

600 V Reverse Conducting Drive 2 offering cost effective IGBT with monolithically integrated diode

Features

- $V_{CE} = 600\text{ V}$
- $I_C = 1\text{ A}$
- Very tight parameter distribution
- Operating range of 1 to 20 kHz
- Maximum junction temperature 150°C
- Short circuit capability of $3\ \mu\text{s}$
- Humidity robust design
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/rc-d2>

Potential applications

- Ceiling fan
- Countertop appliances - mixing
- Kitchen hood
- Refrigerators
- Residential aircon indoor unit
- Washing machines
- General purpose drives (GPD)

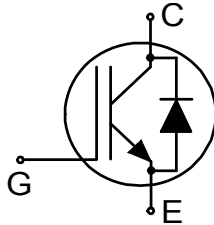
Product validation

- Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

Description



- Green
- Halogen-free
- RoHS



| Type | Package | Marking |
|-------------|-------------|---------|
| IKN01N60RC2 | PG-SOT223-3 | K1DRC2 |

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1 Package

Table 1 Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|---------------|---|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Storage temperature | T_{stg} | | -55 | | 150 | °C |
| Soldering temperature | T_{sold} | wave soldering / reflow soldering (MSL1 according to JEDEC J-STA-020) | | | 260 | °C |
| Thermal resistance, min. footprint junction-ambient | $R_{th(j-a)}$ | | | | 160 | K/W |
| Thermal resistance, 6 cm ² Cu on PCB junction to ambient | $R_{th(j-a)}$ | | | | 75 | K/W |
| IGBT thermal resistance, junction-case ¹⁾ | $R_{th(j-c)}$ | | | | 24.4 | K/W |
| Diode thermal resistance, junction-case ¹⁾ | $R_{th(j-c)}$ | | | | 43.5 | K/W |

1) R_{th}/Z_{th} based on single cooling pulse. Please be aware that a correct R_{th} measurement of the diode, is not possible using a thermocouple.

2 IGBT

Table 2 Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit | |
|--|--------------|---|------------------------|---------------|---|
| Collector-emitter voltage | V_{CE} | $T_{vj} \geq 25 \text{ °C}$ | 600 | V | |
| DC collector current, limited by T_{vjmax} ¹⁾ | I_C | | $T_c = 25 \text{ °C}$ | 2.2 | A |
| | | | $T_c = 100 \text{ °C}$ | 1.3 | |
| Pulsed collector current, t_p limited by T_{vjmax} | I_{Cpulse} | | 3 | A | |
| Turn-off safe operating area | | $V_{CE} \leq 600 \text{ V}, t_p = 1 \text{ }\mu\text{s}, T_{vj} \leq 150 \text{ °C}$ | 3 | A | |
| Gate-emitter voltage | V_{GE} | | ± 20 | V | |
| Transient gate-emitter voltage | V_{GE} | $t_p \leq 10 \text{ }\mu\text{s}, D < 0.01$ | ± 30 | V | |
| Short-circuit withstand time | t_{SC} | $V_{CC} \leq 400 \text{ V}, V_{GE} = 15 \text{ V}$, Allowed number of short circuits < 1000, Time between short circuits $\geq 1.0 \text{ s}, T_{vj} = 150 \text{ °C}$ | 3 | μs | |
| Power dissipation | P_{tot} | | $T_c = 25 \text{ °C}$ | 5.1 | W |
| | | | $T_c = 100 \text{ °C}$ | 2 | |

1) DPAK equivalent

Table 3 Characteristic values

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|--------------------------------------|--------------|--|--|--------|------|------|---------------|
| | | | | Min. | Typ. | Max. | |
| Collector-emitter saturation voltage | V_{CEsat} | $I_C = 1\text{ A}, V_{GE} = 15\text{ V}$ | $T_{vj} = 25\text{ °C}$ | | 2 | 2.3 | V |
| | | | $T_{vj} = 150\text{ °C}$ | | 2.3 | | |
| Gate-emitter threshold voltage | V_{GETh} | $I_C = 10\text{ }\mu\text{A}, V_{CE} = V_{GE}$ | | 4.3 | 5 | 5.7 | V |
| Zero gate-voltage collector current | I_{CES} | $V_{CE} = 600\text{ V}, V_{GE} = 0\text{ V}$ | $T_{vj} = 25\text{ °C}$ | | | 25 | μA |
| | | | $T_{vj} = 150\text{ °C}$ | | | 2500 | |
| Gate-emitter leakage current | I_{GES} | $V_{CE} = 0\text{ V}, V_{GE} = 20\text{ V}$ | | | | 100 | nA |
| Transconductance | g_{fs} | $I_C = 1\text{ A}, V_{CE} = 20\text{ V}$ | | | 0.5 | | S |
| Input capacitance | C_{ies} | $V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$ | | | 55 | | pF |
| Output capacitance | C_{oes} | $V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$ | | | 4 | | pF |
| Reverse transfer capacitance | C_{res} | $V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}, f = 1000\text{ kHz}$ | | | 2.5 | | pF |
| Gate charge | Q_G | $I_C = 1\text{ A}, V_{CC} = 480\text{ V}, V_{GE} = 15\text{ V}$ | | | 9 | | nC |
| Turn-on delay time | $t_{d(on)}$ | $V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$ | $T_{vj} = 25\text{ °C}, I_C = 1\text{ A}$ | | 5.6 | | ns |
| | | | $T_{vj} = 150\text{ °C}, I_C = 1\text{ A}$ | | 6 | | |
| Rise time (inductive load) | t_r | $V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$ | $T_{vj} = 25\text{ °C}, I_C = 1\text{ A}$ | | 4 | | ns |
| | | | $T_{vj} = 150\text{ °C}, I_C = 1\text{ A}$ | | 4 | | |
| Turn-off delay time | $t_{d(off)}$ | $V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$ | $T_{vj} = 25\text{ °C}, I_C = 1\text{ A}$ | | 80 | | ns |
| | | | $T_{vj} = 150\text{ °C}, I_C = 1\text{ A}$ | | 100 | | |
| Fall time (inductive load) | t_f | $V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$ | $T_{vj} = 25\text{ °C}, I_C = 1\text{ A}$ | | 10 | | ns |
| | | | $T_{vj} = 150\text{ °C}, I_C = 1\text{ A}$ | | 10 | | |
| Turn-on energy | E_{on} | $V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$ | $T_{vj} = 25\text{ °C}, I_C = 1\text{ A}$ | | 25.1 | | μJ |
| | | | $T_{vj} = 150\text{ °C}, I_C = 1\text{ A}$ | | 34.3 | | |
| Turn-off energy | E_{off} | $V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$ | $T_{vj} = 25\text{ °C}, I_C = 1\text{ A}$ | | 13.5 | | μJ |
| | | | $T_{vj} = 150\text{ °C}, I_C = 1\text{ A}$ | | 22.7 | | |
| Total switching energy | E_{ts} | $V_{CC} = 400\text{ V}, V_{GE} = 0/15\text{ V}, R_{Gon} = 49\text{ }\Omega, R_{Goff} = 49\text{ }\Omega, L_\sigma = 30\text{ nH}, C_\sigma = 32\text{ pF}$ | $T_{vj} = 25\text{ °C}, I_C = 1\text{ A}$ | | 38.7 | | μJ |
| | | | $T_{vj} = 150\text{ °C}, I_C = 1\text{ A}$ | | 57 | | |

(table continues...)

Table 3 (continued) Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|--------------------------------|----------|------------------------|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Operating junction temperature | T_{vj} | | -40 | | 150 | °C |

Note: Electrical Characteristic, at $T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified

3 Diode

Table 4 Maximum rated values

| Parameter | Symbol | Note or test condition | Values | Unit | |
|---|--------------|----------------------------------|-----------------------------|------|---|
| Repetitive peak reverse voltage | V_{RRM} | $T_{vj} \geq 25^{\circ}\text{C}$ | 600 | V | |
| Diode forward current, limited by T_{vjmax} ¹⁾ | I_F | | $T_c = 25^{\circ}\text{C}$ | 2 | A |
| | | | $T_c = 100^{\circ}\text{C}$ | 1 | |
| Diode pulsed current, t_p limited by T_{vjmax} | I_{Fpulse} | | 3 | A | |

1) DPAK equivalent

Table 5 Characteristic values

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|-------------------------------------|-----------|------------------------|---|------|------|---------------|
| | | | Min. | Typ. | Max. | |
| Diode forward voltage | V_F | $I_F = 1\text{ A}$ | $T_{vj} = 25^{\circ}\text{C}$ | 1.85 | 2.2 | V |
| | | | $T_{vj} = 150^{\circ}\text{C}$ | 1.9 | | |
| Diode reverse recovery time | t_{rr} | $V_R = 400\text{ V}$ | $T_{vj} = 25^{\circ}\text{C}$, $I_F = 1\text{ A}$, $-di_F/dt = 272\text{ A}/\mu\text{s}$ | 59.5 | | ns |
| | | | $T_{vj} = 150^{\circ}\text{C}$, $I_F = 1\text{ A}$, $-di_F/dt = 236\text{ A}/\mu\text{s}$ | 89.3 | | |
| Diode reverse recovery charge | Q_{rr} | $V_R = 400\text{ V}$ | $T_{vj} = 25^{\circ}\text{C}$, $I_F = 1\text{ A}$, $-di_F/dt = 272\text{ A}/\mu\text{s}$ | 0.06 | | μC |
| | | | $T_{vj} = 150^{\circ}\text{C}$, $I_F = 1\text{ A}$, $-di_F/dt = 236\text{ A}/\mu\text{s}$ | 0.11 | | |
| Diode peak reverse recovery current | I_{rrm} | $V_R = 400\text{ V}$ | $T_{vj} = 25^{\circ}\text{C}$, $I_F = 1\text{ A}$, $-di_F/dt = 272\text{ A}/\mu\text{s}$ | 1.9 | | A |
| | | | $T_{vj} = 150^{\circ}\text{C}$, $I_F = 1\text{ A}$, $-di_F/dt = 236\text{ A}/\mu\text{s}$ | 2.4 | | |

(table continues...)

Table 5 (continued) Characteristic values

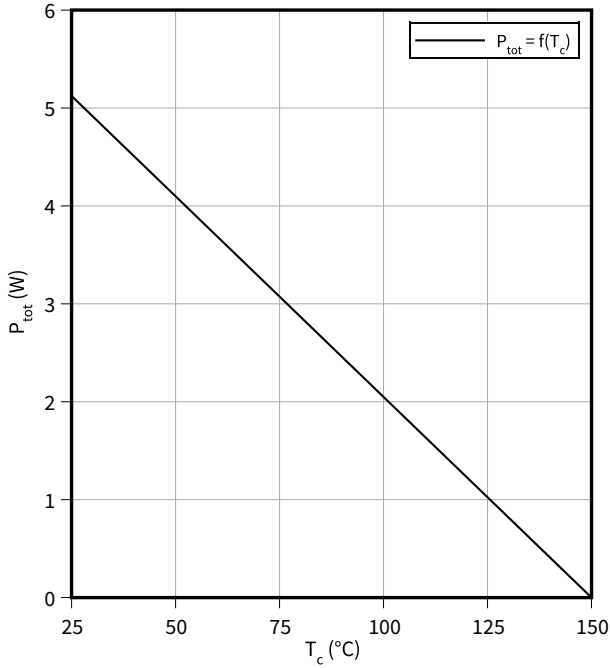
| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|--------------|------------------------|--|--------|------|------|------------------|
| | | | | Min. | Typ. | Max. | |
| Diode peak rate of fall of reverse recovery current | di_{rr}/dt | $V_R = 400 \text{ V}$ | $T_{vj} = 25 \text{ °C}, I_F = 1 \text{ A},$ $-di_F/dt = 272 \text{ A}/\mu\text{s}$ | | 38.7 | | A/ μs |
| | | | $T_{vj} = 150 \text{ °C},$ $I_F = 1 \text{ A},$ $-di_F/dt = 236 \text{ A}/\mu\text{s}$ | | 30.9 | | |
| Operating junction temperature | T_{vj} | | | -40 | | 150 | °C |

Note: For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

4 Characteristics diagrams

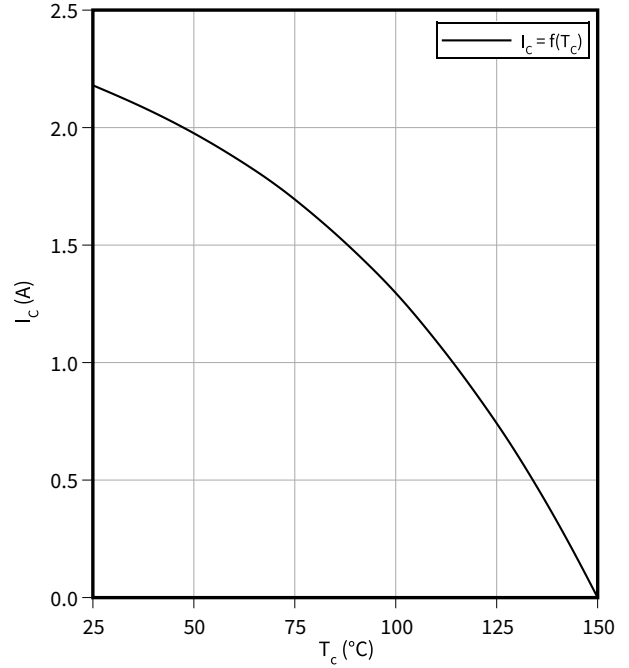
Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_c)$
 $T_{vj} \leq 150\text{ }^\circ\text{C}$



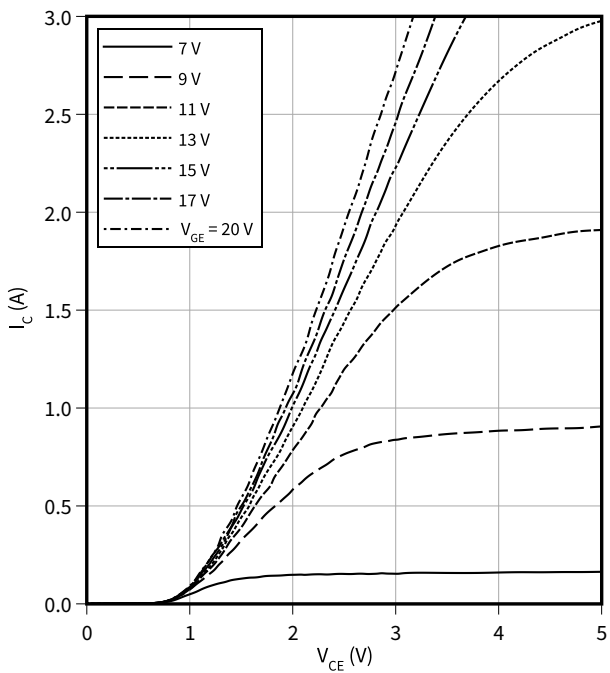
Collector current as a function of heatsink temperature

$I_c = f(T_c)$
 $T_{vj} \leq 150\text{ }^\circ\text{C}, V_{GE} \geq 15\text{ V}$



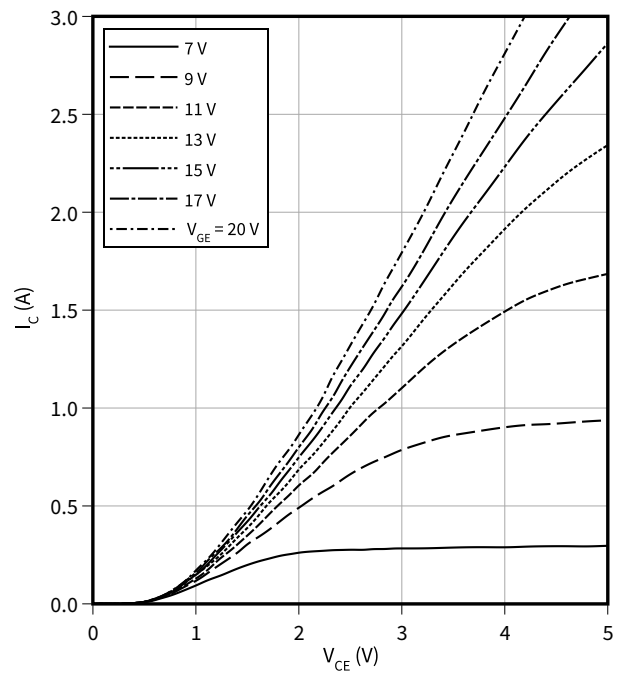
Typical output characteristic

$I_c = f(V_{CE})$
 $T_{vj} = 25\text{ }^\circ\text{C}$



Typical output characteristic

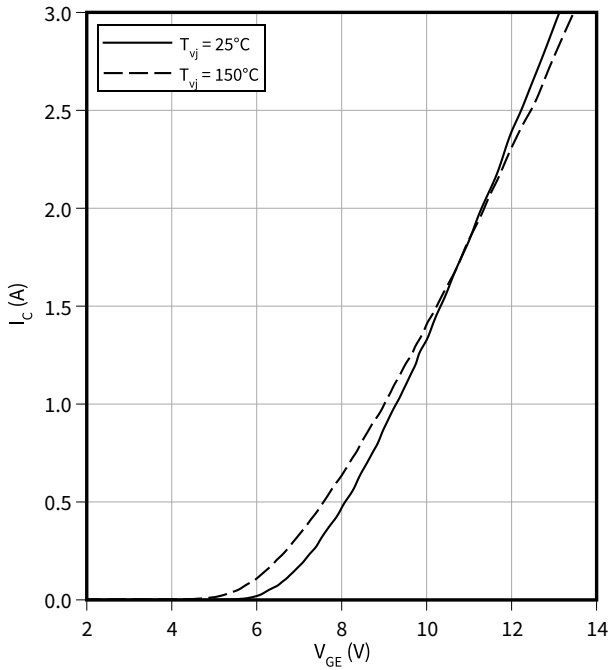
$I_c = f(V_{CE})$
 $T_{vj} = 150\text{ }^\circ\text{C}$



4 Characteristics diagrams

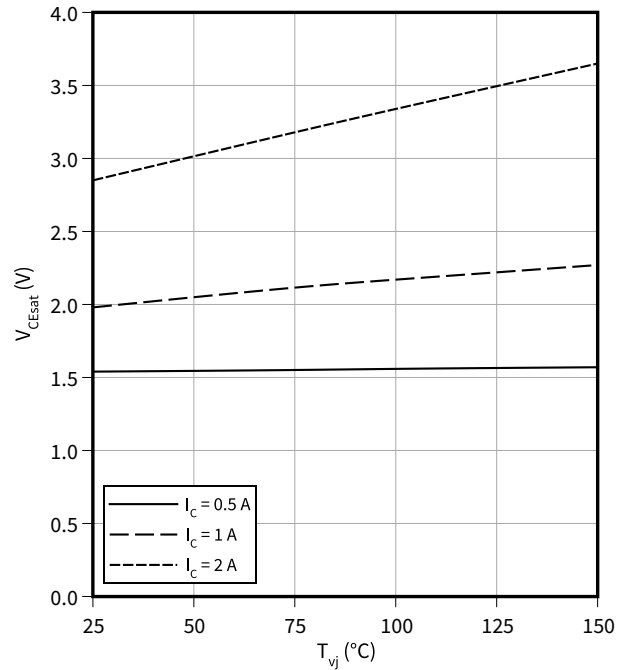
Typical transfer characteristic

$I_C = f(V_{GE})$
 $V_{CE} = 20 \text{ V}$



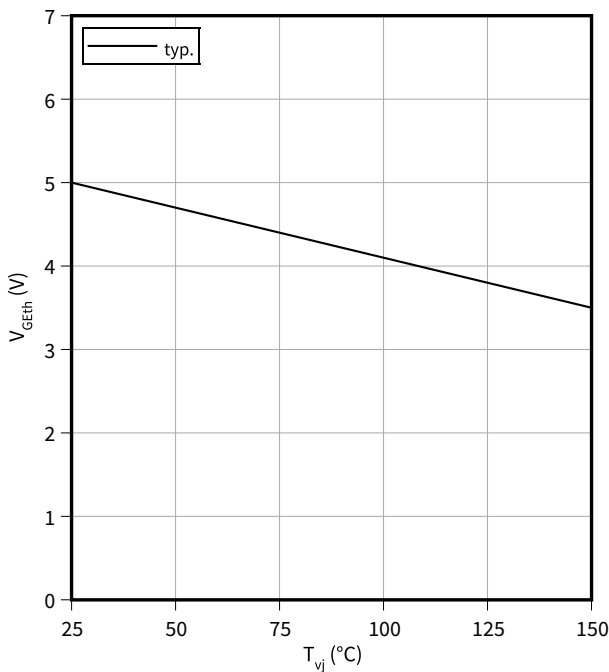
Typical collector-emitter saturation voltage as a function of junction temperature

$V_{CEsat} = f(T_{vj})$
 $V_{GE} = 15 \text{ V}$



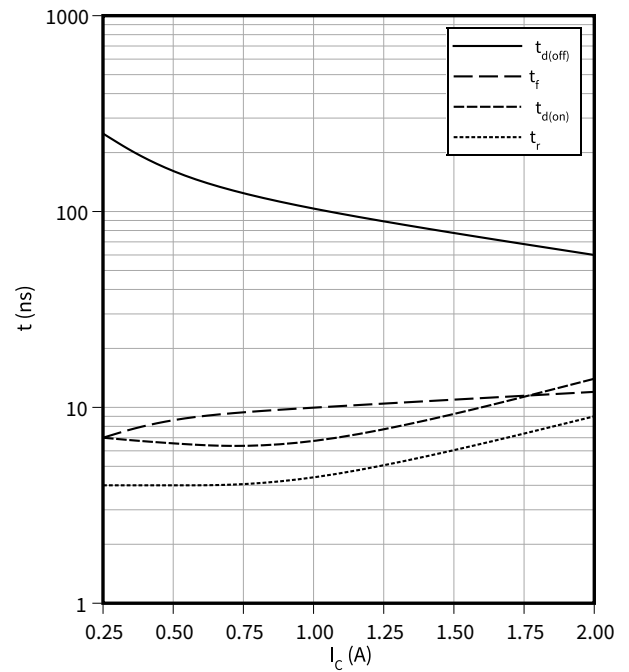
Gate-emitter threshold voltage as a function of junction temperature

$V_{GEth} = f(T_{vj})$
 $I_C = 10 \mu\text{A}$



Typical switching times as a function of collector current

$t = f(I_C)$
 $V_{CC} = 400 \text{ V}, T_{vj} = 150^\circ\text{C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \Omega$

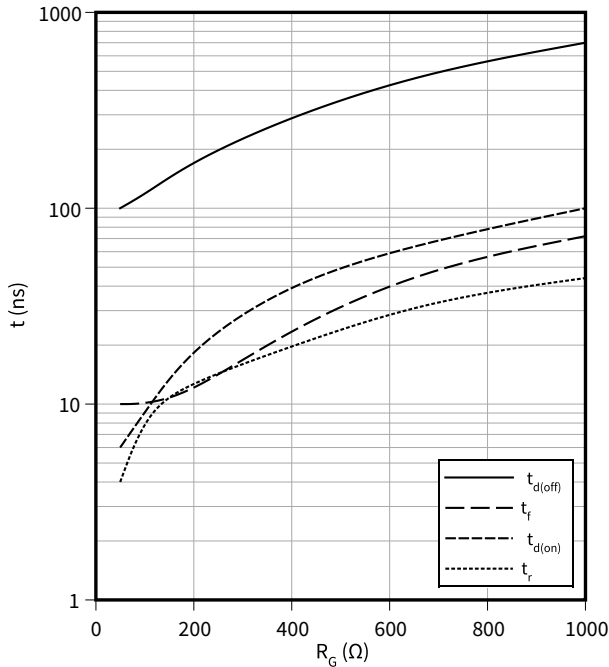


4 Characteristics diagrams

Typical switching times as a function of gate resistor

$t = f(R_G)$

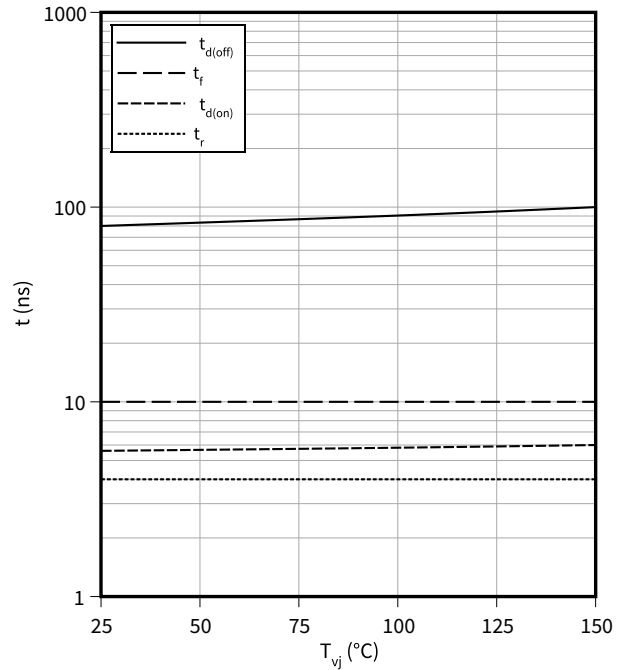
$I_C = 1 \text{ A}$, $V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$



Typical switching times as a function of junction temperature

$t = f(T_{vj})$

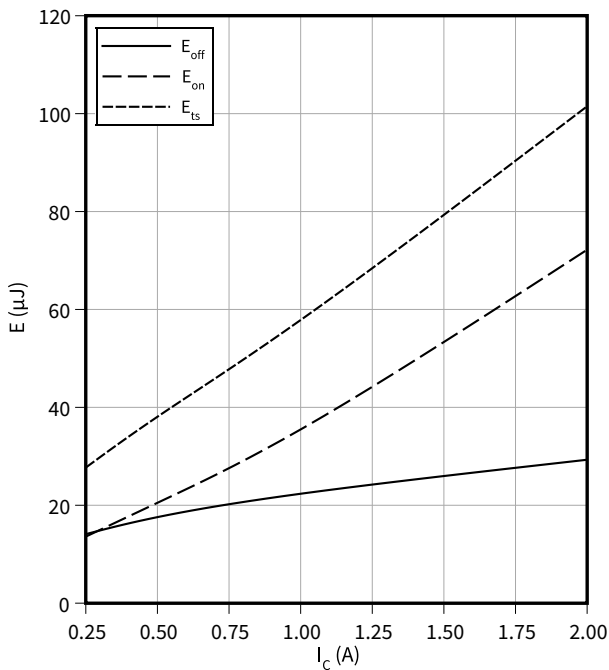
$I_C = 1 \text{ A}$, $V_{CC} = 400 \text{ V}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \text{ } \Omega$



Typical switching energy losses as a function of collector current

$E = f(I_C)$

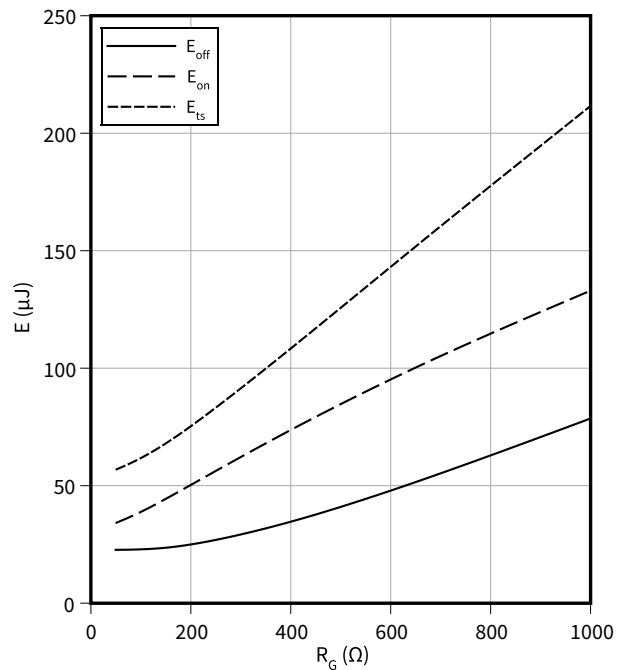
$V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$, $R_G = 49 \text{ } \Omega$



Typical switching energy losses as a function of gate resistor

$E = f(R_G)$

$I_C = 1 \text{ A}$, $V_{CC} = 400 \text{ V}$, $T_{vj} = 150 \text{ }^\circ\text{C}$, $V_{GE} = 0/15 \text{ V}$

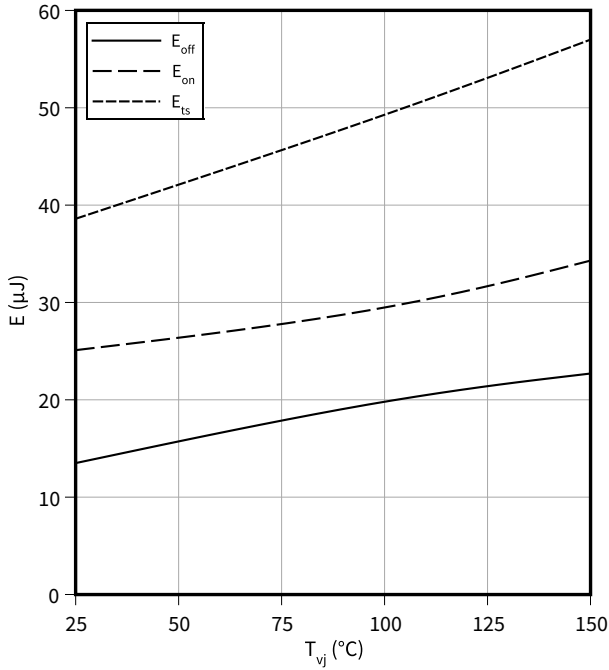


4 Characteristics diagrams

Typical switching energy losses as a function of junction temperature

$E = f(T_{vj})$

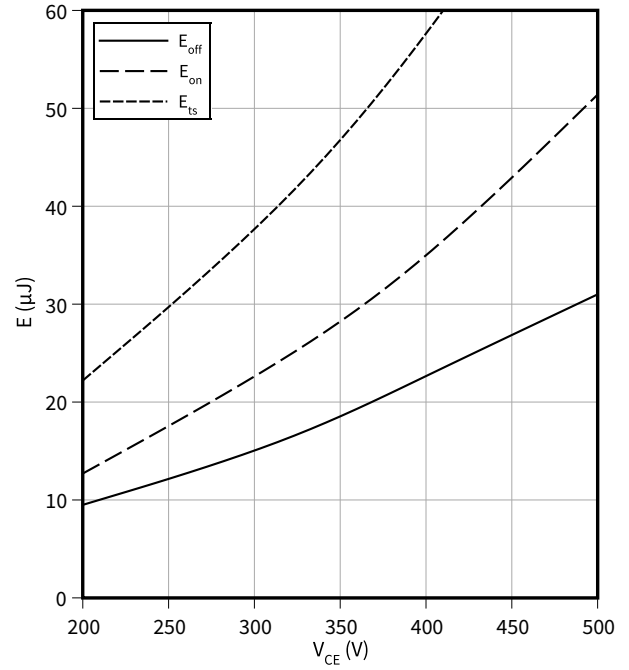
$I_C = 1 \text{ A}, V_{CC} = 400 \text{ V}, V_{GE} = 0/15 \text{ V}, R_G = 49 \Omega$



Typical switching energy losses as a function of collector emitter voltage

$E = f(V_{CE})$

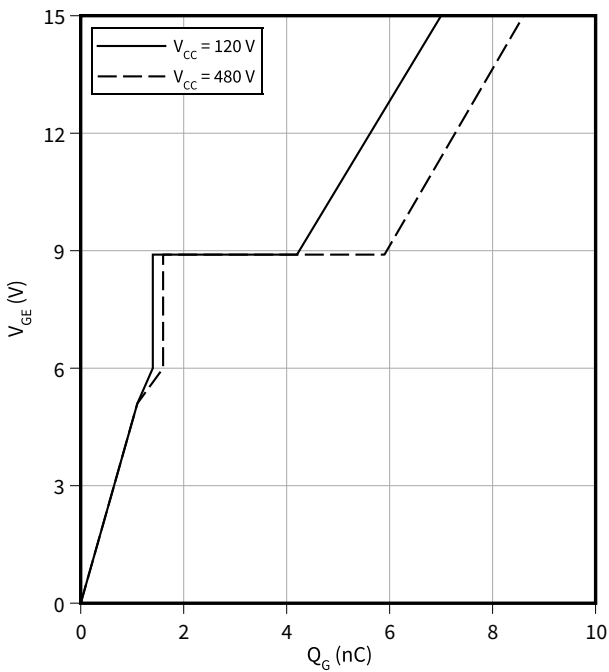
$I_C = 1 \text{ A}, T_{vj} = 150 \text{ °C}, V_{GE} = 0/15 \text{ V}, R_G = 49 \Omega$



Typical gate charge

$V_{GE} = f(Q_G)$

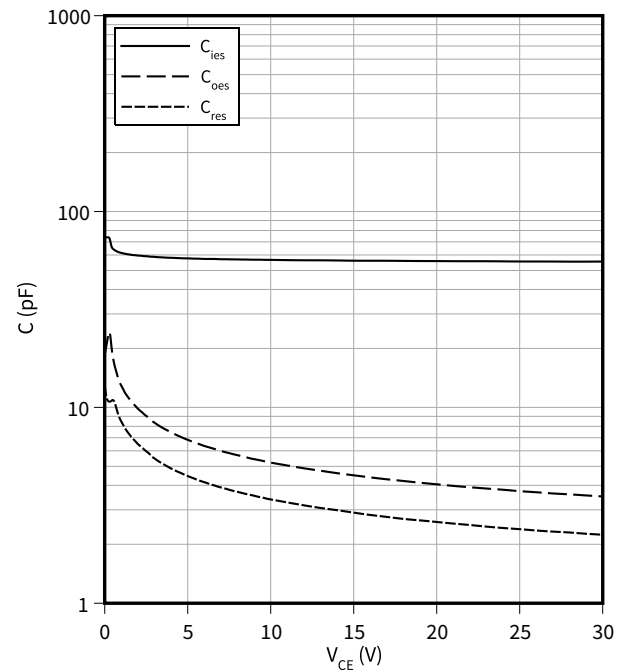
$I_C = 1 \text{ A}$



Typical capacitance as a function of collector-emitter voltage

$C = f(V_{CE})$

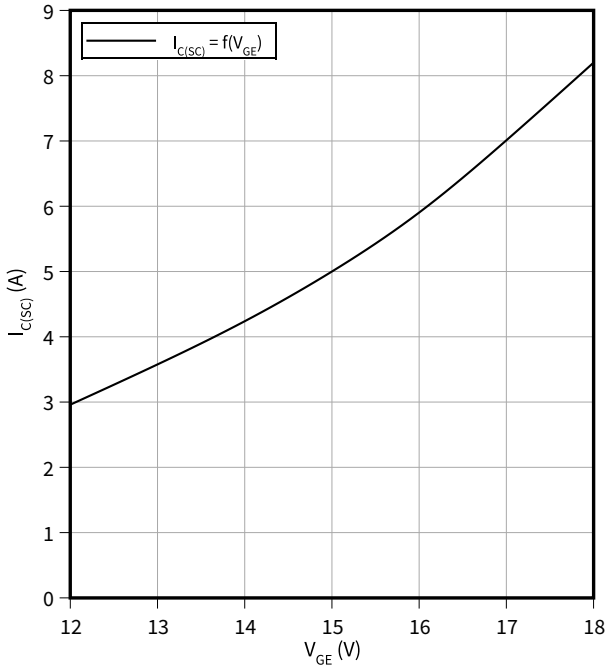
$f = 1000 \text{ kHz}, V_{GE} = 0 \text{ V}$



4 Characteristics diagrams

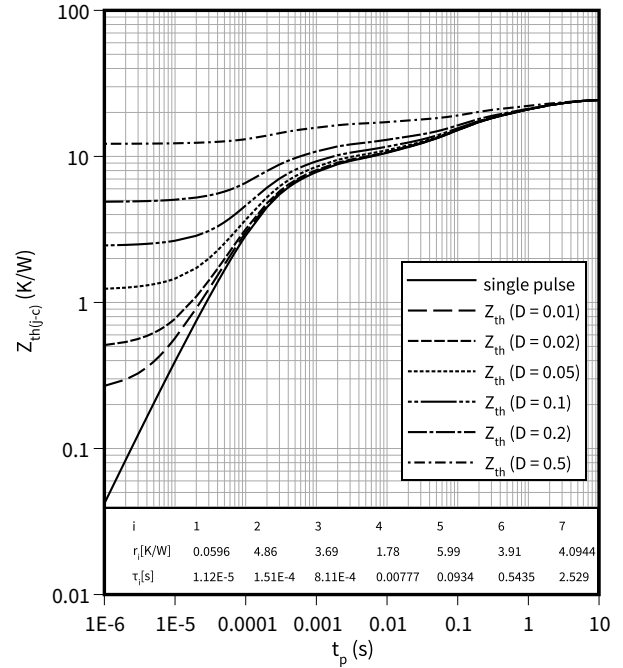
Typical short circuit collector current as a function of gate-emitter voltage

$I_{C(SC)} = f(V_{GE})$
 $T_{vj} \leq 150\text{ }^{\circ}\text{C}, V_{CC} \leq 400\text{ V}$



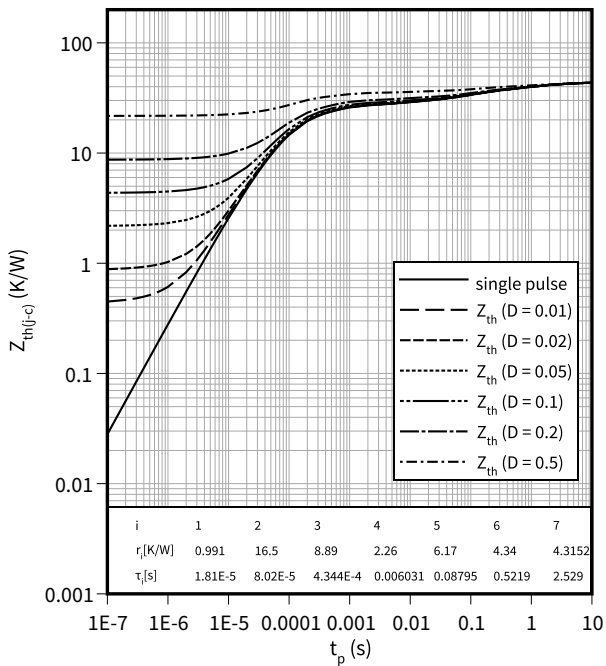
IGBT transient thermal impedance as a function of pulse width

$Z_{th(j-c)} = f(t_p)$
 $D = t_p/T$



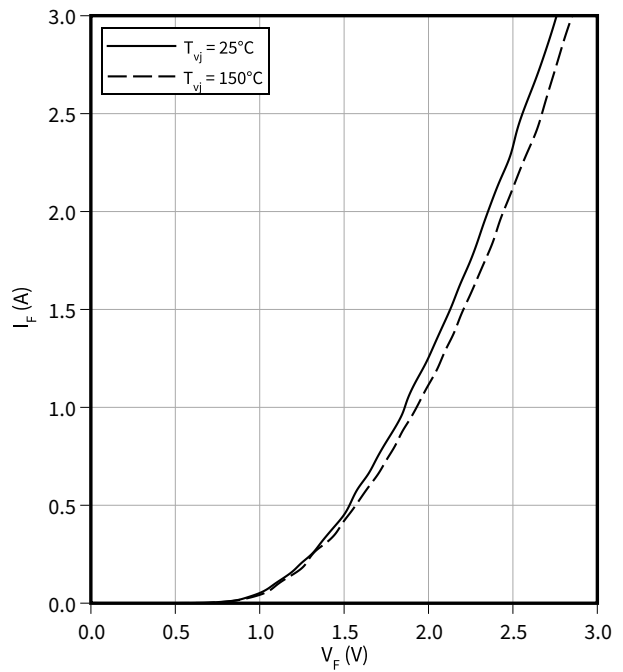
Diode transient thermal impedance as a function of pulse width

$Z_{th(j-c)} = f(t_p)$
 $D = t_p/T$



Typical diode forward current as a function of forward voltage

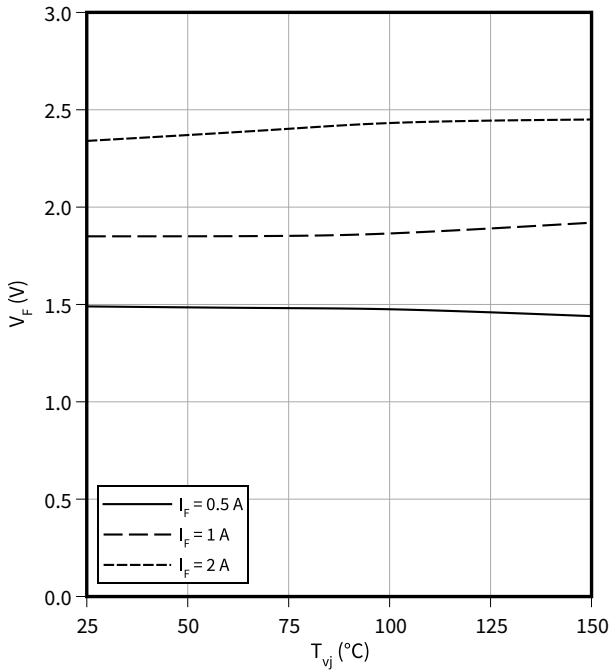
$I_F = f(V_F)$



4 Characteristics diagrams

Typical diode forward voltage as a function of junction temperature

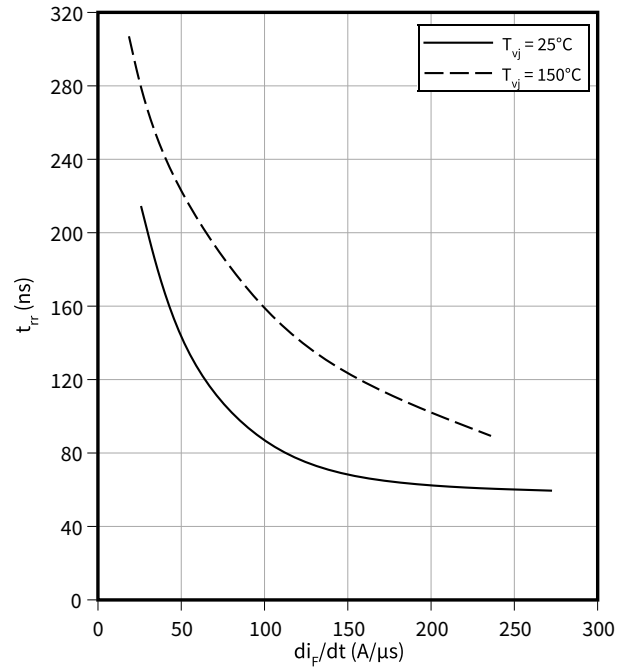
$V_F = f(T_{vj})$



Typical reverse recovery time as a function of diode current slope

$t_{rr} = f(di_F/dt)$

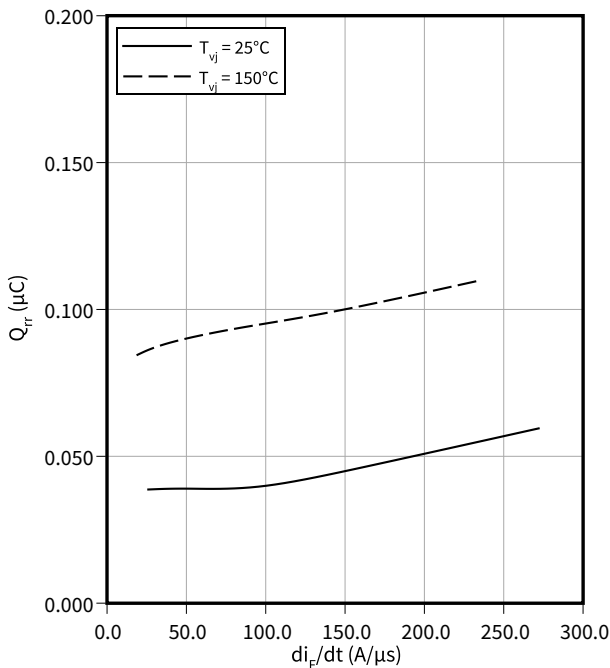
$V_R = 400$ V, $I_F = 1$ A



Typical reverse recovery charge as a function of diode current slope

$Q_{rr} = f(di_F/dt)$

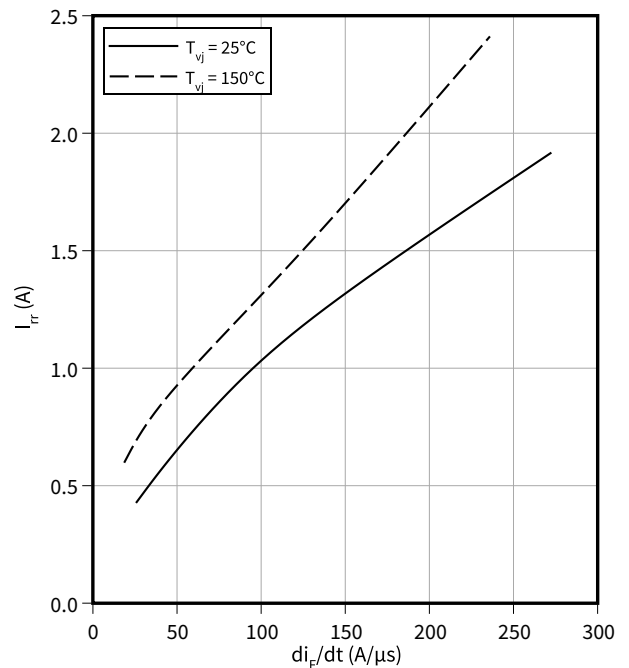
$V_R = 400$ V, $I_F = 1$ A



Typical reverse recovery current as a function of diode current slope

$I_{rr} = f(di_F/dt)$

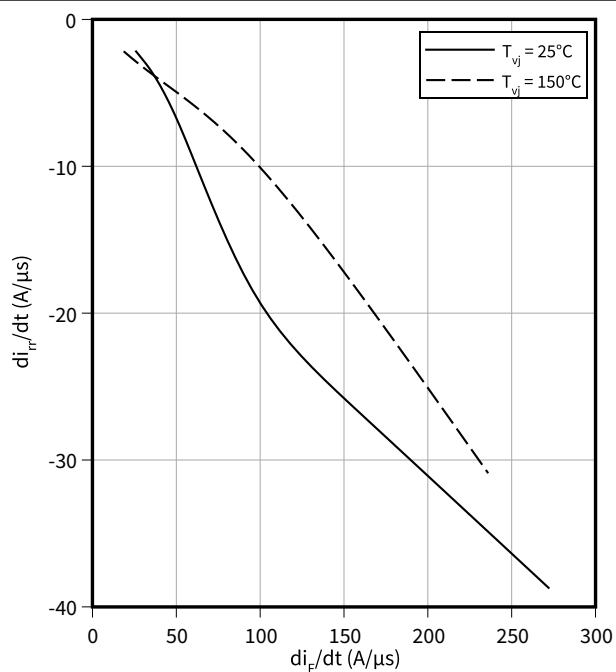
$V_R = 400$ V, $I_F = 1$ A



Typical diode peak rate of fall of reverse recovery current as a function of diode current slope

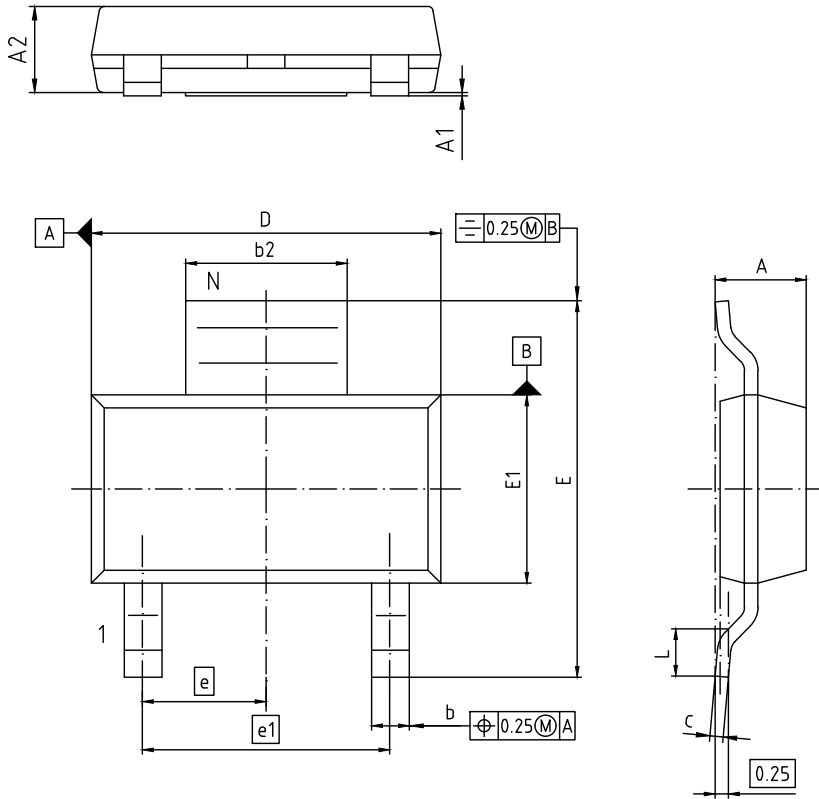
$$di_{rr}/dt = f(di_F/dt)$$

$V_R = 400 \text{ V}$, $I_F = 1 \text{ A}$



5 Package outlines

PG-SOT223-3



NOTES:
 1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-261

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.52 | 1.80 | 0.060 | 0.071 |
| A1 | - | 0.10 | - | 0.004 |
| A2 | 1.50 | 1.70 | 0.059 | 0.067 |
| b | 0.60 | 0.80 | 0.024 | 0.031 |
| b2 | 2.95 | 3.10 | 0.116 | 0.122 |
| c | 0.24 | 0.32 | 0.009 | 0.013 |
| D | 6.30 | 6.70 | 0.248 | 0.264 |
| E | 6.70 | 7.30 | 0.264 | 0.287 |
| E1 | 3.30 | 3.70 | 0.130 | 0.146 |
| e | 2.3 BASIC | | 0.091 BASIC | |
| e1 | 4.6 BASIC | | 0.181 BASIC | |
| L | 0.75 | 1.10 | 0.030 | 0.043 |
| N | 3 | | 3 | |
| O | 0° | 10° | 0° | 10° |

| |
|------------------------------------|
| DOCUMENT NO. Z8B00180553 |
| SCALE |
| EUROPEAN PROJECTION |
| ISSUE DATE 24-02-2016 |
| REVISION 01 |

Figure 1

6 Testing conditions

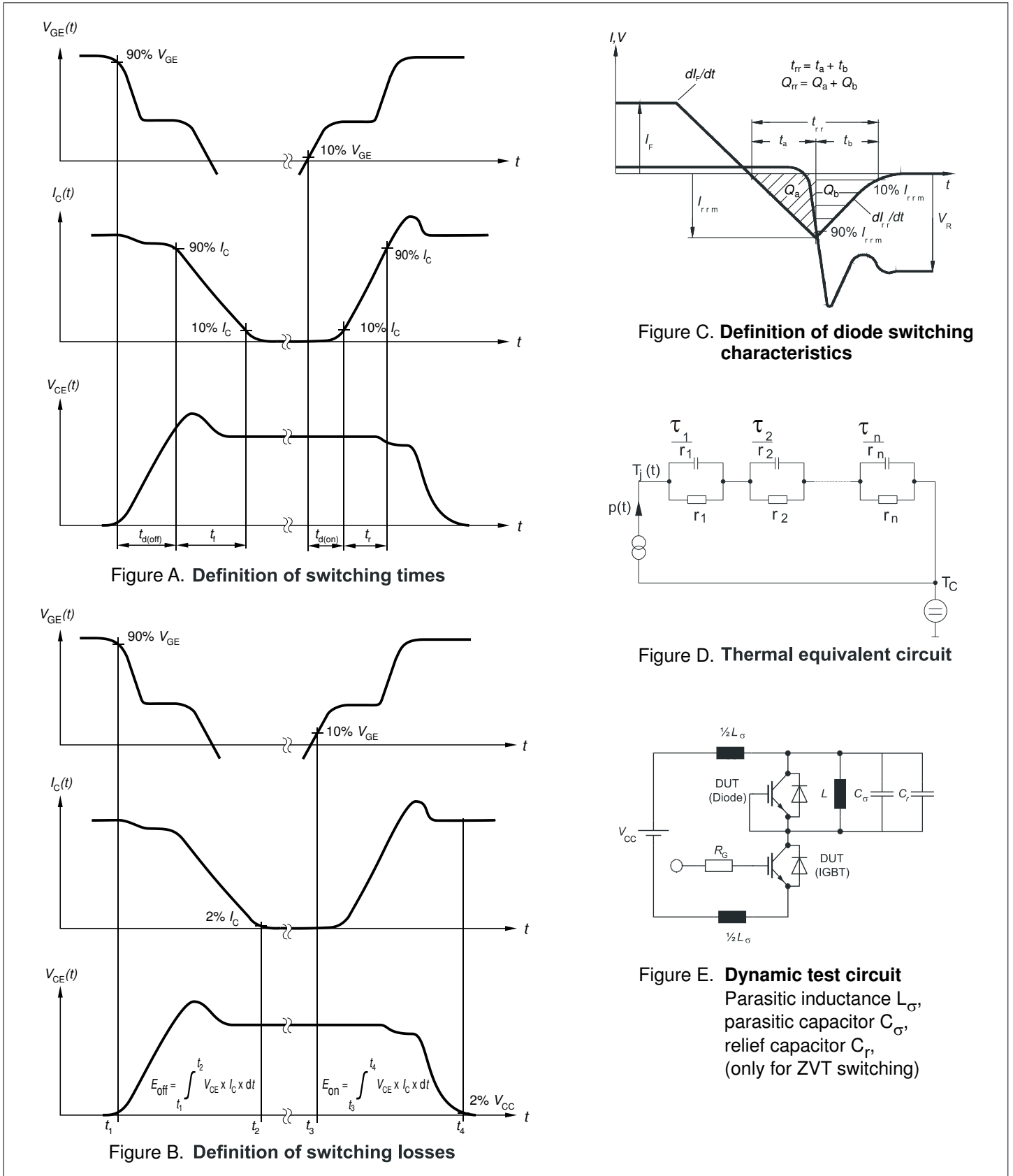


Figure 2

Revision history

| Document revision | Date of release | Description of changes |
|-------------------|-----------------|----------------------------------|
| 1.00 | 2021-09-27 | Final datasheet |
| 1.01 | 2021-10-15 | Change of Potential Applications |
| 1.10 | 2022-09-21 | Add of wave soldering conditions |

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