



flowPIM E1

1200 V / 15 A

Features

- IGBT M7 with low VCEsat and improved EMC behavior
- Standard industrial housing
- Optimized Rth(j-s) with Phase Change Material
- Built-in NTC

Target applications

- Industrial Drives

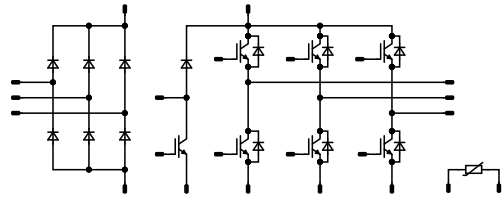
Types

- 10-E112PMA015M7-L928A78Z

flow E1 12 mm housing



Schematic





Vincotech

Maximum Ratings

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

| Parameter | Symbol | Conditions | Value | Unit |
|-----------------------------------|------------|---|----------|--------------------|
| Inverter Switch | | | | |
| Collector-emitter voltage | V_{CES} | | 1200 | V |
| Collector current (DC current) | I_C | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 23 | A |
| Repetitive peak collector current | I_{CRM} | t_p limited by T_{jmax} | 30 | A |
| Total power dissipation | P_{tot} | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 64 | W |
| Gate-emitter voltage | V_{GES} | | ± 20 | V |
| Short circuit ratings | t_{SC} | $V_{GE} = 0\text{ V}$, $V_{CC} = 800\text{ V}$ $T_j = 150\text{ °C}$ | 9,5 | μs |
| 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 | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 24 | A |
| Repetitive peak forward current | I_{FRM} | t_p limited by T_{jmax} | 30 | A |
| Total power dissipation | P_{tot} | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 51 | 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 | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 23 | A |
| Repetitive peak collector current | I_{CRM} | t_p limited by T_{jmax} | 30 | A |
| Total power dissipation | P_{tot} | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 64 | W |
| Gate-emitter voltage | V_{GES} | | ± 20 | V |
| Short circuit ratings | t_{SC} | $V_{GE} = 0\text{ V}$, $V_{CC} = 800\text{ V}$ $T_j = 150\text{ °C}$ | 9,5 | μs |
| Maximum junction temperature | T_{jmax} | | 175 | $^{\circ}\text{C}$ |



Vincotech

Maximum Ratings

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

| Parameter | Symbol | Conditions | Value | Unit |
|---------------------------------|------------|---------------------------------------|-------|------|
| Brake Diode | | | | |
| 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 |
| Total power dissipation | P_{tot} | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 43 | 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 | | 370 | A ² s |
| Total power dissipation | P_{tot} | $T_j = T_{jmax}$ $T_s = 80\text{ °C}$ | 61 | 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 | | | >12,7 | mm |
| Comparative Tracking Index | CTI | | ≥ 600 | |

*100 % tested in production



Vincotech

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 | 0,0015 | 25 | 5,4 | 6 | 6,6 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 15 | 25 125 150 | | 1,7 1,95 2,01 | 2,15 ⁽¹⁾ | V |
| Collector-emitter cut-off current | I_{CES} | | 0 | 1200 | | 25 | | | 60 | μA |
| Gate-emitter leakage current | I_{GES} | | 0 | 0 | | 25 | | | 500 | nA |
| Internal gate resistance | r_g | | | | | | | None | | Ω |
| Input capacitance | C_{ies} | | | | | | | 2900 | | pF |
| Output capacitance | C_{oes} | | 0 | 10 | | 25 | | 120 | | pF |
| Reverse transfer capacitance | C_{res} | | | | | | | 34 | | pF |
| Gate charge | Q_g | $V_{CC} = 600$ V | 15 | | 15 | 25 | | 110 | | nC |

Thermal

| | | | | | | | | | | |
|--|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|
| Thermal resistance junction to sink ⁽²⁾ | $R_{th(j-s)}$ | $\lambda_{paste} = 3,4$ W/mK (PSX) | | | | | | 1,48 | | K/W |
|--|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|

Dynamic

| | | | | | | | | | | |
|-----------------------------|--------------|---|--|--|--|------------------|--|---------------------------|--|-----|
| Turn-on delay time | $t_{d(on)}$ | | | | | 25 125 150 | | 196,2 191,2 189,6 | | ns |
| Rise time | t_r | | | | | 25 125 150 | | 59,6 63,2 64,2 | | ns |
| Turn-off delay time | $t_{d(off)}$ | | | | | 25 125 150 | | 181,4 206,2 211,4 | | ns |
| Fall time | t_f | | | | | 25 125 150 | | 94,66 113,14 114,01 | | ns |
| Turn-on energy (per pulse) | E_{on} | $Q_{tFWD} = 1,5$ μC $Q_{tFWD} = 2,46$ μC $Q_{tFWD} = 2,68$ μC | | | | 25 125 150 | | 1,68 2,11 2,21 | | mWs |
| Turn-off energy (per pulse) | E_{off} | | | | | 25 125 150 | | 0,987 1,33 1,41 | | mWs |



Vincotech

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 | | | 15 | 25 125 150 | | 1,62 1,74 1,73 | 2,1 ⁽¹⁾ | | V |
| Reverse leakage current | I_R | $V_r = 1200$ V | | | 25 | | | 30 | | μA |
| Thermal | | | | | | | | | | |
| Thermal resistance junction to sink ⁽²⁾ | $R_{th(j-s)}$ | $\lambda_{paste} = 3,4$ W/mK (PSX) | | | | | 1,88 | | | K/W |
| Dynamic | | | | | | | | | | |
| Peak recovery current | I_{RRM} | | | | 25 125 150 | | 9,46 10,72 10,9 | | | A |
| Reverse recovery time | t_{rr} | | | | 25 125 150 | | 285,73 421,73 470,63 | | | ns |
| Recovered charge | Q_r | $di/dt=181$ A/μs $di/dt=205$ A/μs $di/dt=175$ A/μs | ±15 | 600 | 15 | 25 125 150 | 1,5 2,46 2,68 | | | μC |
| Reverse recovered energy | E_{rec} | | | | 25 125 150 | | 0,497 0,913 1 | | | mWs |
| Peak rate of fall of recovery current | $(di_r/dt)_{max}$ | | | | 25 125 150 | | 76,99 48,52 43,64 | | | A/μs |



Vincotech

Characteristic Values

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

Brake Switch

Static

| | | | | | | | | | | |
|--------------------------------------|---------------|------------------|----|------|--------|------------------|-----|---------------------|---------------------|----|
| Gate-emitter threshold voltage | $V_{GE(th)}$ | | | 10 | 0,0015 | 25 | 5,4 | 6 | 6,6 | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | | 15 | | 15 | 25 125 150 | | 1,7 1,95 2,01 | 2,15 ⁽¹⁾ | V |
| Collector-emitter cut-off current | I_{CES} | | 0 | 1200 | | 25 | | | 60 | μA |
| Gate-emitter leakage current | I_{GES} | | 0 | 0 | | 25 | | | 500 | nA |
| Internal gate resistance | r_g | | | | | | | None | | Ω |
| Input capacitance | C_{ies} | | | | | | | 2900 | | pF |
| Output capacitance | C_{oes} | | 0 | 10 | | 25 | | 120 | | pF |
| Reverse transfer capacitance | C_{res} | | | | | | | 34 | | pF |
| Gate charge | Q_g | $V_{CC} = 600$ V | 15 | | 15 | 25 | | 110 | | nC |

Thermal

| | | | | | | | | | | |
|--|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|
| Thermal resistance junction to sink ⁽²⁾ | $R_{th(j-s)}$ | $\lambda_{paste} = 3,4$ W/mK (PSX) | | | | | | 1,48 | | K/W |
|--|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|

Dynamic

| | | | | | | | | | | |
|-----------------------------|--------------|--|--|--|--|------------------|--|-------------------------|--|-----|
| Turn-on delay time | $t_{d(on)}$ | | | | | 25 125 150 | | 299,8 261,6 252,6 | | ns |
| Rise time | t_r | | | | | 25 125 150 | | 193,8 204,6 209,2 | | ns |
| Turn-off delay time | $t_{d(off)}$ | | | | | 25 125 150 | | 387,8 427,8 438,2 | | ns |
| Fall time | t_f | | | | | 25 125 150 | | 66,52 86,69 88,96 | | ns |
| Turn-on energy (per pulse) | E_{on} | $Q_{tFWD} = 1,11$ μC $Q_{tFWD} = 1,78$ μC $Q_{tFWD} = 2,04$ μC | | | | 25 125 150 | | 2,5 3 3,19 | | mWs |
| Turn-off energy (per pulse) | E_{off} | | | | | 25 125 150 | | 1,12 1,44 1,54 | | mWs |



Vincotech

Characteristic Values

| Parameter | Symbol | Conditions | | | | | Values | | | Unit |
|--|-------------------|---|---|-------------------------------------|------------|------------------|--------|----------------------------|--------------------|------|
| | | V_{GE} [V] V_{GS} [V] | V_{CE} [V] V_{DS} [V] V_F [V] | I_C [A] I_D [A] I_F [A] | T_j [°C] | Min | Typ | Max | | |
| Brake Diode | | | | | | | | | | |
| Static | | | | | | | | | | |
| Forward voltage | V_F | | | | 10 | 25 125 150 | | 1,61 1,69 1,7 | 2,1 ⁽¹⁾ | V |
| Reverse leakage current | I_R | $V_r = 1200$ V | | | | 25 | | | 25 | μA |
| Thermal | | | | | | | | | | |
| Thermal resistance junction to sink ⁽²⁾ | $R_{th(j-s)}$ | $\lambda_{paste} = 3,4$ W/mK (PSX) | | | | | | 2,19 | | K/W |
| Dynamic | | | | | | | | | | |
| Peak recovery current | I_{RRM} | | | | | 25 125 150 | | 5,91 6,68 6,84 | | A |
| Reverse recovery time | t_{rr} | | | | | 25 125 150 | | 317,36 472,66 542,16 | | ns |
| Recovered charge | Q_r | $di/dt=74$ A/μs $di/dt=65$ A/μs $di/dt=62$ A/μs | 0/15 | 600 | 15 | 25 125 150 | | 1,11 1,78 2,04 | | μC |
| Reverse recovered energy | E_{rec} | | | | | 25 125 150 | | 0,368 0,644 0,753 | | mWs |
| Peak rate of fall of recovery current | $(di_r/dt)_{max}$ | | | | | 25 125 150 | | 40,15 27,59 23,82 | | A/μs |



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 | | 1,15 1,11 | 1,5 ⁽¹⁾ | V |
| Reverse leakage current | I_R | $V_i = 1600$ V | | | | 25 150 | | | 100 1000 | μA |

Thermal

| | | | | | | | | | | |
|--|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|
| Thermal resistance junction to sink ⁽²⁾ | $R_{th(j-s)}$ | $\lambda_{paste} = 3,4$ W/mK (PSX) | | | | | | 1,15 | | K/W |
|--|---------------|---------------------------------------|--|--|--|--|--|------|--|-----|

Thermistor

Static

| | | | | | | | | | | |
|--------------------------------|----------------|-------------------|--|--|--|-----|----|------|---|------|
| Rated resistance | R | | | | | 25 | | 5 | | kΩ |
| Deviation of R_{100} | $\Delta_{R/R}$ | $R_{100} = 493$ Ω | | | | 100 | -5 | | 5 | % |
| Power dissipation | P | | | | | | | 245 | | mW |
| Power dissipation constant | d | | | | | 25 | | 1,4 | | mW/K |
| B-value | $B_{(25/50)}$ | Tol. ±2 % | | | | | | 3375 | | K |
| B-value | $B_{(25/100)}$ | Tol. ±2 % | | | | | | 3437 | | K |
| Vincotech Thermistor Reference | | | | | | | | | K | |

⁽¹⁾ Value at chip level

⁽²⁾ Only valid with pre-applied Vincotech thermal interface material.

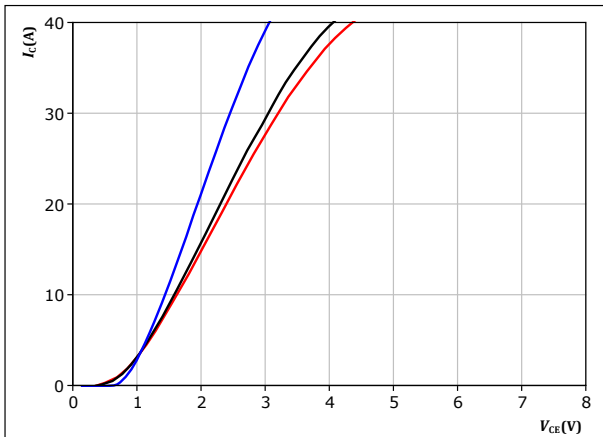


Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

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



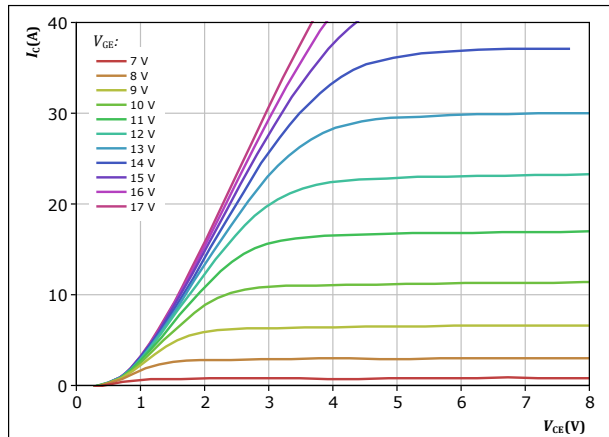
$t_p = 250 \mu\text{s}$
 $V_{GE} = 15 \text{ V}$

T_j : 25 °C (blue), 125 °C (black), 150 °C (red)

figure 2. IGBT

Typical output characteristics

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

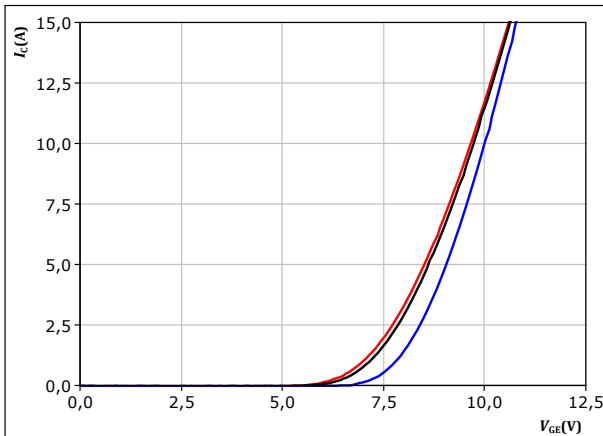


$t_p = 250 \mu\text{s}$
 $T_j = 150 \text{ °C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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



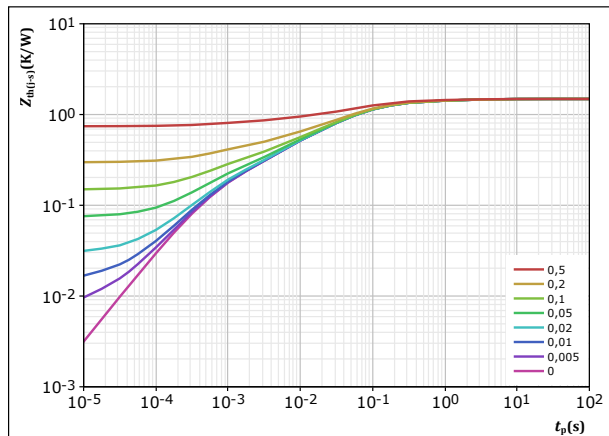
$t_p = 250 \mu\text{s}$
 $V_{CE} = 10 \text{ V}$

T_j : 25 °C (blue), 125 °C (black), 150 °C (red)

figure 4. IGBT

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,485 \text{ K/W}$

IGBT thermal model values

| R (K/W) | τ (s) |
|-----------|------------|
| 4,90E-02 | 3,61E+00 |
| 1,10E-01 | 6,54E-01 |
| 4,70E-01 | 1,09E-01 |
| 4,98E-01 | 2,97E-02 |
| 2,21E-01 | 4,73E-03 |
| 1,37E-01 | 5,51E-04 |

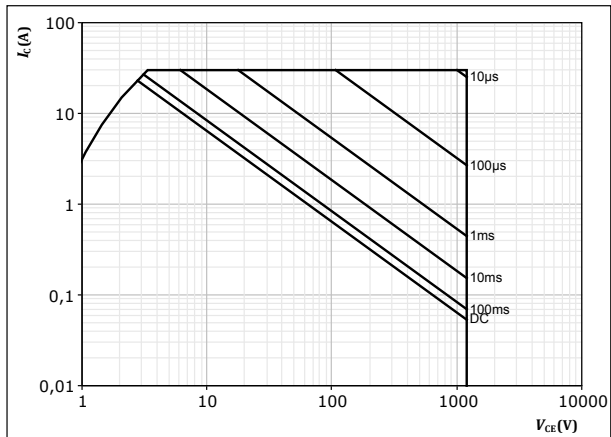


Inverter Switch Characteristics

figure 5. IGBT

Safe operating area

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



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



Inverter Diode Characteristics

figure 6. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

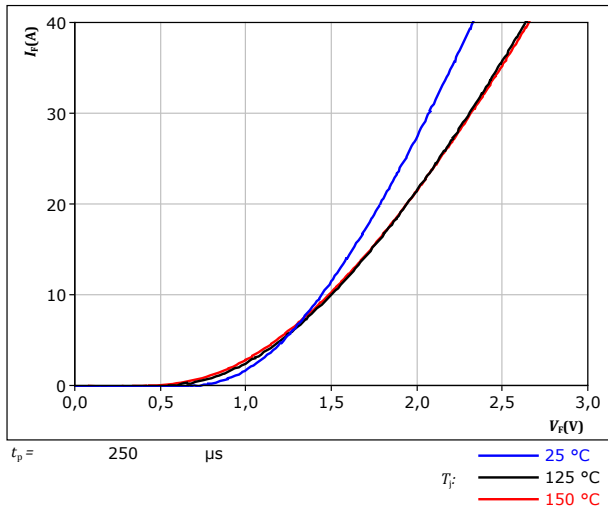
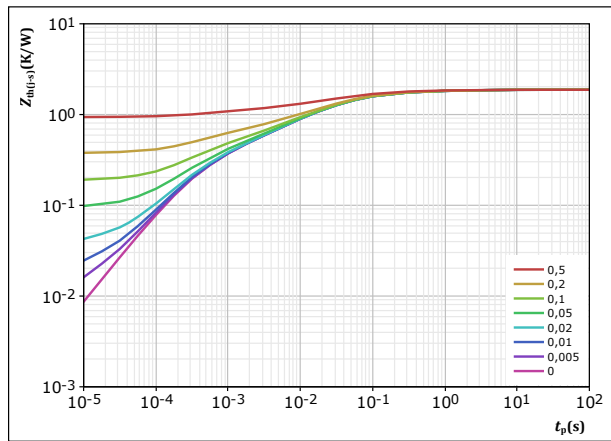


figure 7. FWD

Transient thermal impedance as a function of pulse width

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



$D = \frac{t_p}{T}$
 $R_{th(j-s)} = 1,875 \text{ K/W}$
 FWD thermal model values

| R (K/W) | τ (s) |
|----------|------------|
| 7,31E-02 | 2,45E+00 |
| 1,93E-01 | 2,55E-01 |
| 6,27E-01 | 4,97E-02 |
| 4,83E-01 | 1,15E-02 |
| 2,56E-01 | 2,33E-03 |
| 2,42E-01 | 3,41E-04 |

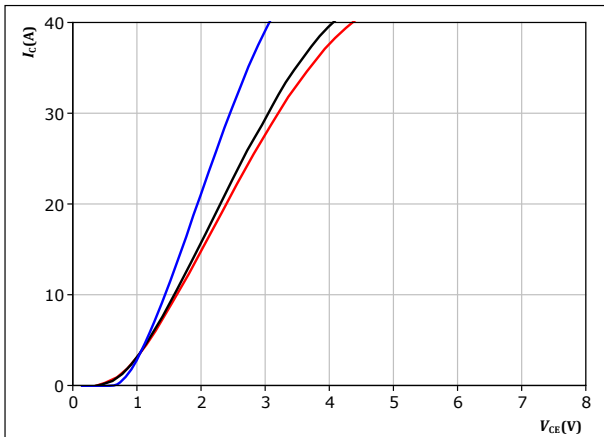


Brake Switch Characteristics

figure 8. IGBT

Typical output characteristics

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

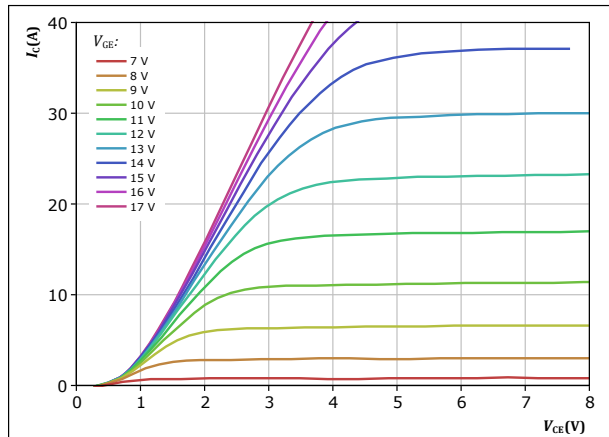


$t_p = 250\ \mu\text{s}$
 $V_{GE} = 15\ \text{V}$
 $T_j:$ — 25 °C
— 125 °C
— 150 °C

figure 9. IGBT

Typical output characteristics

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

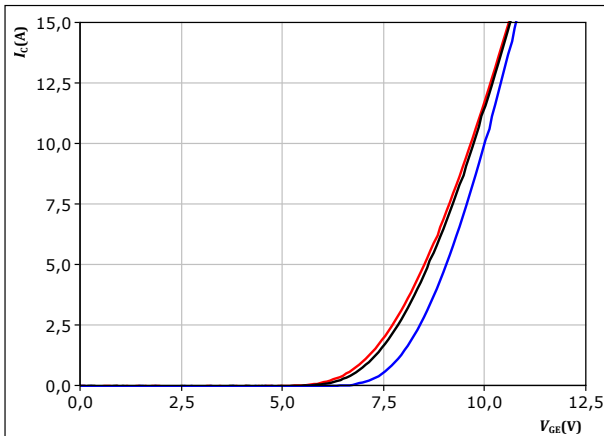


$t_p = 250\ \mu\text{s}$
 $T_j = 150\text{ °C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 10. IGBT

Typical transfer characteristics

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

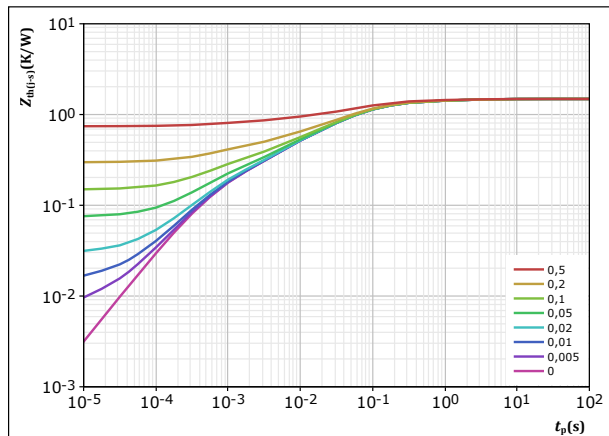


$t_p = 250\ \mu\text{s}$
 $V_{CE} = 10\ \text{V}$
 $T_j:$ — 25 °C
— 125 °C
— 150 °C

figure 11. IGBT

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,485\ \text{K/W}$
IGBT thermal model values

| R (K/W) | τ (s) |
|-----------|------------|
| 4,90E-02 | 3,61E+00 |
| 1,10E-01 | 6,54E-01 |
| 4,70E-01 | 1,09E-01 |
| 4,98E-01 | 2,97E-02 |
| 2,21E-01 | 4,73E-03 |
| 1,37E-01 | 5,51E-04 |

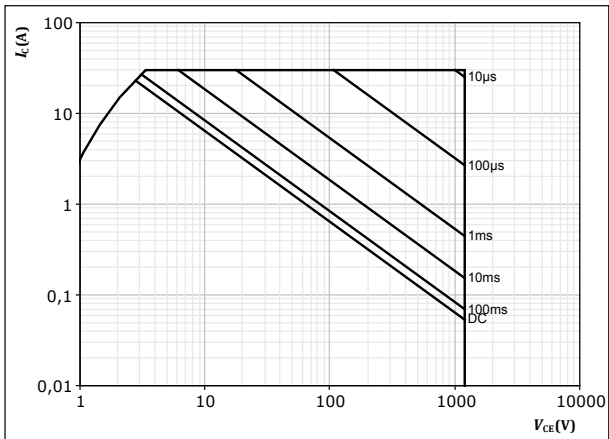


Brake Switch Characteristics

figure 12. IGBT

Safe operating area

$I_C = f(V_{CE})$



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



Brake Diode Characteristics

figure 13. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

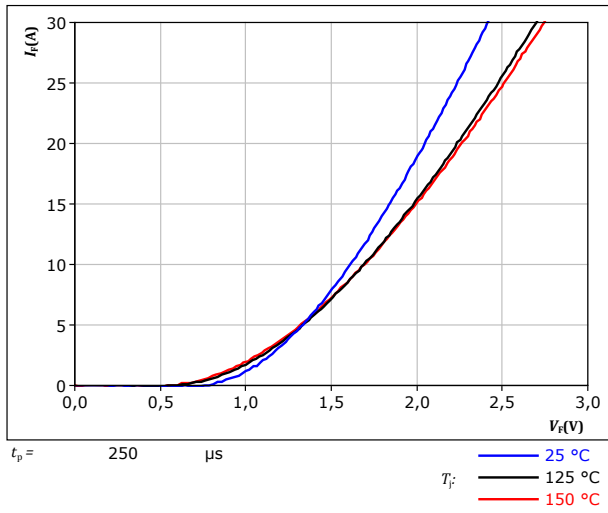
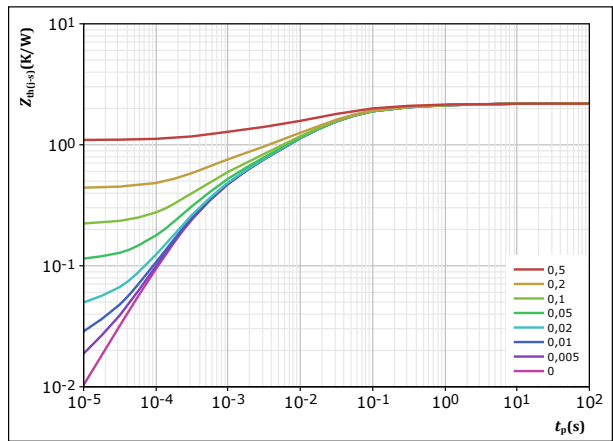


figure 14. FWD

Transient thermal impedance as a function of pulse width

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



$D = \frac{t_p}{T}$
 $R_{th(j-s)} = 2,189 \text{ K/W}$
 FWD thermal model values

| R (K/W) | τ (s) |
|----------|------------|
| 8,09E-02 | 3,20E+00 |
| 2,08E-01 | 2,82E-01 |
| 6,85E-01 | 4,41E-02 |
| 5,92E-01 | 1,02E-02 |
| 3,27E-01 | 2,02E-03 |
| 2,95E-01 | 3,64E-04 |



Rectifier Diode Characteristics

figure 15. Rectifier

Typical forward characteristics

$$I_F = f(V_F)$$

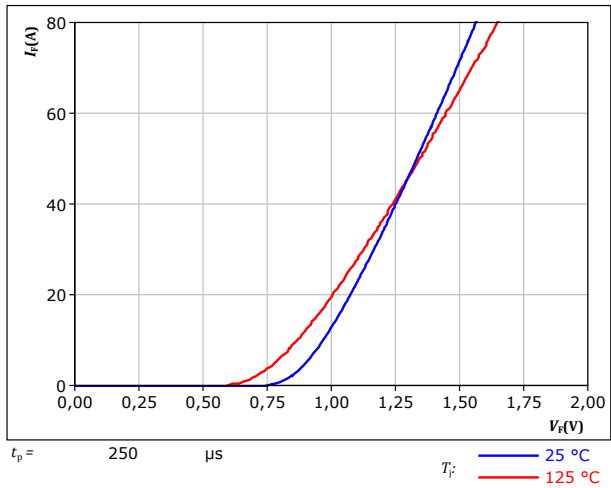
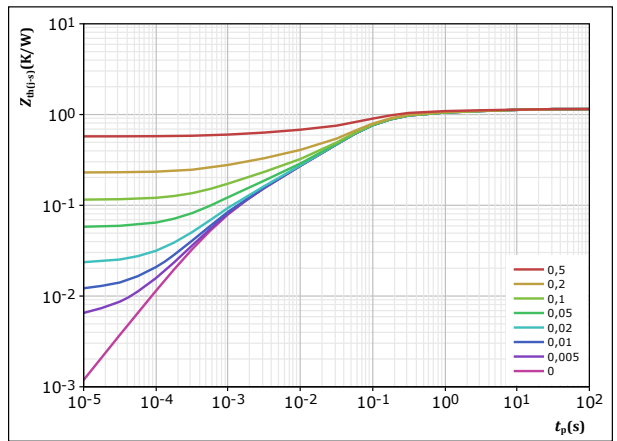


figure 16. Rectifier

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,149 \text{ K/W}$

Rectifier thermal model values

| R (K/W) | τ (s) |
|-----------|------------|
| 8,29E-02 | 7,59E+00 |
| 1,02E-01 | 6,72E-01 |
| 4,20E-01 | 1,19E-01 |
| 3,78E-01 | 4,22E-02 |
| 1,08E-01 | 4,04E-03 |
| 5,78E-02 | 7,21E-04 |

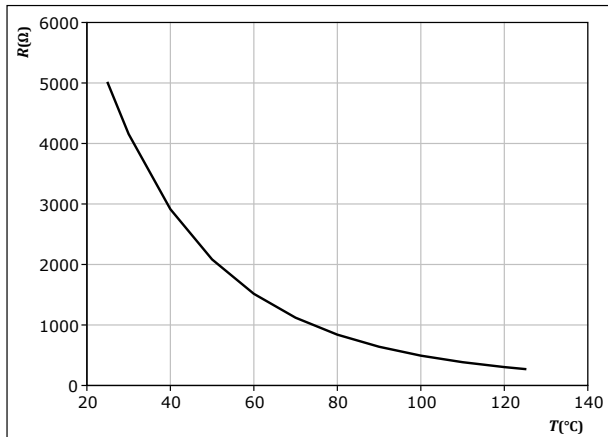


Thermistor Characteristics

figure 17. Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$

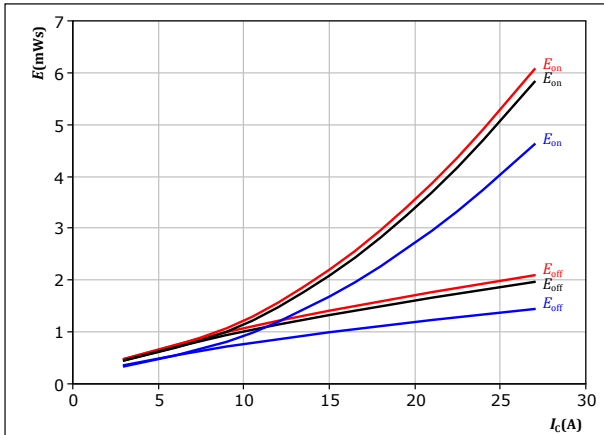




Inverter Switching Characteristics

figure 18. IGBT

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

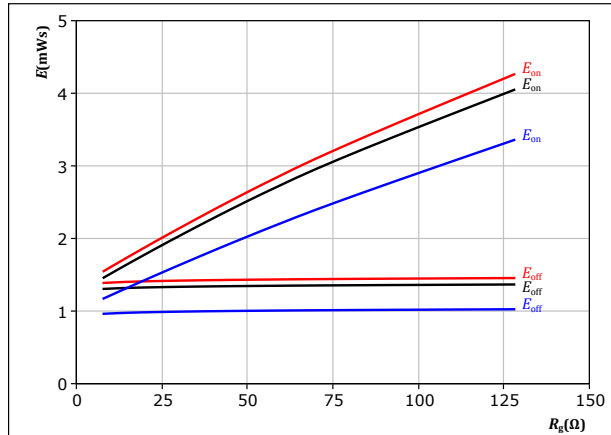


With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω
 $R_{goff} = 32$ Ω

T_j : — 25 °C
 — 125 °C
 — 150 °C

figure 19. IGBT

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

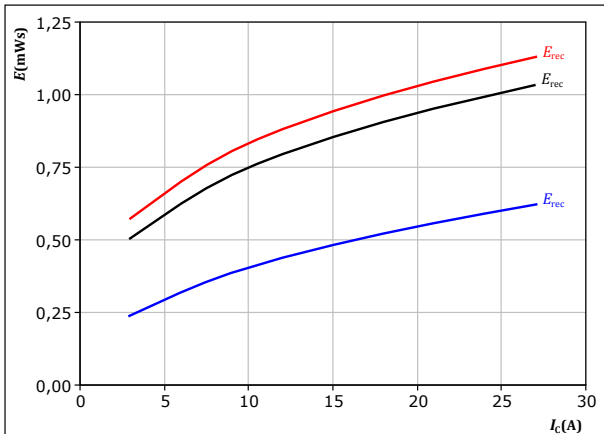


With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

T_j : — 25 °C
 — 125 °C
 — 150 °C

figure 20. FWD

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

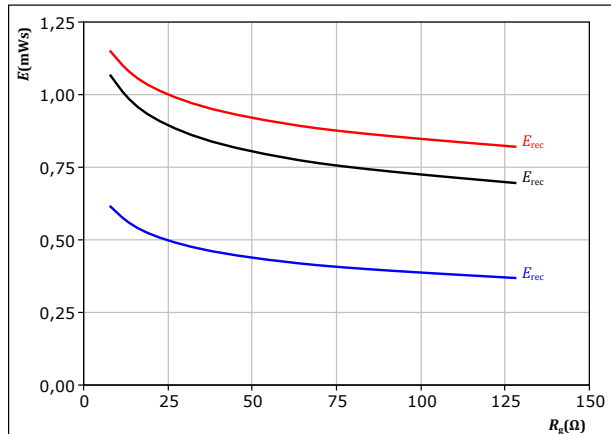


With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω

T_j : — 25 °C
 — 125 °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
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

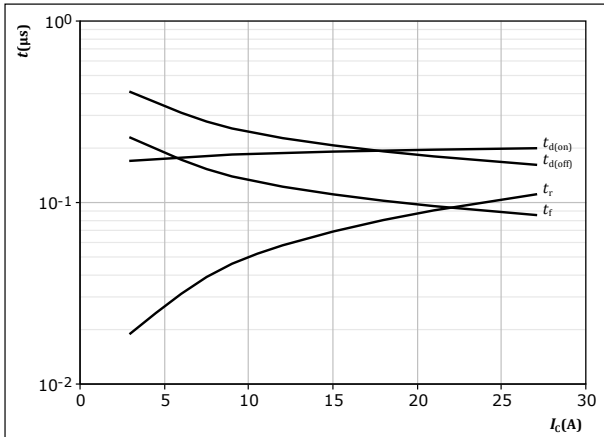
T_j : — 25 °C
 — 125 °C
 — 150 °C



Inverter Switching Characteristics

figure 22. IGBT

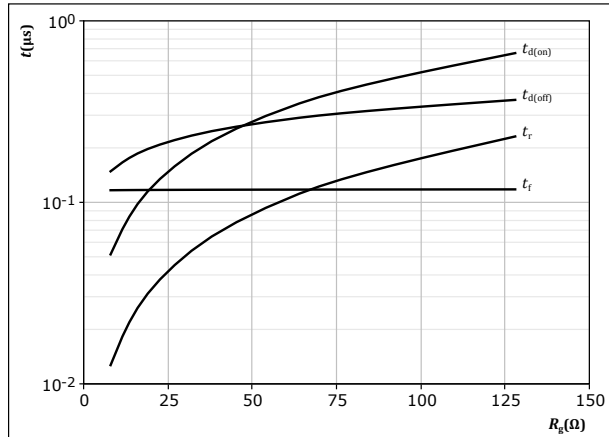
Typical switching times as a function of collector current
 $t = f(I_c)$



With an inductive load at
 $T_j = 150 \text{ } ^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 32 \text{ } \Omega$
 $R_{goff} = 32 \text{ } \Omega$

figure 23. IGBT

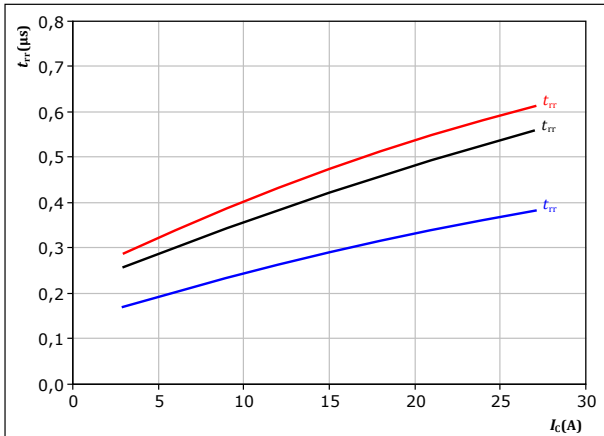
Typical switching times as a function of gate resistor
 $t = f(R_g)$



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

figure 24. FWD

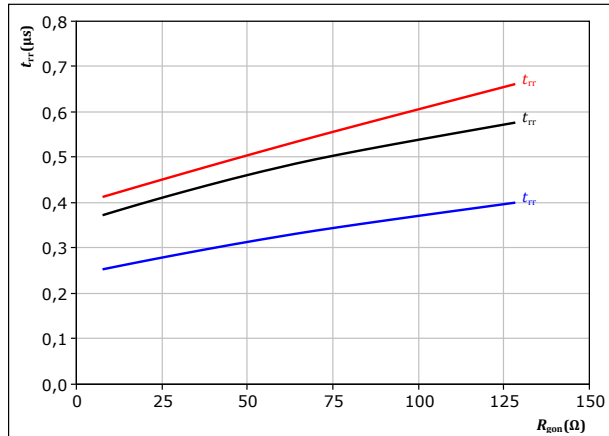
Typical reverse recovery time as a function of collector current
 $t_{rr} = f(I_c)$



With an inductive load at
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 32 \text{ } \Omega$
 $T_j:$ — 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
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$
 $T_j:$ — 25 °C
 — 125 °C
 — 150 °C

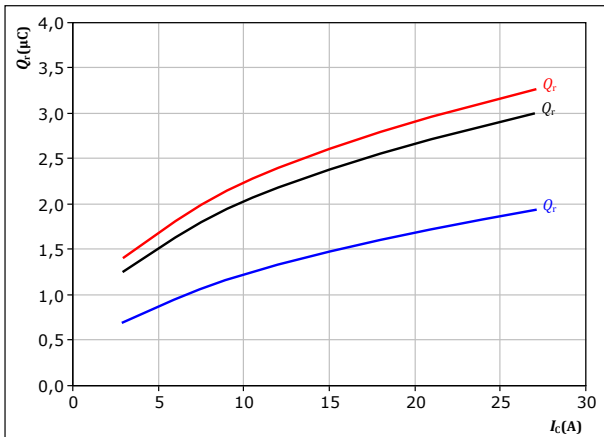


Inverter Switching Characteristics

figure 26. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

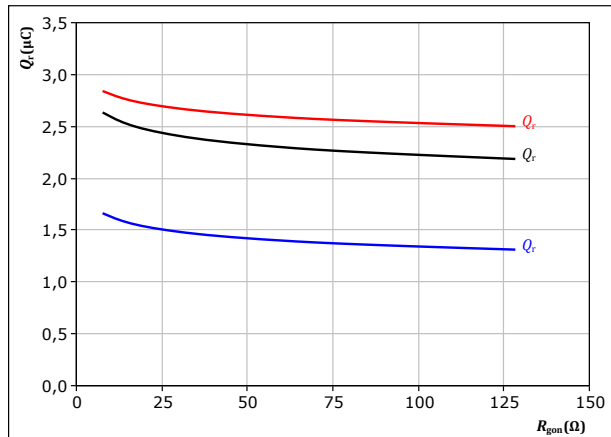
$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 32 \ \Omega$

T_j : — 25 °C
— 125 °C
— 150 °C

figure 27. FWD

Typical recovered charge as a function of turn on gate resistor

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



With an inductive load at

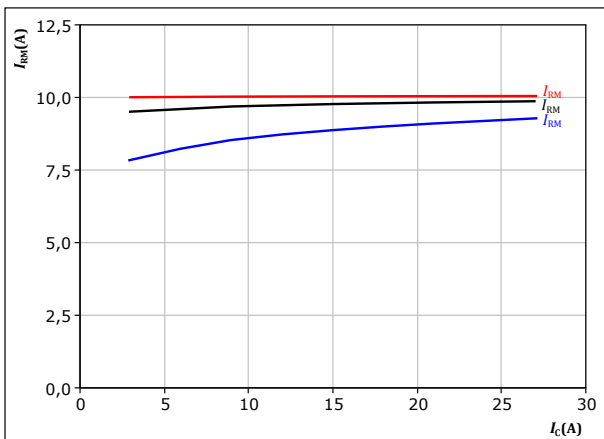
$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$

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

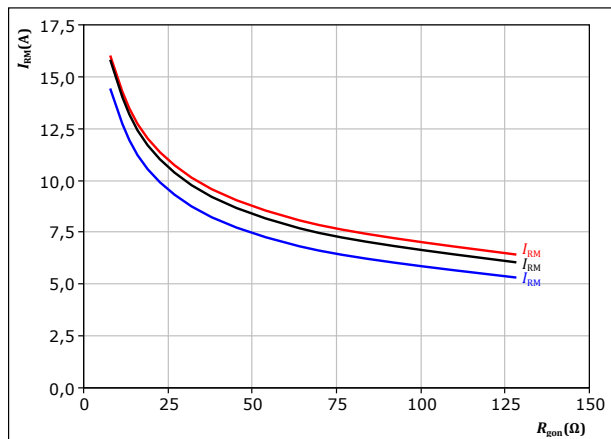
$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 32 \ \Omega$

T_j : — 25 °C
— 125 °C
— 150 °C

figure 29. FWD

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

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



With an inductive load at

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

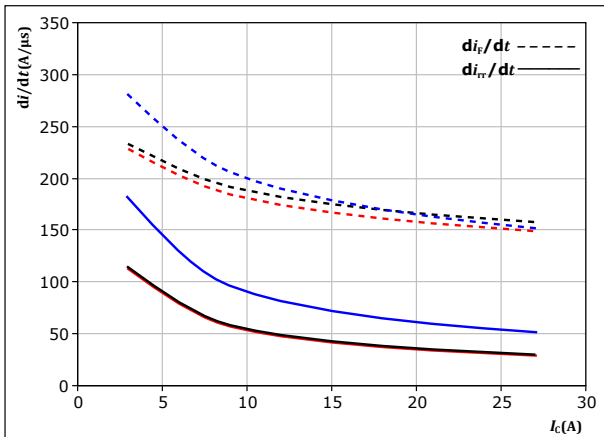
T_j : — 25 °C
— 125 °C
— 150 °C



Inverter Switching Characteristics

figure 30. FWD

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

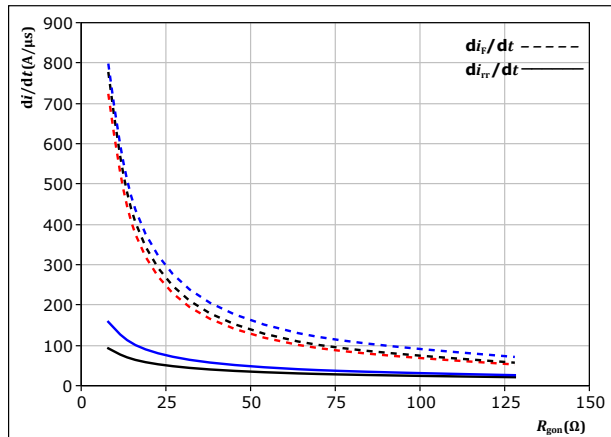


With an inductive load at

| | |
|--------------------------------|------------------------------------|
| $V_{CE} = 600 \text{ V}$ | $T_j = 25 \text{ }^\circ\text{C}$ |
| $V_{GE} = \pm 15 \text{ V}$ | $T_j = 125 \text{ }^\circ\text{C}$ |
| $R_{gon} = 32 \text{ } \Omega$ | $T_j = 150 \text{ }^\circ\text{C}$ |

figure 31. FWD

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

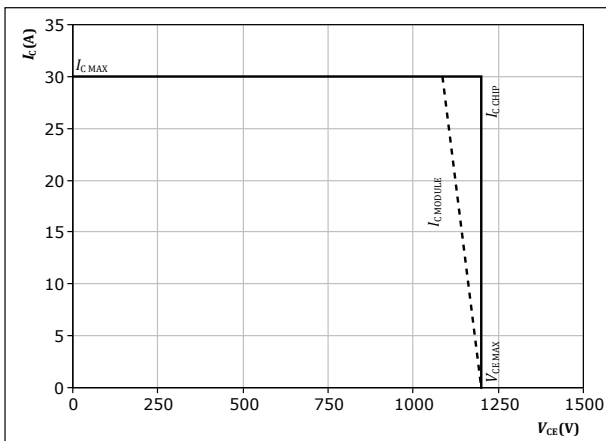


With an inductive load at

| | |
|-----------------------------|------------------------------------|
| $V_{CE} = 600 \text{ V}$ | $T_j = 25 \text{ }^\circ\text{C}$ |
| $V_{GE} = \pm 15 \text{ V}$ | $T_j = 125 \text{ }^\circ\text{C}$ |
| $I_c = 15 \text{ A}$ | $T_j = 150 \text{ }^\circ\text{C}$ |

figure 32. IGBT

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



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

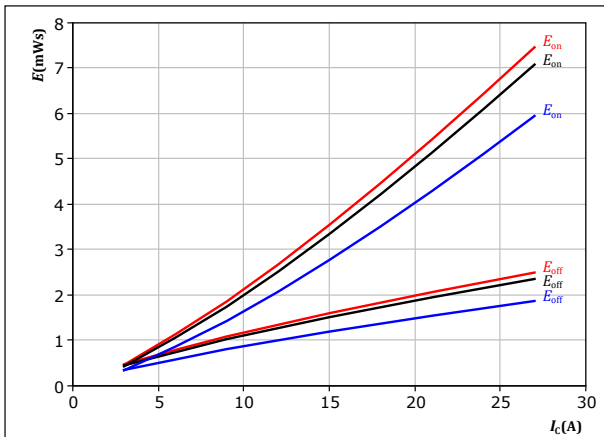


Brake Switching Characteristics

figure 33. IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_c)$$



With an inductive load at

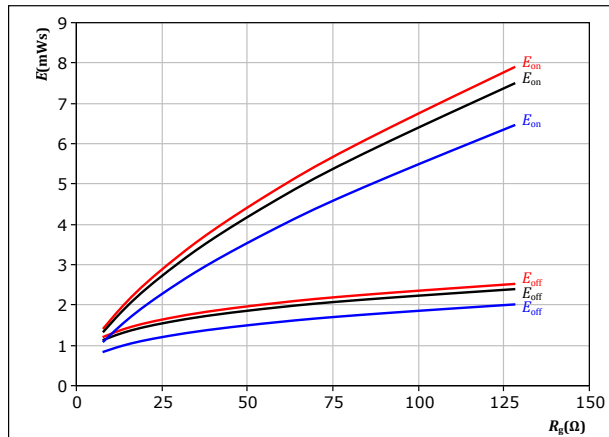
$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $R_{gon} = 32 \ \Omega$
 $R_{goff} = 32 \ \Omega$

T_j : — 25 °C
— 125 °C
— 150 °C

figure 34. IGBT

Typical switching energy losses as a function of gate resistor

$$E = f(R_g)$$



With an inductive load at

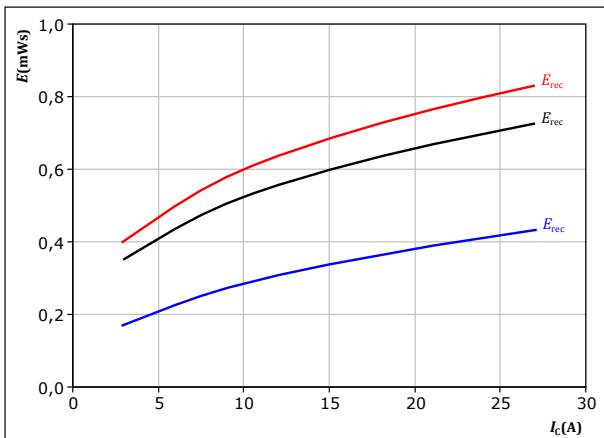
$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $I_c = 15 \text{ A}$

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

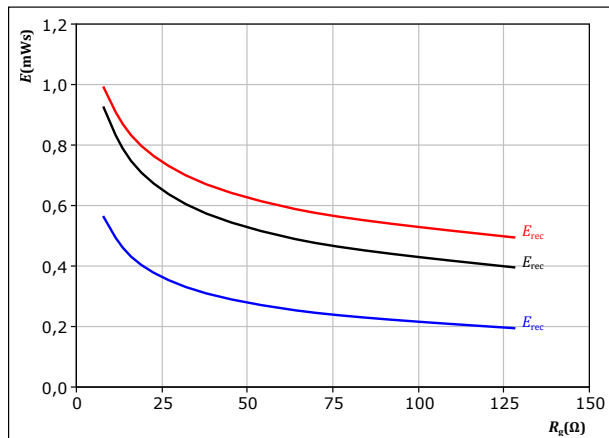
$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $R_{gon} = 32 \ \Omega$

T_j : — 25 °C
— 125 °C
— 150 °C

figure 36. FWD

Typical reverse recovered energy loss as a function of gate resistor

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



With an inductive load at

$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $I_c = 15 \text{ A}$

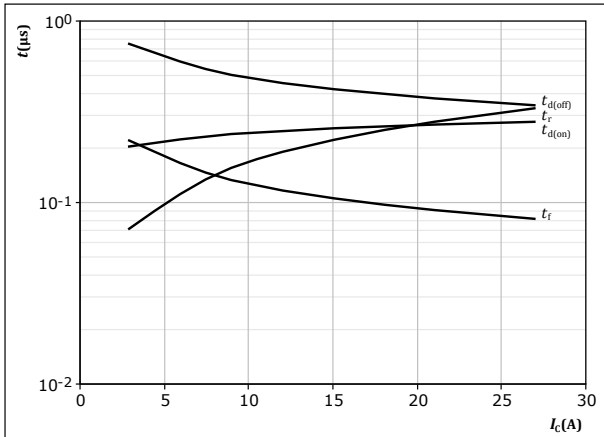
T_j : — 25 °C
— 125 °C
— 150 °C



Brake Switching Characteristics

figure 37. IGBT

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

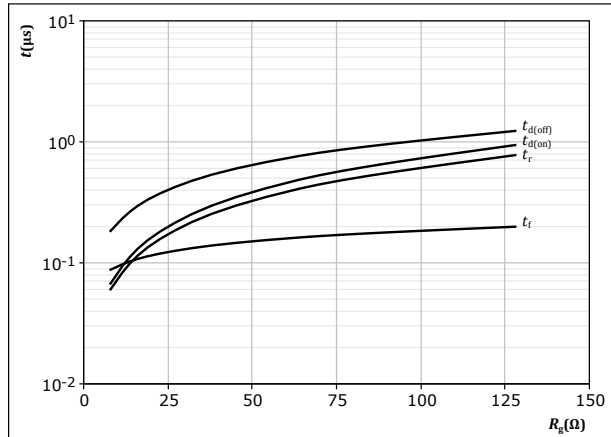


With an inductive load at

$T_j = 150 \text{ } ^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $R_{gon} = 32 \text{ } \Omega$
 $R_{goff} = 32 \text{ } \Omega$

figure 38. IGBT

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

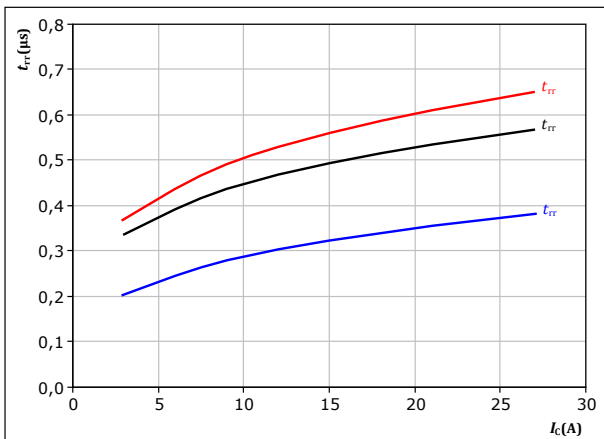


With an inductive load at

$T_j = 150 \text{ } ^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $I_c = 15 \text{ A}$

figure 39. FWD

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



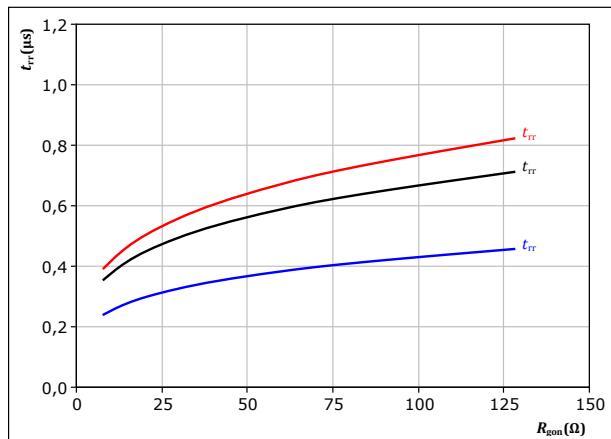
With an inductive load at

$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $R_{gon} = 32 \text{ } \Omega$

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

$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $I_c = 15 \text{ A}$

T_j : — 25 °C
— 125 °C
— 150 °C

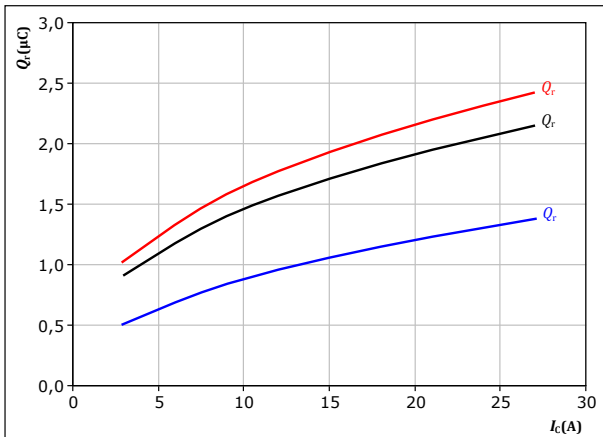


Brake Switching Characteristics

figure 41. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

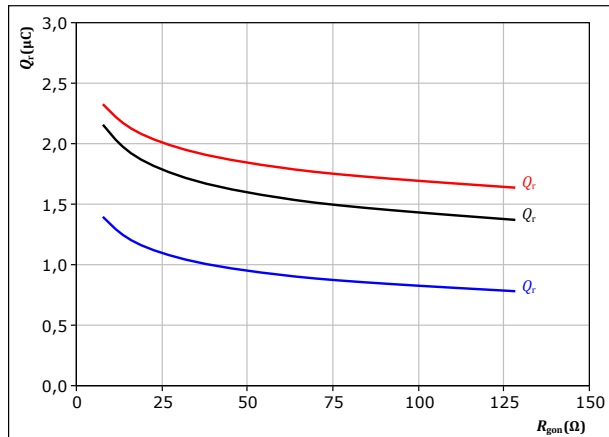
$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $R_{gon} = 32 \ \Omega$

T_j : $25 \text{ }^\circ\text{C}$ (blue)
 $125 \text{ }^\circ\text{C}$ (black)
 $150 \text{ }^\circ\text{C}$ (red)

figure 42. FWD

Typical recovered charge as a function of turn on gate resistor

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



With an inductive load at

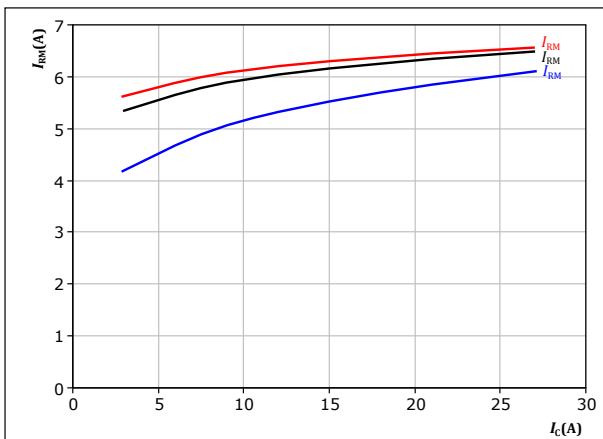
$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $I_c = 15 \text{ A}$

T_j : $25 \text{ }^\circ\text{C}$ (blue)
 $125 \text{ }^\circ\text{C}$ (black)
 $150 \text{ }^\circ\text{C}$ (red)

figure 43. FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

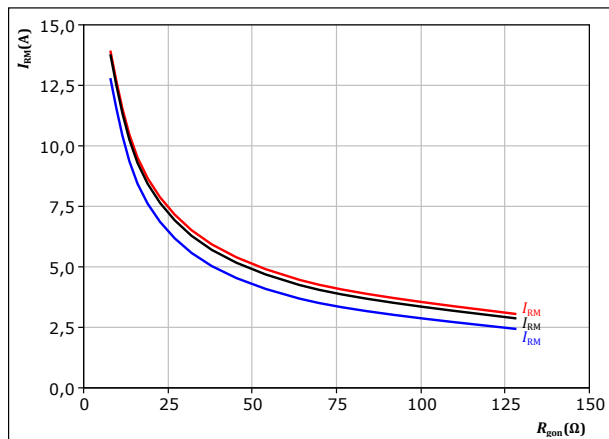
$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $R_{gon} = 32 \ \Omega$

T_j : $25 \text{ }^\circ\text{C}$ (blue)
 $125 \text{ }^\circ\text{C}$ (black)
 $150 \text{ }^\circ\text{C}$ (red)

figure 44. FWD

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

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



With an inductive load at

$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $I_c = 15 \text{ A}$

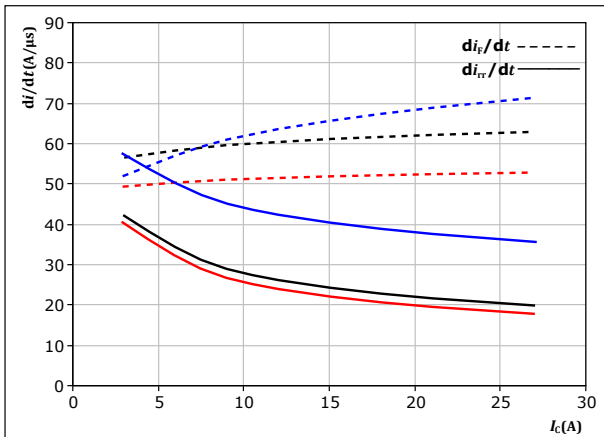
T_j : $25 \text{ }^\circ\text{C}$ (blue)
 $125 \text{ }^\circ\text{C}$ (black)
 $150 \text{ }^\circ\text{C}$ (red)



Brake Switching Characteristics

figure 45. FWD

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



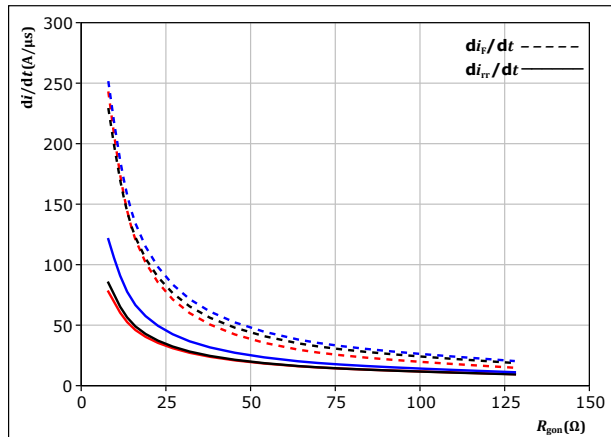
With an inductive load at

$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $R_{gon} = 32 \ \Omega$

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

figure 46. FWD

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



With an inductive load at

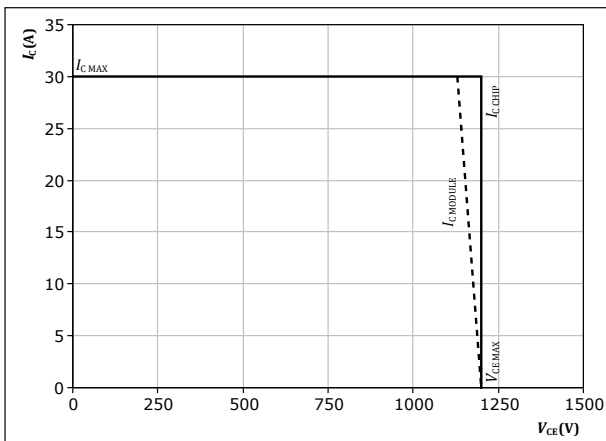
$V_{CE} = 600 \text{ V}$
 $V_{GE} = 0/15 \text{ V}$
 $I_c = 15 \text{ A}$

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

figure 47. IGBT

Reverse bias safe operating area

$I_c = f(V_{CE})$



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



Switching Definitions

figure 48. IGBT

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

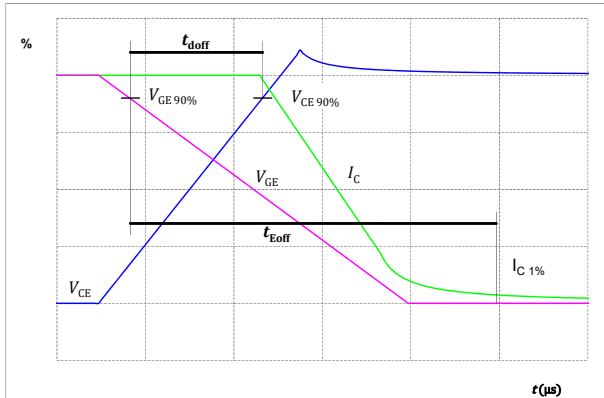


figure 49. IGBT

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

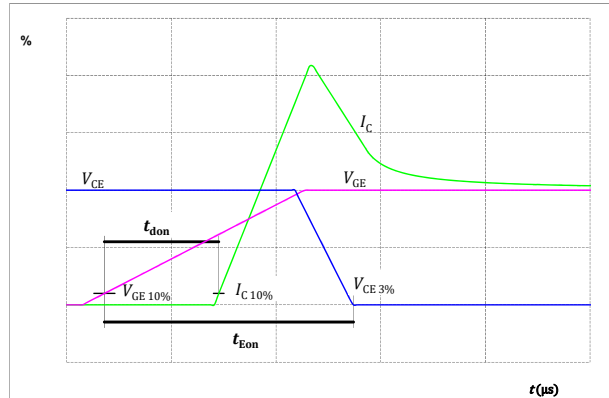


figure 50. IGBT

Turn-off Switching Waveforms & definition of t_f

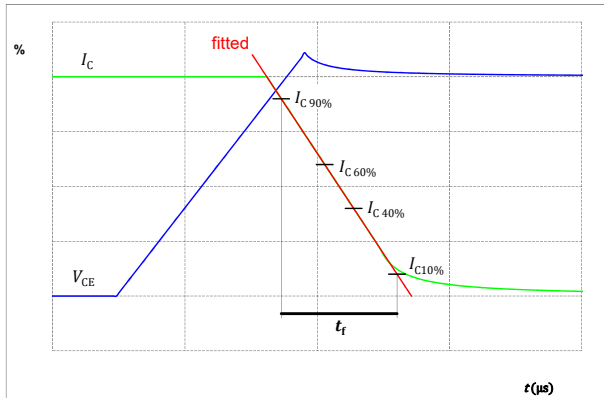
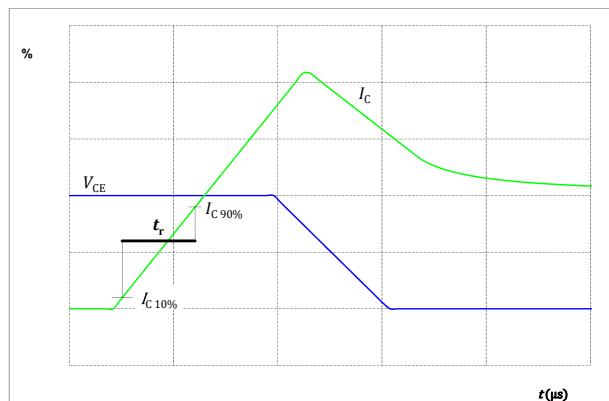


figure 51. IGBT

Turn-on Switching Waveforms & definition of t_r





Switching Definitions

figure 52. FWD

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

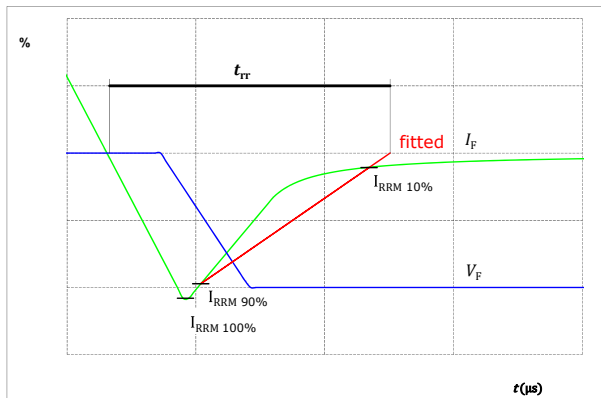
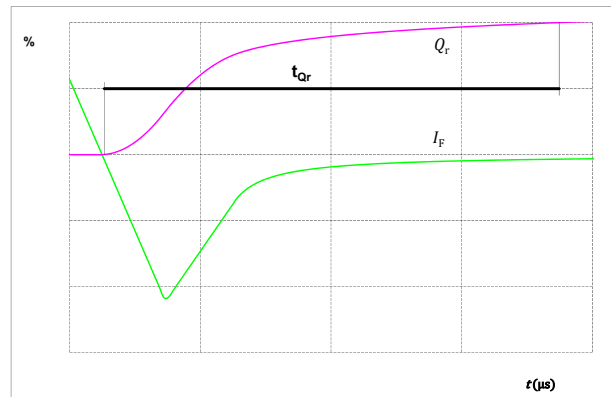


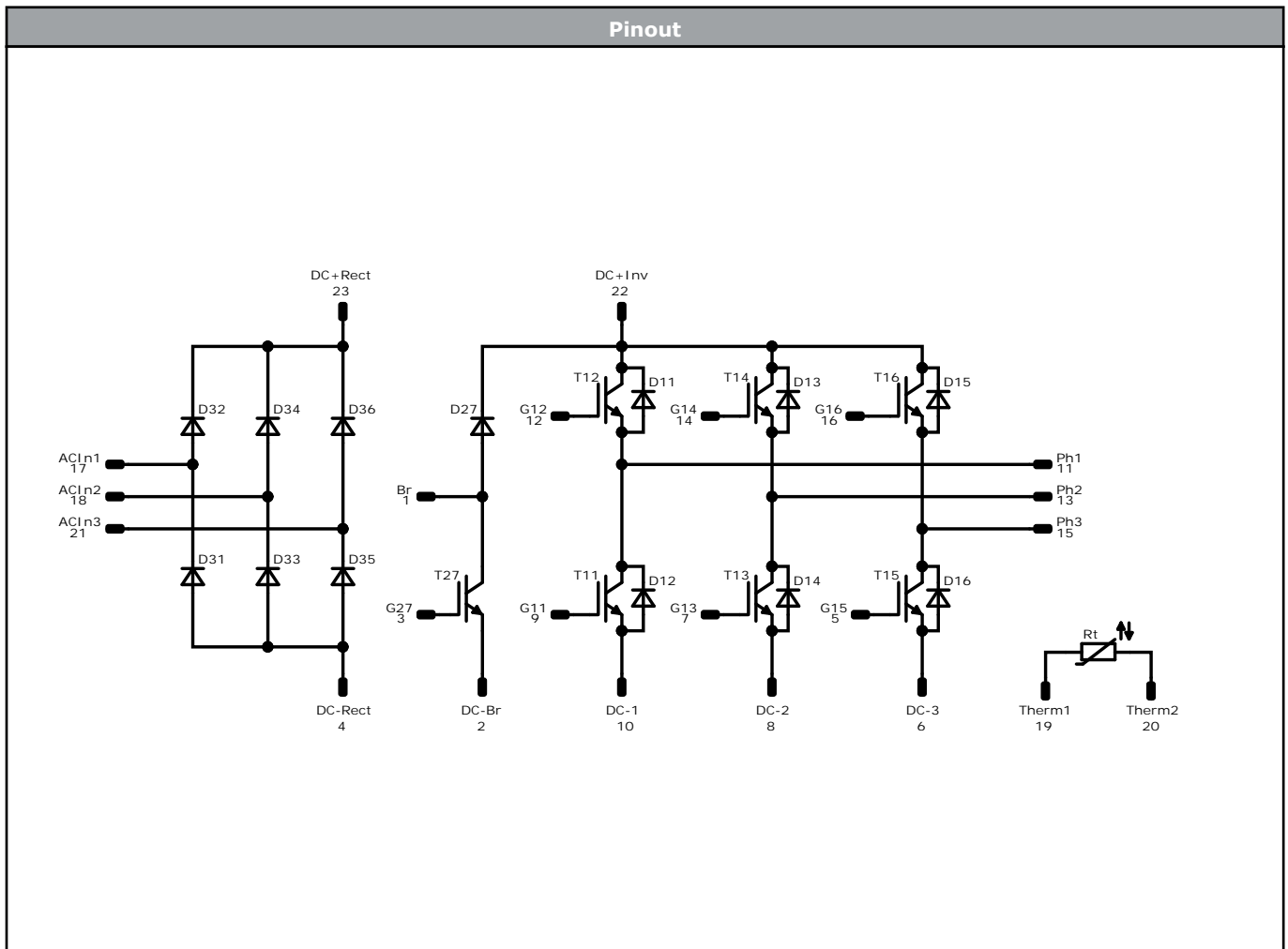
figure 53. FWD

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





Vincotech



| Identification | | | | | |
|------------------------------|-----------|---------|---------|-----------------|---------|
| ID | Component | Voltage | Current | Function | Comment |
| T11, T12, T13, T14, T15, T16 | IGBT | 1200 V | 15 A | Inverter Switch | |
| D11, D12, D13, D14, D15, D16 | FWD | 1200 V | 15 A | Inverter Diode | |
| T27 | IGBT | 1200 V | 15 A | Brake Switch | |
| D27 | FWD | 1200 V | 10 A | Brake Diode | |
| D31, D32, D33, D34, D35, D36 | Rectifier | 1600 V | 28 A | Rectifier Diode | |
| Rt | NTC | | | Thermistor | |




Vincotech

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

| Handling instruction |
|--|
| Handling instructions for <i>flow</i> E1 packages see vincotech.com website. |

| Package data |
|---|
| Package data for <i>flow</i> E1 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 |
|--------------------------------|--------------|---|-------|
| 10-E112PMA015M7-L928A78Z-D5-14 | 16 Mar. 2021 | New Datasheet format Update characteristics of Rectifier Diode | |

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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.