



Vincotech

# V23990-P589-A418-PM

datasheet

flowPIM 1

1200 V / 25 A

## Features

- Three-phase rectifier, optional BRC, Inverter, NTC
- Very compact housing, easy to route
- IGBT4 / EmCon4 technology for low saturation losses and improved EMC behaviour

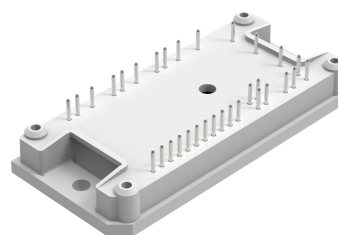
## Target applications

- Industrial drives
- Embedded Drives

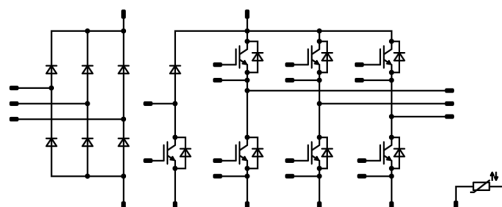
## Types

- V23990-P589-A418-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      | $^{\circ}\text{C}$ |

## Inverter Diode

|                                 |            |                                       |      |                    |
|---------------------------------|------------|---------------------------------------|------|--------------------|
| 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  | $^{\circ}\text{C}$ |

## Brake Switch

|                                   |            |  |          |                    |
|-----------------------------------|------------|--|----------|--------------------|
| 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,<br>$t_p = 10\text{ ms}$ $T_j = 150\text{ °C}$ | 270  | A   |
| Surge current capability               | $I^2t$     |  | 370  | A²s |
| 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                  |            |                                     | 7,91  | mm |
| Comparative Tracking Index | CTI        |                                     | ≥ 200 |    |

\*100 % tested in production



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## Characteristic Values

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

### 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 | $V_{CEsat}$  |                     | 15 |      | 25      | 25<br>150 | 1,58 | 1,87<br>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> | $R_{th(j-s)}$ | $\lambda_{paste} = 3,4 \text{ W/mK}$<br>(PSX) |  |  |  |  |  | 0,96 |  | K/W |
|--|---------------|---|--|--|--|--|--|------|--|-----|

#### Dynamic

|                             |              |   |          |     |    |           |  |                |  |     |
|-----------------------------|--------------|---|----------|-----|----|-----------|--|----------------|--|-----|
| Turn-on delay time          | $t_{d(on)}$  | $R_{gon} = 32 \Omega$<br>$R_{goff} = 32 \Omega$ | $\pm 15$ | 600 | 25 | 25<br>150 |  | 126,2<br>126,4 |  | ns  |
| Rise time                   | $t_r$        |   |          |     |    | 25<br>150 |  | 21,4<br>28     |  | ns  |
| Turn-off delay time         | $t_{d(off)}$ |   |          |     |    | 25<br>150 |  | 220,2<br>284   |  | ns  |
| Fall time                   | $t_f$        |   |          |     |    | 25<br>150 |  | 74,2<br>99,96  |  | ns  |
| Turn-on energy (per pulse)  | $E_{on}$     |   |          |     |    | 25<br>150 |  | 1,64<br>2,53   |  | mWs |
| Turn-off energy (per pulse) | $E_{off}$    |   |          |     |    | 25<br>150 |  | 1,38<br>2,17   |  | mWs |



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## Characteristic Values

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

### Inverter Diode

#### Static

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

#### Thermal

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

#### Dynamic

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



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## Characteristic Values

| Parameter | Symbol | Conditions |                              |   |                                     |            | Values |     |     | Unit |
|-----------|--------|------------|------------------------------|---|-------------------------------------|------------|--------|-----|-----|------|
|           |        |            | $V_{GE}$ [V]<br>$V_{GS}$ [V] | $V_{CE}$ [V]<br>$V_{DS}$ [V]<br>$V_F$ [V] | $I_C$ [A]<br>$I_D$ [A]<br>$I_F$ [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 | $V_{CEsat}$  |                     | 15 |      | 15     | 25<br>125 | 1,58 | 1,88<br>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> | $R_{th(j-s)}$ | $\lambda_{paste} = 3,4 \text{ W/mK}$<br>(PSX) |  |  |  |  |  | 1,35 |  | K/W |
|--|---------------|---|--|--|--|--|--|------|--|-----|

#### Dynamic

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



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## Characteristic Values

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

### Brake Diode

#### Static

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

#### Thermal

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

#### Dynamic

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



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## Characteristic Values

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

### Rectifier Diode

#### Static

|                         |       |                |  |  |    |           |  |                |   |    |
|-------------------------|-------|----------------|--|--|----|-----------|--|----------------|---|----|
| Forward voltage         | $V_F$ |                |  |  | 13 | 25<br>125 |  | 0,988<br>0,899 | 1,21 <sup>(1)</sup><br>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<br>(PSX) |  |  |  |  |  | 1,25 |  | K/W |
|--|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|

### 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.



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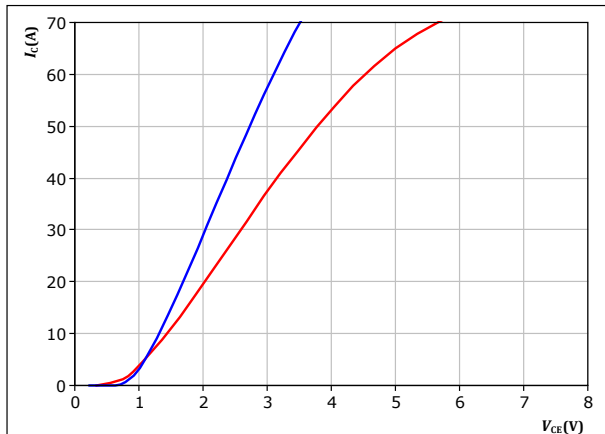
V23990-P589-A418-PM  
datasheet

## Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

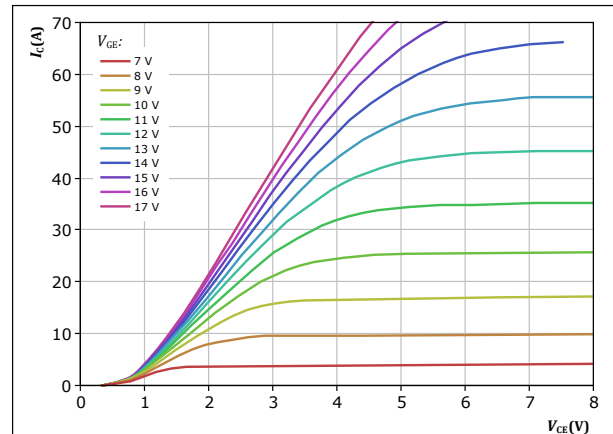


$t_p = 250 \mu s$   
 $V_{GE} = 15 V$   
 $T_j:$  — 25 °C  
— 150 °C

figure 2. IGBT

Typical output characteristics

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

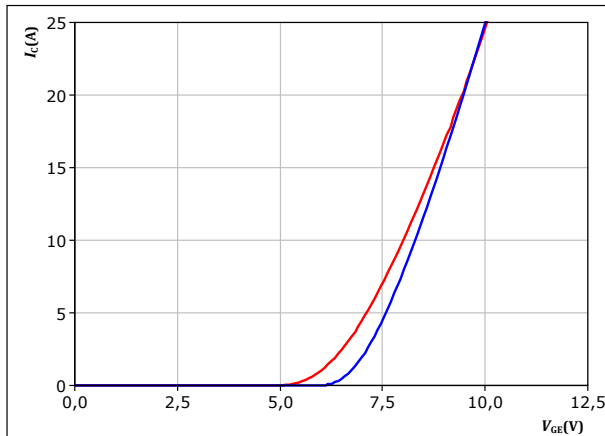


$t_p = 250 \mu s$   
 $T_j = 150 ^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

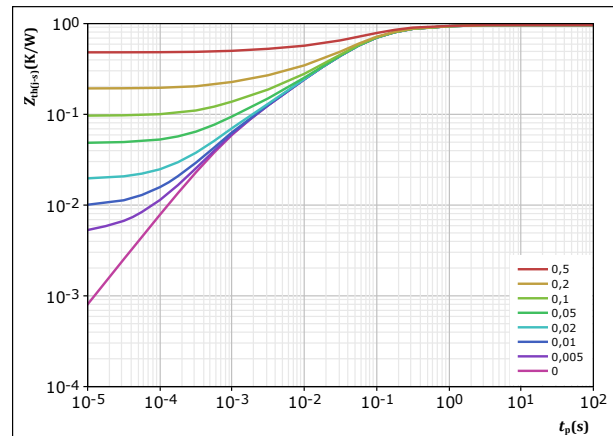


$t_p = 250 \mu s$   
 $V_{CE} = 10 V$   
 $T_j:$  — 25 °C  
— 150 °C

figure 4. IGBT

Transient thermal impedance as a function of pulse width

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



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



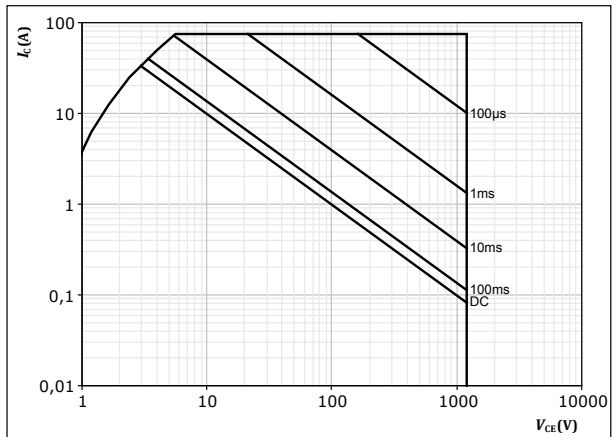
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## Inverter Switch Characteristics

**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

$$I_F = f(V_F)$$

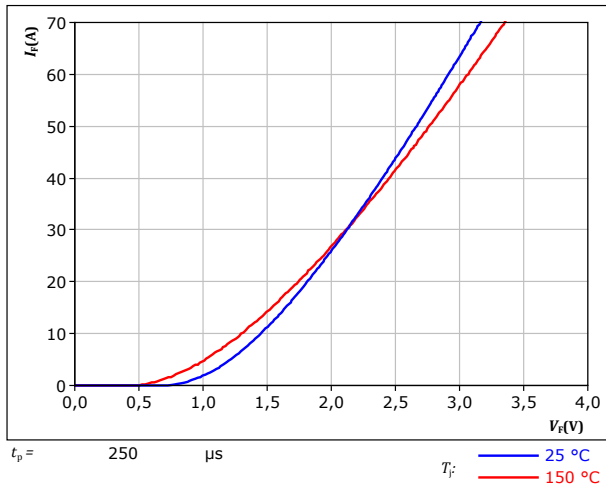
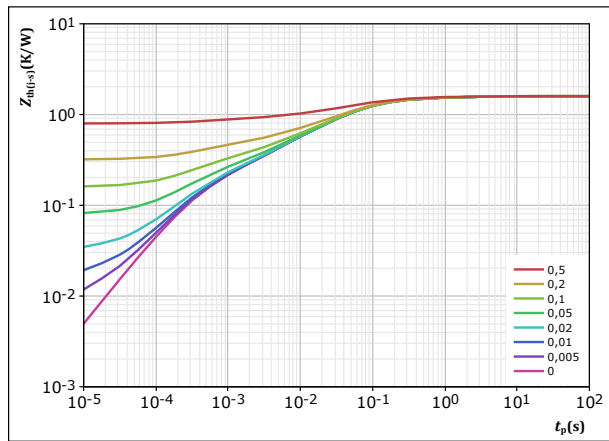


figure 7.

FWD

Transient thermal impedance as a function of pulse width

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



|                          |            |     |
|--------------------------|------------|-----|
| $D =$                    | $t_p / T$  |     |
| $R_{th(j-s)} =$          | 1,594      | 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   |     |



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# V23990-P589-A418-PM datasheet

## Brake Switch Characteristics

figure 8. IGBT

Typical output characteristics

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

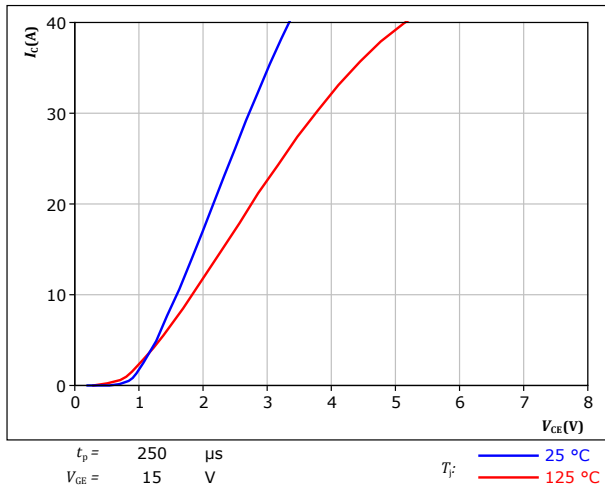


figure 9. IGBT

Typical output characteristics

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

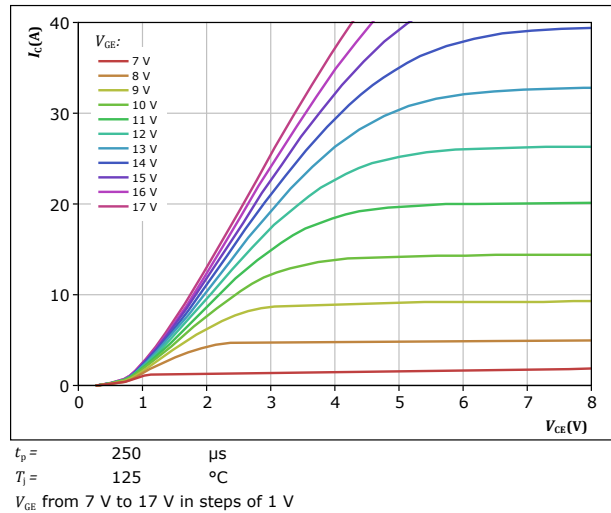


figure 10. IGBT

Typical transfer characteristics

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

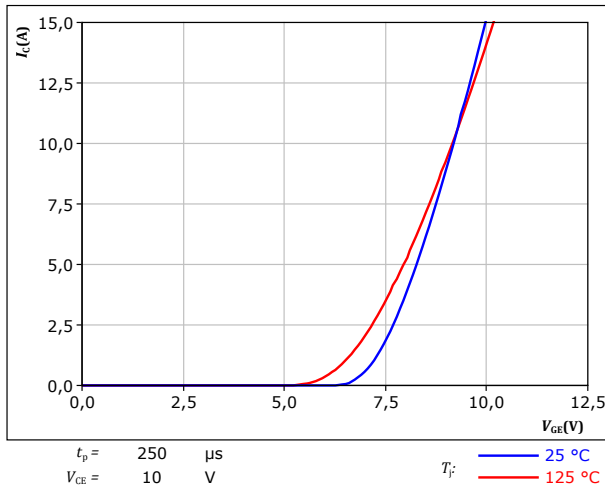
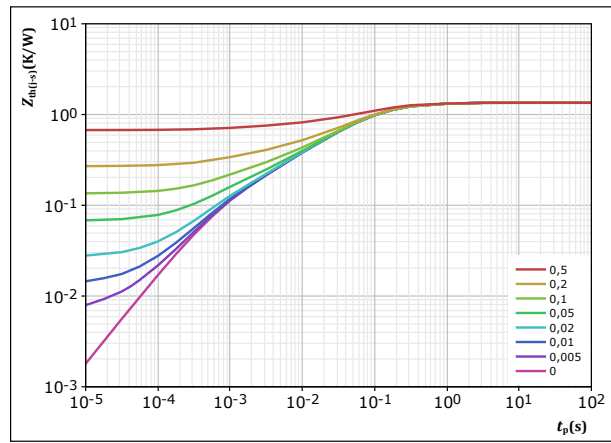


figure 11. IGBT

Transient thermal impedance as a function of pulse width

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



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   |



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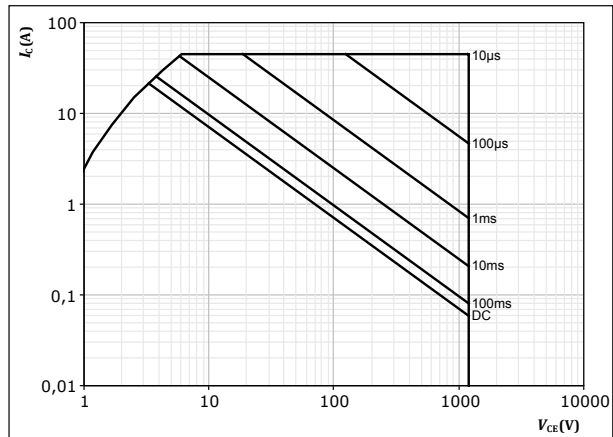
## Brake Switch Characteristics

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

$$I_F = f(V_F)$$

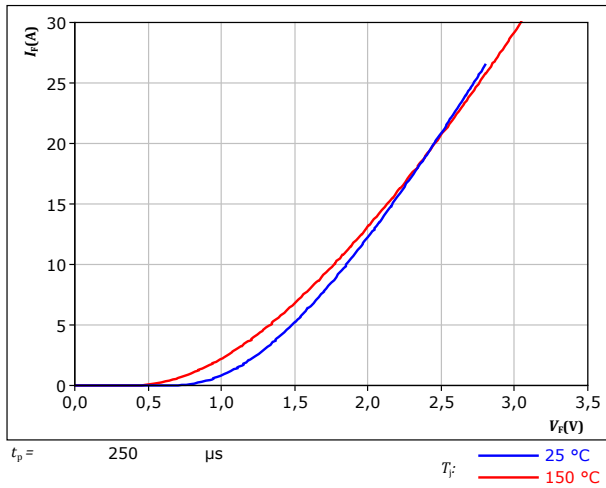
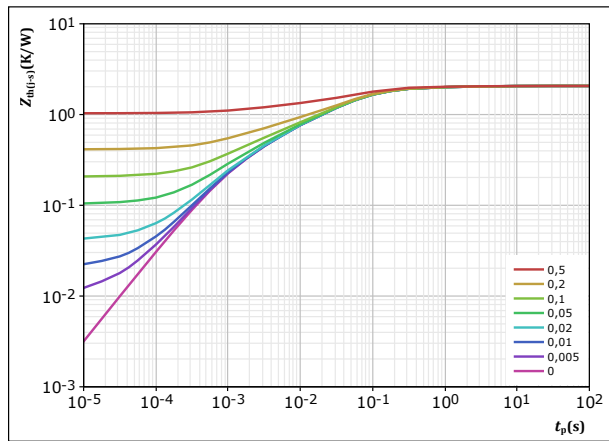


figure 14.

FWD

Transient thermal impedance as a function of pulse width

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





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## Rectifier Diode Characteristics

figure 15.

Rectifier

Typical forward characteristics

$$I_F = f(V_F)$$

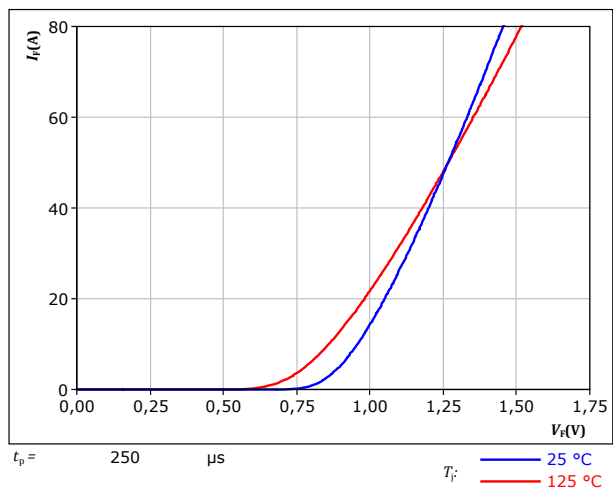
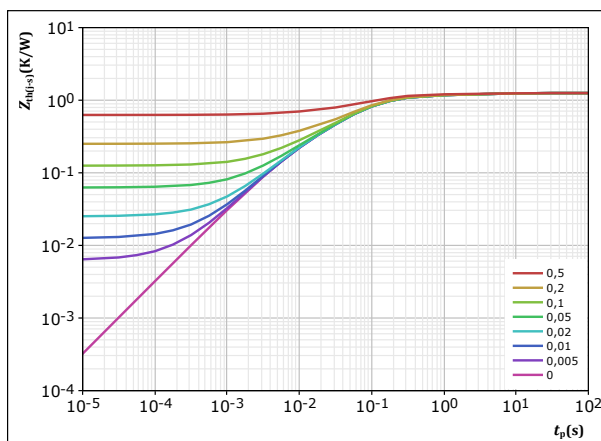


figure 16.

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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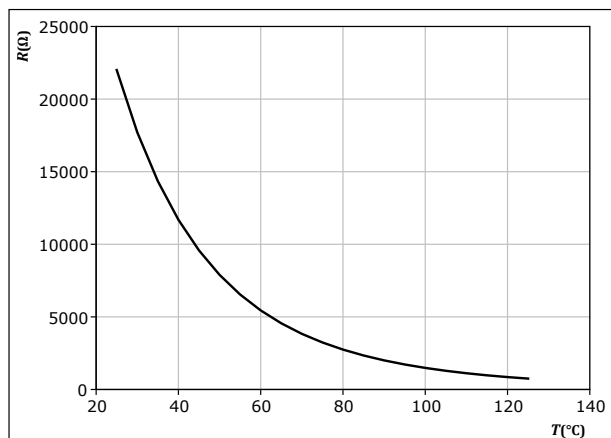
## Thermistor Characteristics

figure 17.

Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$





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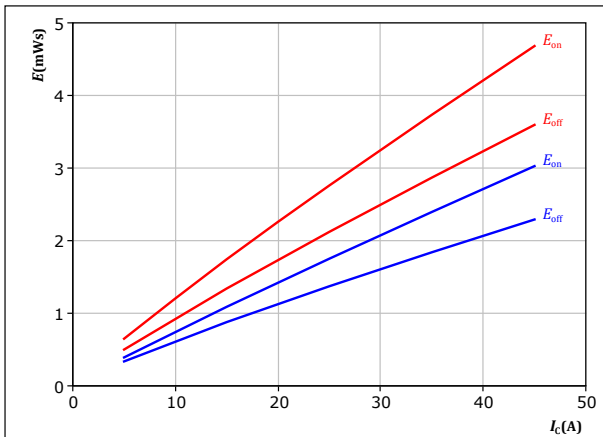
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datasheet

## 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

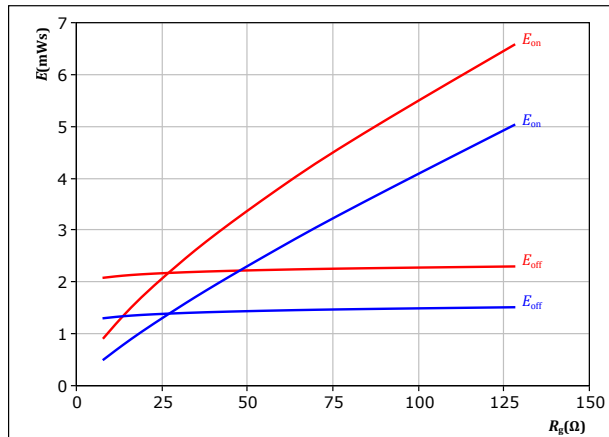
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 32 \text{ } \Omega$   
 $R_{goff} = 32 \text{ } \Omega$

$T_j$ : — 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

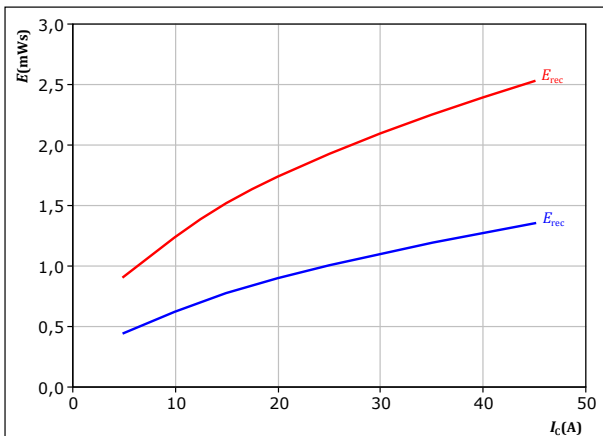
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 25 \text{ A}$

$T_j$ : — 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

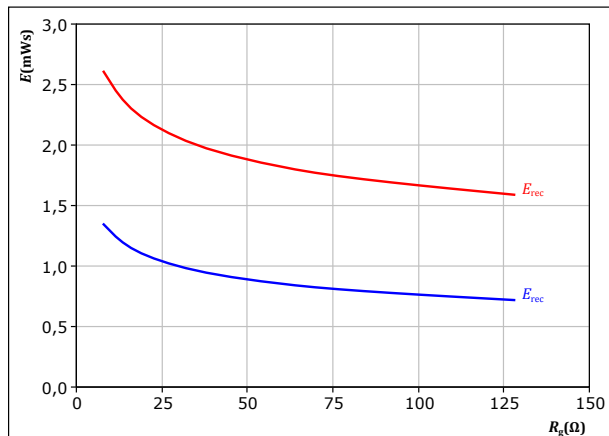
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 32 \text{ } \Omega$

$T_j$ : — 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



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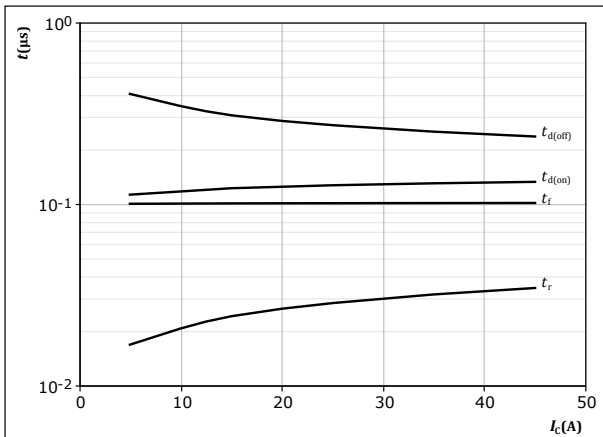
## Inverter Switching Characteristics

figure 22.

IGBT

Typical switching times as a function of collector current

$$t = f(I_c)$$



With an inductive load at

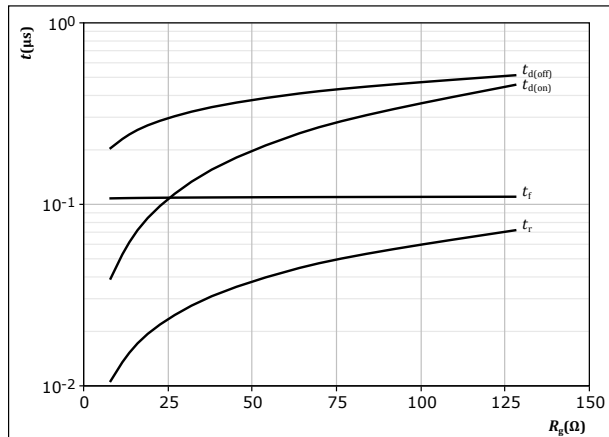
|              |     |    |
|--------------|-----|----|
| $T_j =$      | 150 | °C |
| $V_{CE} =$   | 600 | V  |
| $V_{GE} =$   | ±15 | V  |
| $R_{gon} =$  | 32  | Ω  |
| $R_{goff} =$ | 32  | Ω  |

figure 23.

IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



With an inductive load at

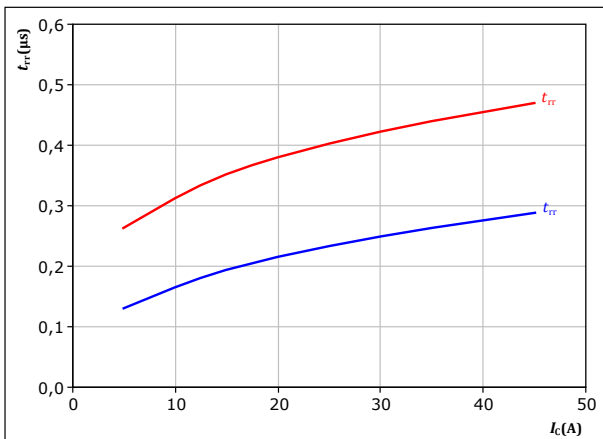
|            |     |    |
|------------|-----|----|
| $T_j =$    | 150 | °C |
| $V_{CE} =$ | 600 | V  |
| $V_{GE} =$ | ±15 | V  |
| $I_c =$    | 25  | A  |

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 |
| $V_{GE} =$  | ±15 | V |
| $R_{gon} =$ | 32  | Ω |

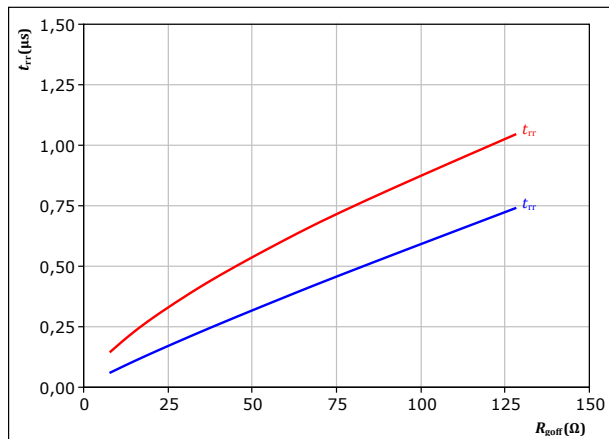
$T_j$ : — 25 °C  
— 150 °C

figure 25.

FWD

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

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



With an inductive load at

|            |     |   |
|------------|-----|---|
| $V_{CE} =$ | 600 | V |
| $V_{GE} =$ | ±15 | V |
| $I_c =$    | 25  | A |

$T_j$ : — 25 °C  
— 150 °C



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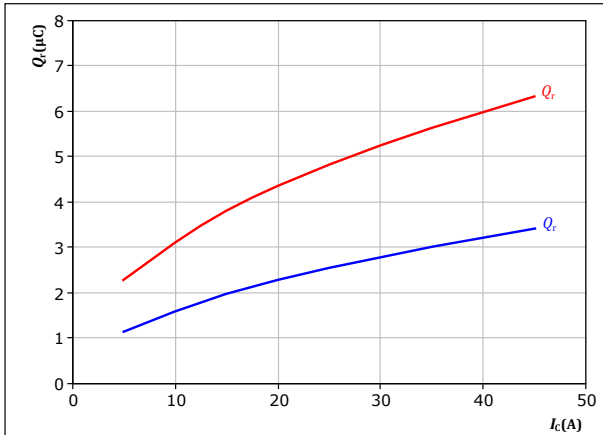
## Inverter Switching Characteristics

figure 26.

FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

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

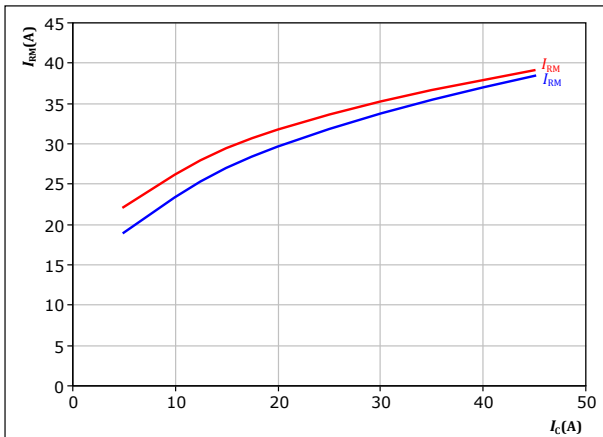
$T_j$ : — 25 °C  
— 150 °C

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  
 $R_{gon} = 32$  Ω

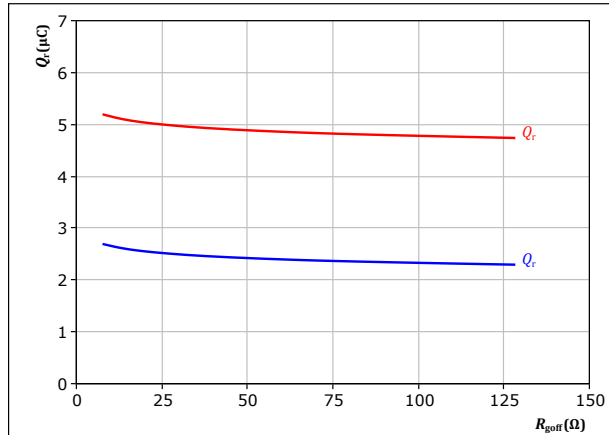
$T_j$ : — 25 °C  
— 150 °C

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

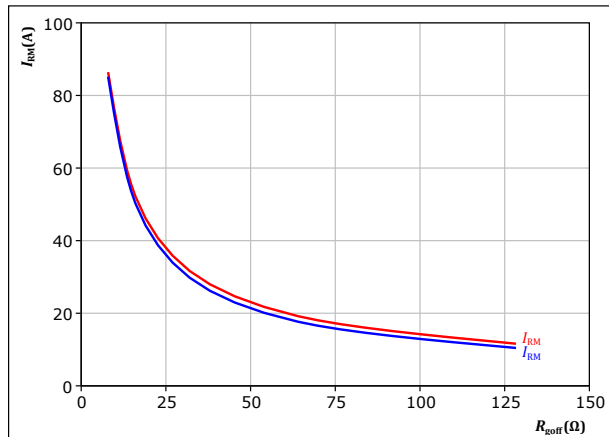
$T_j$ : — 25 °C  
— 150 °C

figure 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



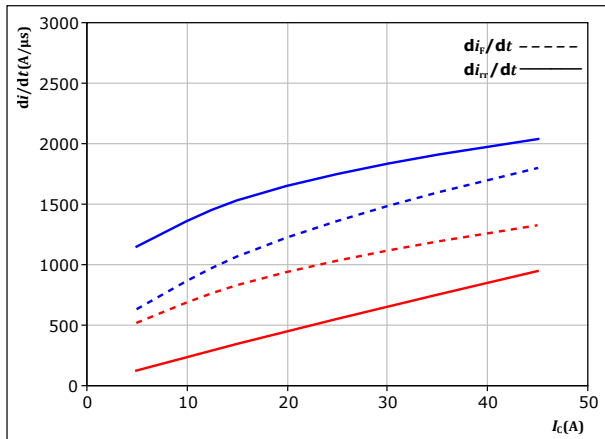
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## Inverter Switching Characteristics

figure 30. FWD

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



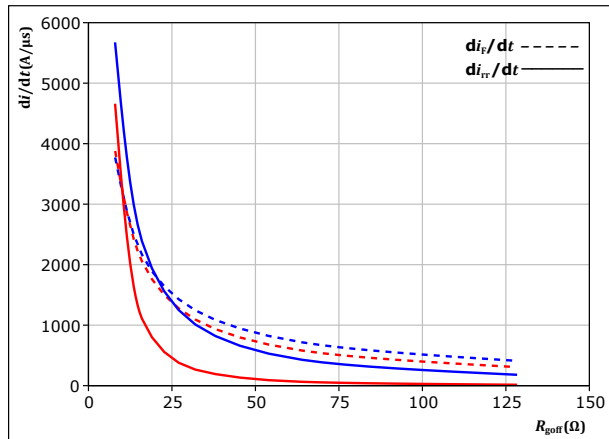
With an inductive load at

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

$T_j$ : — 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  
 $di_f/dt, di_r/dt = f(R_{goff})$



With an inductive load at

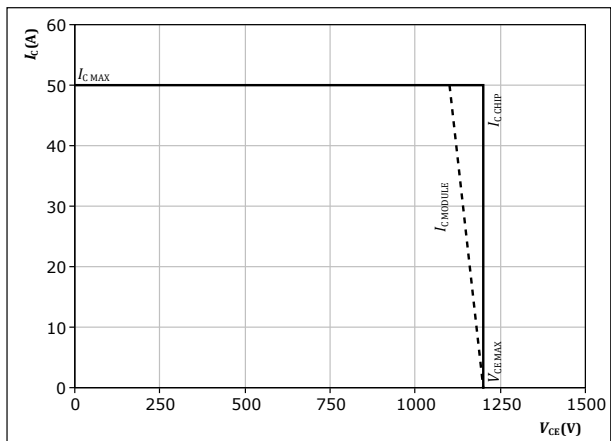
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 25 \text{ A}$

$T_j$ : — 25 °C  
— 150 °C

figure 32. IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



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



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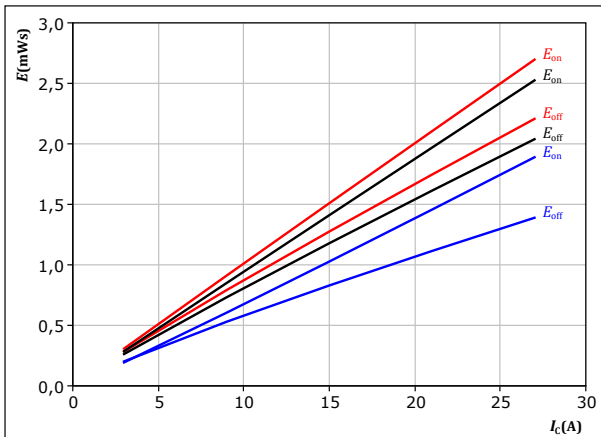
## Brake Switching Characteristics

figure 33.

IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_C)$$



With an inductive load at

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

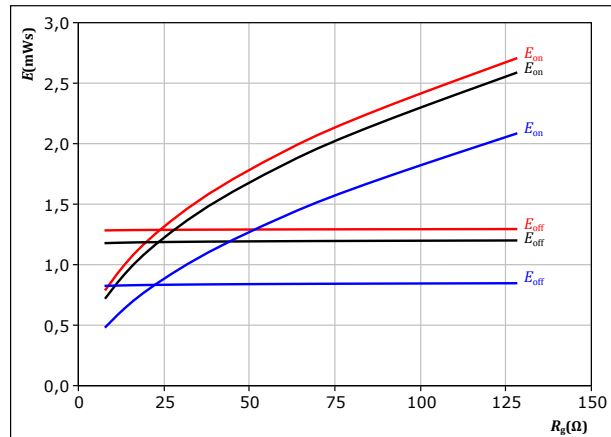
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 34.

IGBT

Typical switching energy losses as a function of gate resistor

$$E = f(R_g)$$



With an inductive load at

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

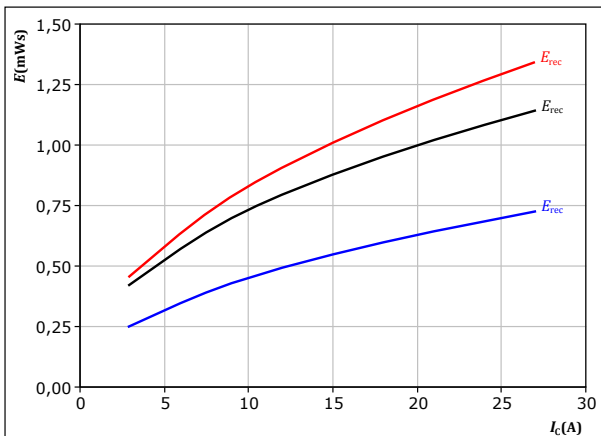
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 35.

FWD

Typical reverse recovered energy loss as a function of collector current

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



With an inductive load at

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

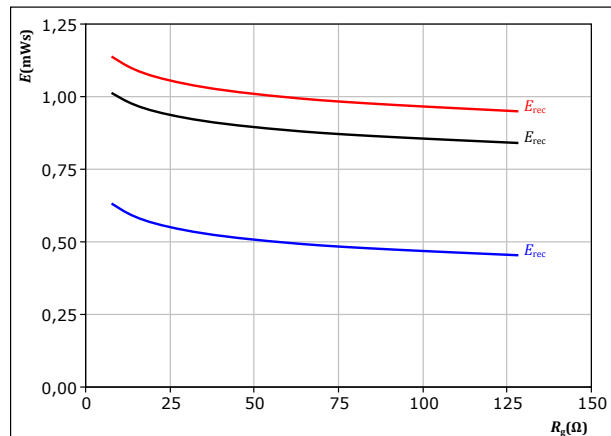
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 36.

FWD

Typical reverse recovered energy loss as a function of gate resistor

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



With an inductive load at

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

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

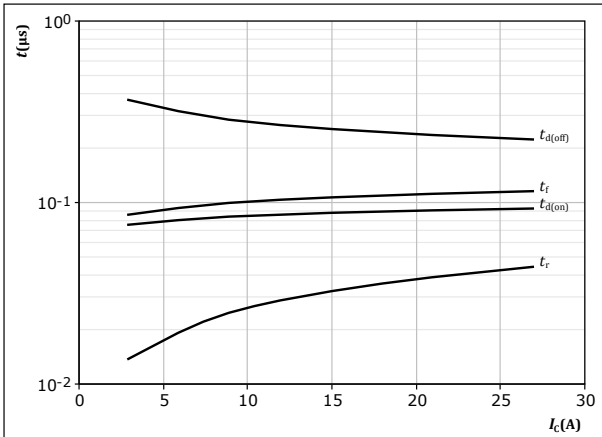


## Brake Switching Characteristics

figure 37.

IGBT

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



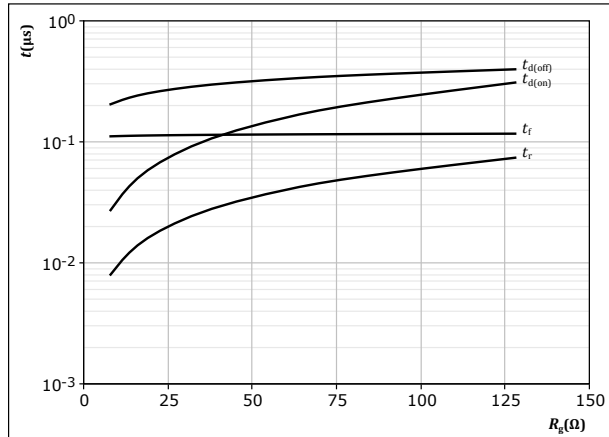
With an inductive load at

$T_j = 150$  °C  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$  Ω  
 $R_{goff} = 32$  Ω

figure 38.

IGBT

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



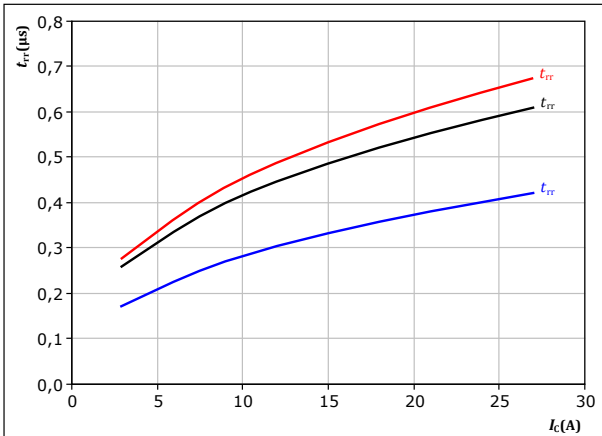
With an inductive load at

$T_j = 150$  °C  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 15$  A

figure 39.

FWD

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



With an inductive load at

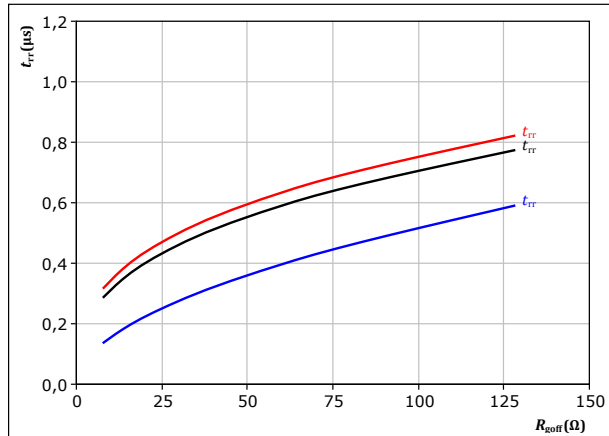
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$  Ω

$T_j$ : 25 °C  
125 °C  
150 °C

figure 40.

FWD

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



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



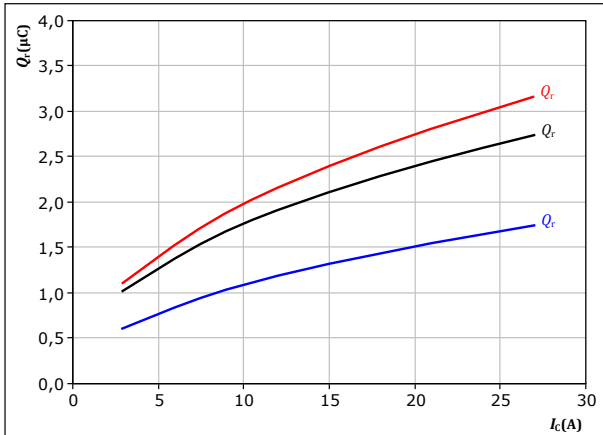
## Brake Switching Characteristics

figure 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  
 $R_{gon} = 32$  Ω

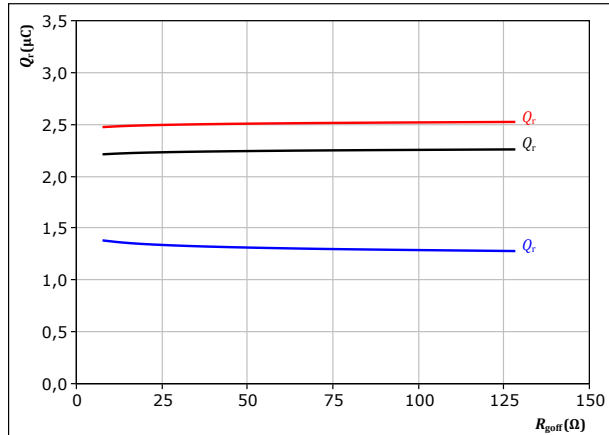
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

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

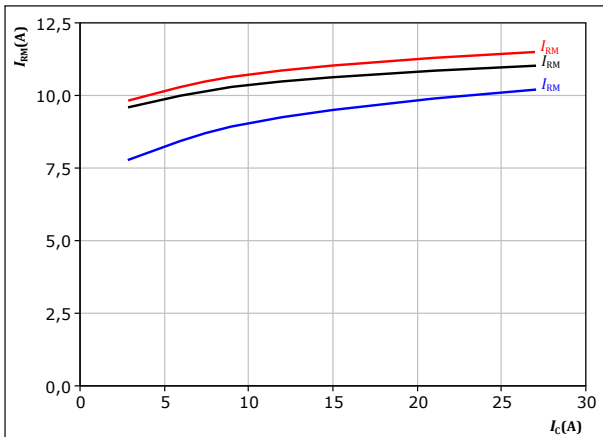
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

figure 43.

FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

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

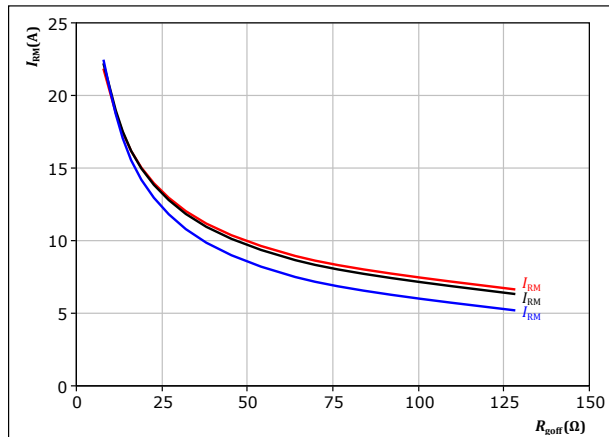
$T_j$ :  
— 25 °C  
— 125 °C  
— 150 °C

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  
— 125 °C  
— 150 °C



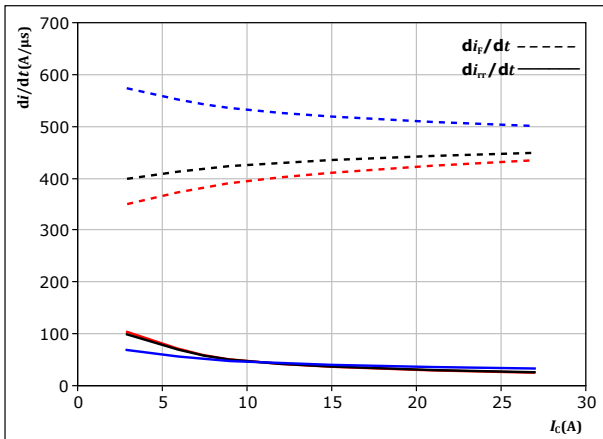
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## Brake Switching Characteristics

figure 45. FWD

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



With an inductive load at

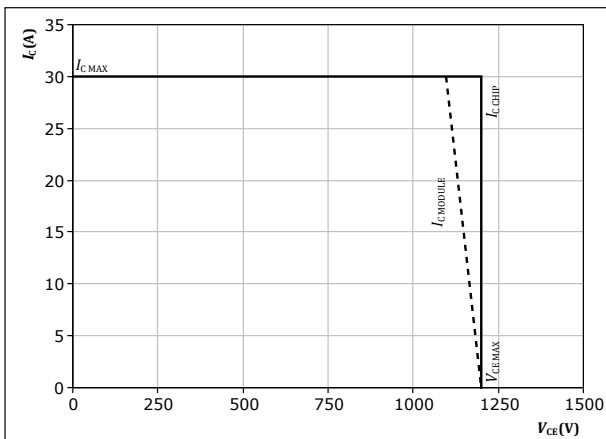
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$   $\Omega$

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

figure 47. IGBT

Reverse bias safe operating area

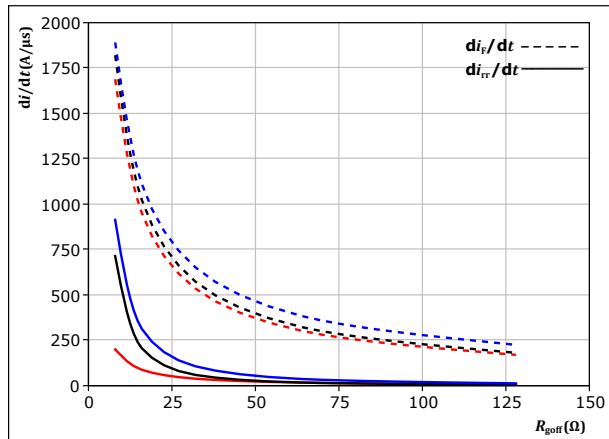
$I_c = f(V_{CE})$



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

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

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

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



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## Switching Definitions

figure 48. IGBT

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

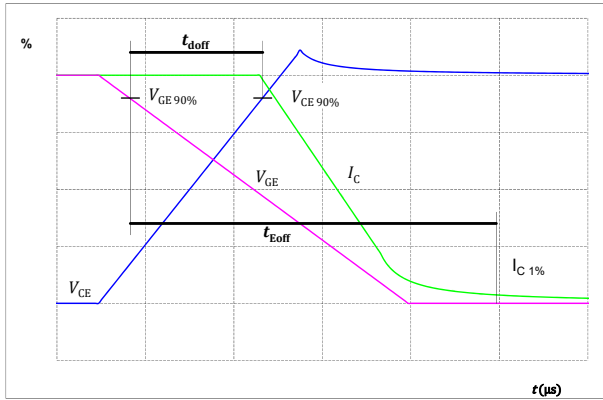


figure 49. IGBT

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

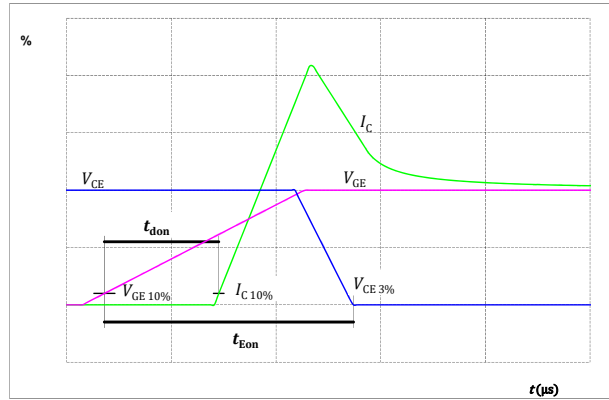


figure 50. IGBT

Turn-off Switching Waveforms & definition of  $t_f$

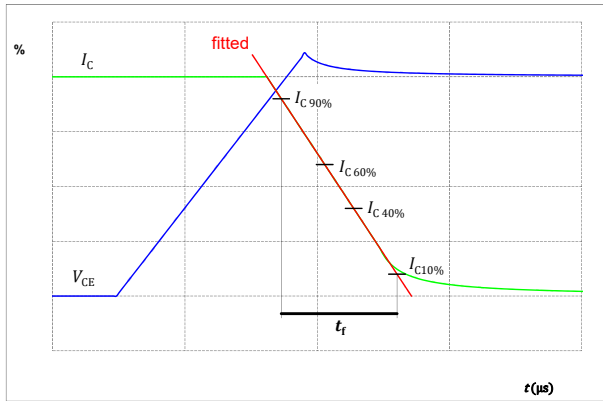
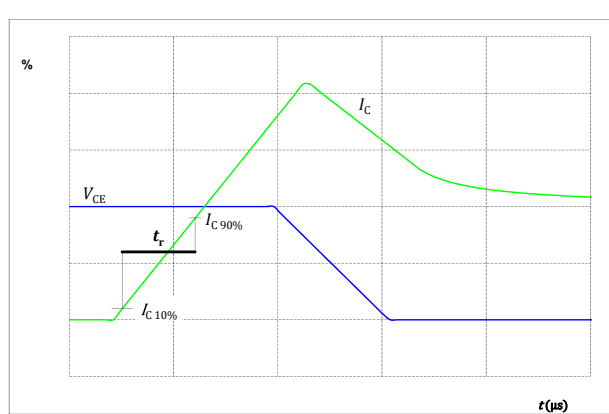


figure 51. IGBT

Turn-on Switching Waveforms & definition of  $t_r$





## Switching Definitions

figure 52.

FWD

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

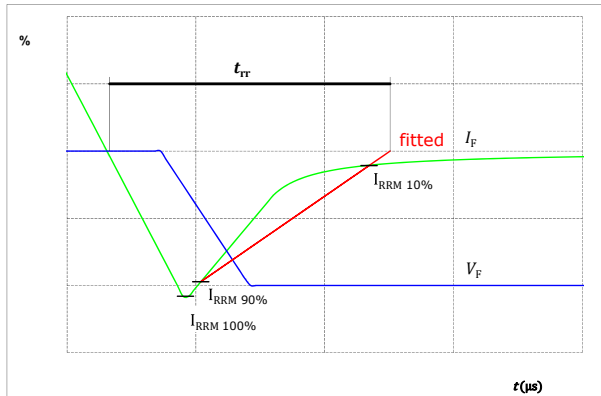
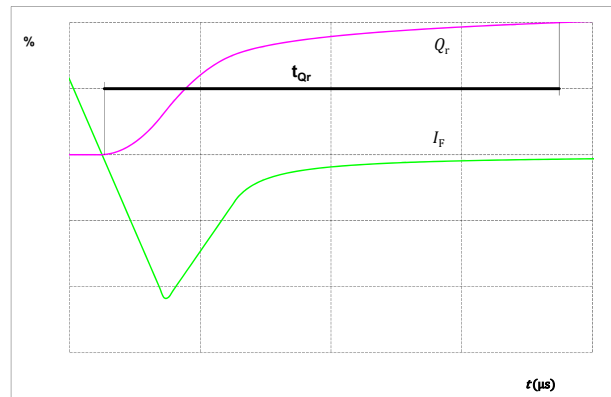


figure 53.

FWD

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







# V23990-P589-A418-PM

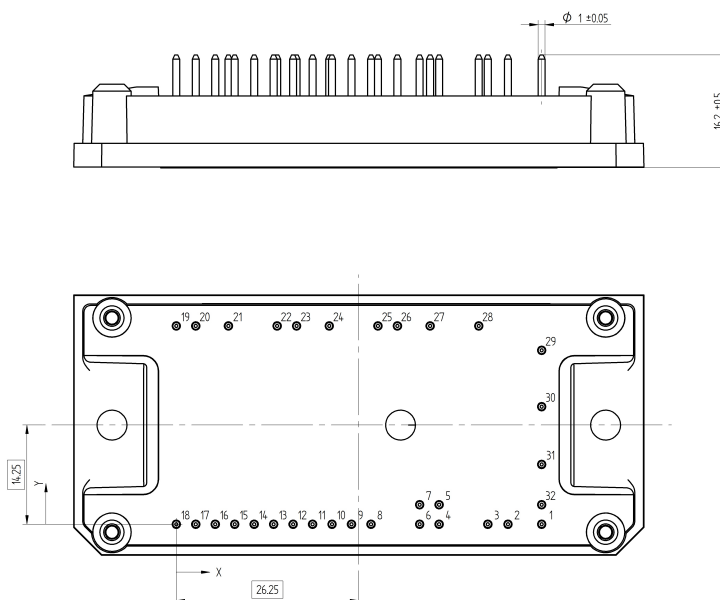
datasheet

Vincotech

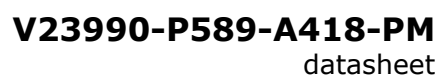
| Ordering Code                            |                         |
|--|-------------------------|
| Version                                  | Ordering Code           |
| Without thermal paste                    | V23990-P589-A418-PM     |
| With thermal paste (5,2 W/mK, PTM6000HV) | V23990-P589-A418-/7/-PM |
| With thermal paste (3,4 W/mK, PSX-P7)    | V23990-P589-A418-/3/-PM |

| Marking  |            |          |            |          |           |       |        |
|--|------------|----------|------------|----------|-----------|-------|--------|
| <div><div>VIN WWYY<br/>TTTTTTVV UL<br/>LLLL SSSS</div><div></div><div></div></div> | Text       | VIN      | Date code  | Type&Ver | UL        | Lot   | Serial |
|  |            | VIN      | WWYY       | TTTTTTVV | UL        | LLLLL | SSSS   |
|  | Datamatrix | Type&Ver | Lot number | Serial   | Date code |       |        |
|  |            | TTTTTTVV | LLLLL      | SSSS     | WWYY      |       |        |

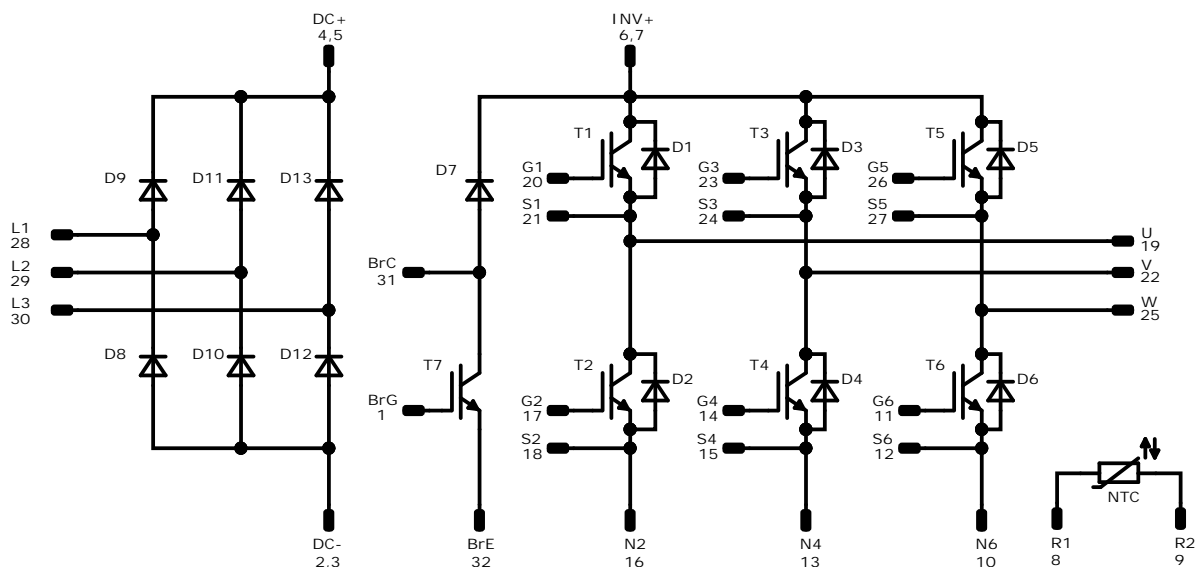
| Outline        |       |      |          |  |
|----------------|-------|------|----------|--|
| Pin table [mm] |       |      |          |  |
| Pin            | X     | Y    | Function |  |
| 1              | 52,55 | 0    | BrG      |  |
| 2              | 47,7  | 0    | DC-      |  |
| 3              | 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      |  |



Tolerance of pinpositions: ±0.5mm 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       | 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</i> 1 packages see vincotech.com website.   |      |          |      |   |
| Package data  |      |          |      |   |
| Package data for <i>flow</i> 1 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-A418-PM-D6-14 | 22 Sep. 2021 | Maximum ratings of Rectifier is updated<br>Clearance is updated<br>Rectifier and Inverter Switch characteristic values are updated<br>The thermal characteristic of Inverter Switch is updated<br>The thermistor characteristics are updated<br>Separated datasheet<br>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.