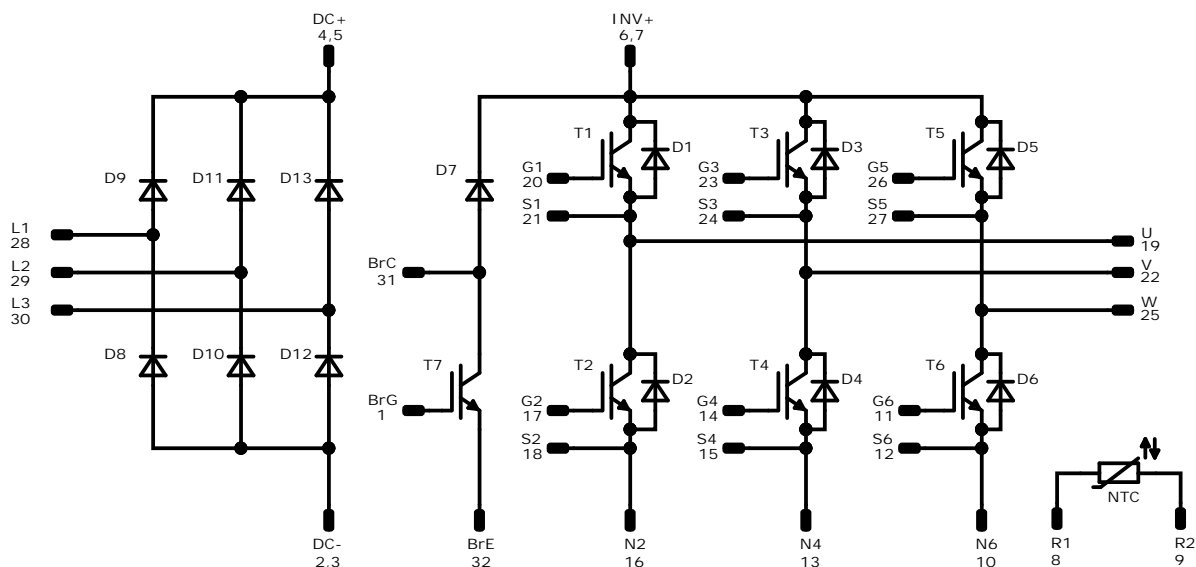
Outline				
Pin table [mm]				
Pin	X	Y	Function	
1	52,55	0	BrG	
2	47,7	0	DC-	
3	44,8	0	DC-	
4	37,8	0	DC+	
5	37,8	2,8	DC+	
6	35	0	Inv+	
7	35	2,8	Inv+	
8	28	0	R1	
9	25,2	0	R2	
10	22,4	0	N6	
11	19,6	0	G6	
12	16,8	0	S6	
13	14	0	N4	
14	11,2	0	G4	
15	8,4	0	S4	
16	5,6	0	N2	
17	2,8	0	G2	
18	0	0	S2	
19	0	28,5	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	

Outline drawing of the V23990-P586-A20-PM package. The top view shows a rectangular package with 32 pins. The side view shows the package height and pin pitch. Dimensions are given in mm. The package is shown in a perspective view.

Tolerance of pinpositions:  $\pm 0,5\text{mm}$  at the end of pins  
Dimension of coordinate axis is only offset without tolerance



Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T2, T1, T4, T3, T6, T5	IGBT	600 V	50 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	600 V	50 A	Inverter Diode	
T7	IGBT	600 V	30 A	Brake Switch	
D7	FWD	600 V	20 A	Brake Diode	
D8, D9, D10, D11, D12, D13	Rectifier	1600 V	35 A	Rectifier Diode	
NTC	NTC			Thermistor	





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**V23990-P586-A20-PM**  
datasheet

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-P586-A20-PM-D6-14	5 May. 2022	Separate datasheet for pressfit pin version & housing	

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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.