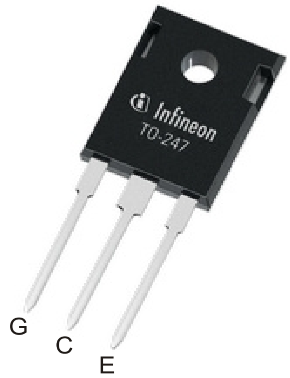
# Short circuit rugged 1200 V TRENCHSTOP™ IGBT 7 technology copacked with soft and fast recovery Emitter Controlled 7 diode

## Features

- $V_{CE}$=1200 V
- $I_C$=50 A
- IGBT co-packed with full current, soft and low Qrr diode
- Low saturation voltage $V_{CE(sat)}$ = 2.0 V at $T_{vj}$=175 °C
- Optimized for hard switching topologies (2-L inverter, 3-L NPC T-type, ...)
- Short circuit ruggedness 8 µsec
- Wide range of dv/dt controllability
- Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/



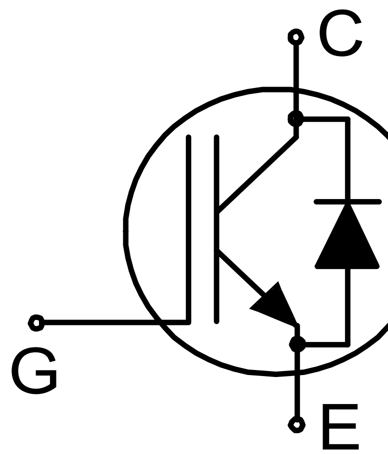

## Potential applications

- Industrial Drives
- Industrial Power Supplies
- Solar Inverters

## Product validation

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

## Description




| Type | Package | Marking |
|---|---|---|
| IKW50N120CS7 | PG-TO247-3 | K50MCS7 |

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# 1 Package

**Table 1 Characteristic values**

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Internal emitter inductance measured 5mm. (0.197in) from case | $L_E$ | | | 13.0 | | nH |
| Storage temperature | $T_{stg}$ | | -55 | | 150 | °C |
| Soldering temperature | | wave soldering 1.6mm (0.063in.) from case for 10s | | | 260 | °C |
| Mounting torque , M3 screw Maximum of mounting process: 3 | $M$ | | | | 0.6 | Nm |
| Thermal resistance, junction-ambient | $R_{th(j-a)}$ | | | | 40 | K/W |

# 2 IGBT

**Table 2 Maximum rated values**

| Parameter | Symbol | Note or test condition | | Values | Unit |
|---|---|---|---|---|---|
| Collector-emitter voltage | $V_{CE}$ | $T_{vj} \geq 25$ °C | | 1200 | V |
| DC collector current, limited by $T_{vjmax}$ | $I_C$ | limited by bondwire | $T_C = 25$ °C | 82 | A |
| | | | $T_C = 100$ °C | 68 | |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$ | $I_{Cpuls}$ | | | 150 | A |
| Turn-off safe operating area | | $V_{CE} \leq$ 1200 V, $T_{vj} \leq$ 175 °C | | 150 | A |
| Gate-emitter voltage | $V_{GE}$ | | | ±20 | V |
| Transient gate-emitter voltage | $V_{GE}$ | $t_p \leq$ 0.5 µs, $D < 0.001$ | | ±25 | V |
| Short circuit withstand time | $t_{SC}$ | $V_{CC} \leq$ 600 V, $V_{GE}$ = 15 V, Allowed number of short circuits < 1000, Time between short circuits ≥ 1.0 s, $T_{vj}$ = 150 °C | | 8 | µs |
| Power dissipation | $P_{tot}$ | | $T_C = 25$ °C | 428 | W |
| | | | $T_C = 100$ °C | 215 | |

**Table 3 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Collector-emitter saturation voltage | $V_{CE\,sat}$ | $I_C$ = 50.0 A, $V_{GE}$ = 15 V | $T_{vj}$ = 25 °C | | 1.65 | 2.00 | V |
| | | | $T_{vj}$ = 175 °C | | 2.00 | | |

**Table 3** **Characteristic values (continued)**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Gate-emitter threshold voltage | $V_{GEth}$ | $I_C$ = 0.98 mA, $V_{CE} = V_{GE}$, $T_{vj}$ = 25 °C | | 5.15 | 5.70 | 6.45 | V |
| Zero gate voltage collector current | $I_{CES}$ | $V_{CE}$ = 1200 V, $V_{GE}$ = 0 V | $T_{vj}$ = 25 °C | | | 40 | µA |
| | | | $T_{vj}$ = 175 °C | | 4000 | | |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$ = 0 V, $V_{GE}$ = 20 V | | | | 100 | nA |
| Transconductance | $g_{fs}$ | $I_C$ = 50.0 A, $V_{CE}$ = 20 V, $T_{vj}$ = 175 °C | | | 21.0 | | S |
| Short circuit collector current | $I_{SC}$ | $V_{CC} \leq$ 600 V, $V_{GE}$ = 15 V, $t_{SC} \leq$ 8 µs, Allowed number of short circuits < 1000 , Time between short circuits ≥ 1.0 s, $T_{vj}$ = 25 °C | | | 300 | | A |
| Input capacitance | $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, $f$ = 100 kHz | | | 7.2 | | nF |
| Output capacitance | $C_{oes}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, $f$ = 100 kHz | | | 140 | | pF |
| Reverse transfer capacitance | $C_{res}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, $f$ = 100 kHz | | | 32 | | pF |
| Gate charge | $Q_G$ | $I_C$ = 50.0 A, $V_{GE}$ = 15 V, $V_{CE}$ = 960 V | | | 290 | | nC |
| Turn-on delay time | $t_{don}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 2.3 Ω, $R_{Goff}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_C$ = 50.0 A | | 29 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 50.0 A | | 26 | | |
| Rise time (inductive load) | $t_r$ | $V_{CE}$ = 600 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 2.3 Ω, $R_{Goff}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_C$ = 50.0 A | | 19 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 50.0 A | | 19 | | |
| Turn-off delay time | $t_{doff}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 2.3 Ω, $R_{Goff}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_C$ = 50.0 A | | 170 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 50.0 A | | 225 | | |
| Fall time (inductive load) | $t_f$ | $V_{CE}$ = 600 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 2.3 Ω, $R_{Goff}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_C$ = 50.0 A | | 100 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 50.0 A | | 245 | | |
| Turn-on energy | $E_{on}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 2.3 Ω, $R_{Goff}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_C$ = 50.0 A | | 2.80 | | mJ |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 50.0 A | | 4.30 | | |
| Turn-off energy | $E_{off}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 2.3 Ω, $R_{Goff}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_C$ = 50.0 A | | 2.20 | | mJ |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 50.0 A | | 4.70 | | |

**Table 3 Characteristic values (continued)**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Total switching energy | $E_{ts}$ | $V_{CE}$ = 600 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 2.3 Ω, $R_{Goff}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_C$ = 50.0 A | | 5.00 | | mJ |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 50.0 A | | 9.00 | | |
| IGBT thermal resistance, junction-case | $R_{thjc}$ | | | | 0.25 | 0.35 | K/W |
| Operating junction temperature | $T_{vj}$ | | | -40 | | 175 | °C |

# 3 Diode

**Table 4 Maximum rated values**

| Parameter | Symbol | Note or test condition | | Values | Unit |
|---|---|---|---|---|---|
| Repetitive peak reverse voltage | $V_{RRM}$ | $T_{vj}$ ≥ 25 °C | | 1200 | V |
| Diode forward current, limited by $T_{vjmax}$ | $I_F$ | limited by bondwire | $T_C$ = 25 °C | 82 | A |
| | | | $T_C$ = 100 °C | 56 | |
| Diode pulsed current, limited by $T_{vjmax}$ | $I_{Fpuls}$ | | | 150 | A |
| Power dissipation | $P_{tot}$ | | $T_C$ = 25 °C | 250 | W |
| | | | $T_C$ = 100 °C | 125 | |

**Table 5 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Diode forward voltage | $V_F$ | $I_F$ = 50.0 A | $T_{vj}$ = 25 °C | | 1.65 | 2.15 | V |
| | | | $T_{vj}$ = 175 °C | | 1.60 | | |
| Reverse leakage current | $I_R$ | $V_R$ = 1200 V | $T_{vj}$ = 25 °C | | | 40 | µA |
| | | | $T_{vj}$ = 175 °C | | 4000 | | |
| Diode reverse recovery time | $t_{rr}$ | $V_R$ = 600 V, $R_{Gon}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_F$ = 50.0 A | | 165 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 50.0 A | | 305 | | |
| Diode reverse recovery charge | $Q_{rr}$ | $V_R$ = 600 V, $R_{Gon}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_F$ = 50.0 A | | 3.20 | | µC |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 50.0 A | | 8.25 | | |

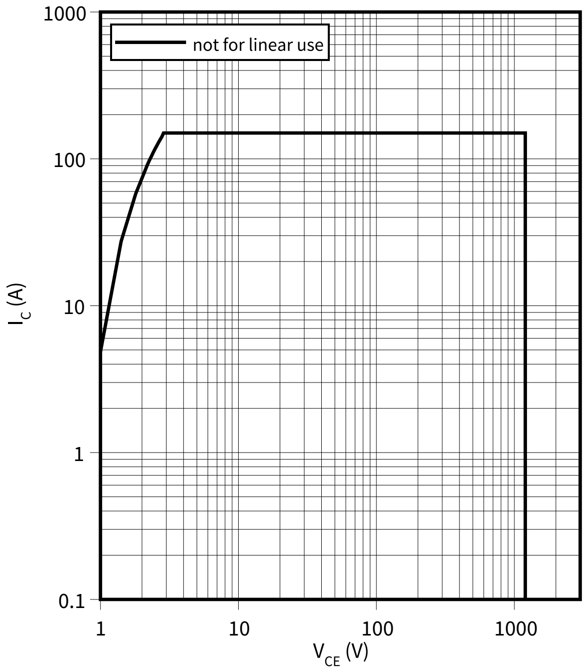
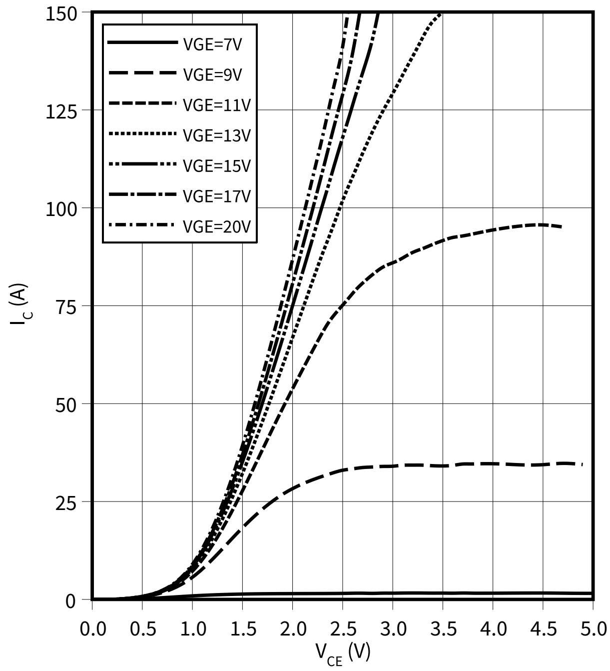
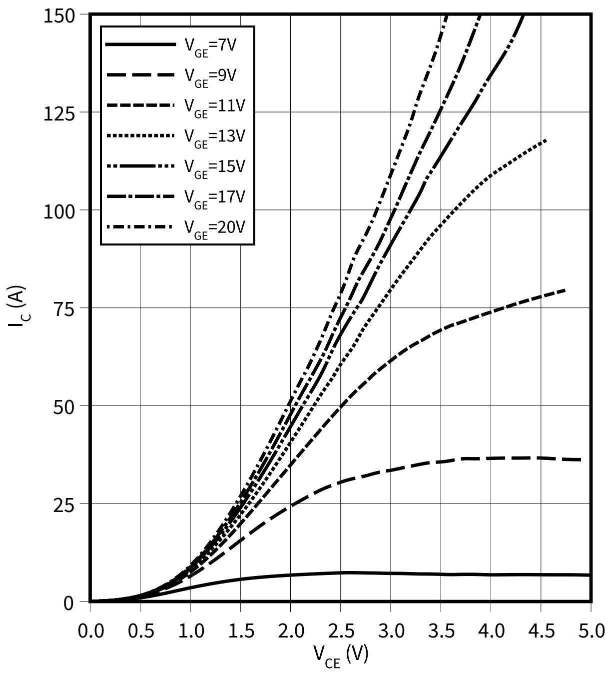
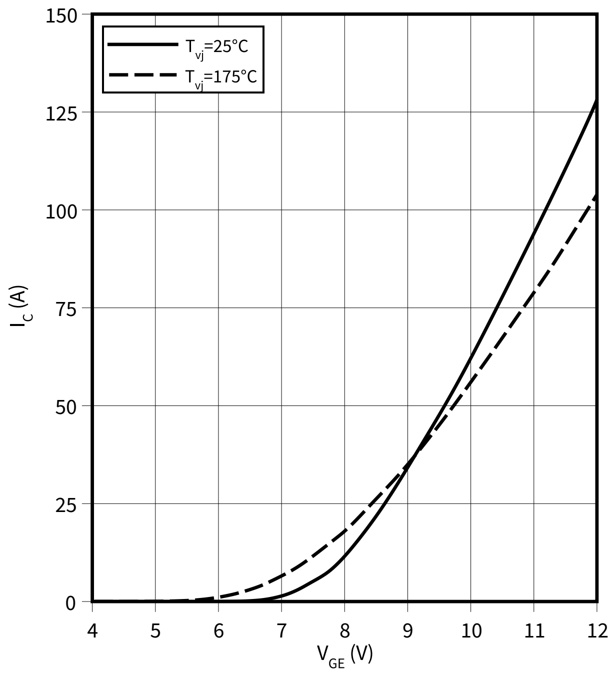
**Table 5 Characteristic values (continued)**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Diode peak reverse recovery current | $I_{rrm}$ | $V_R$ = 600 V, $R_{Gon}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_F$ = 50.0 A | | 40.0 | | A |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 50.0 A | | 54.0 | | |
| Diode peak rate off fall of reverse recovery current | $dI_{rr}/dt$ | $V_R$ = 600 V, $R_{Gon}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_F$ = 50.0 A | | -290 | | A/µs |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 50.0 A | | -185 | | |
| Reverse recovery energy | $E_{rec}$ | $V_R$ = 600 V, $R_{Gon}$ = 2.3 Ω | $T_{vj}$ = 25 °C, $I_F$ = 50.0 A | | 1.00 | | mJ |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 50.0 A | | 3.10 | | |
| Diode thermal resistance, junction-case | $R_{thjc}$ | | | | 0.45 | 0.60 | K/W |
| Operating junction temperature | $T_{vj}$ | | | -40 | | 175 | °C |

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

*Dynamic test circuit, parasitic inductance* $L_\sigma$ *= 30 nH,* $C_\sigma$ *= 28 pF*

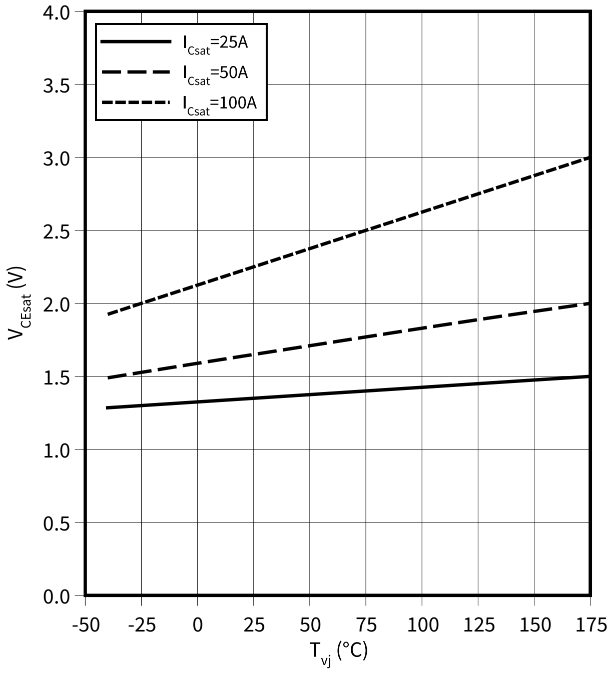
# 4 Characteristics diagrams

| **Reverse bias safe operating area, IGBT**<br>$I_C = f(V_{CE})$<br>$T_{vj} \leq 175$ °C, $V_{GE} = 15$ V | **Typical output characteristic, IGBT**<br>$I_C = f(V_{CE})$<br>$T_{vj} = 25$ °C |
|---|---|
|  |  |
| **Typical output characteristic, IGBT**<br>$I_C = f(V_{CE})$<br>$T_{vj} = 175$ °C | **Typical transfer characteristic, IGBT**<br>$I_C = f(V_{GE})$<br>$V_{CE} = 20$ V |
|  |  |

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

$V_{CEsat} = f(T_{vj})$

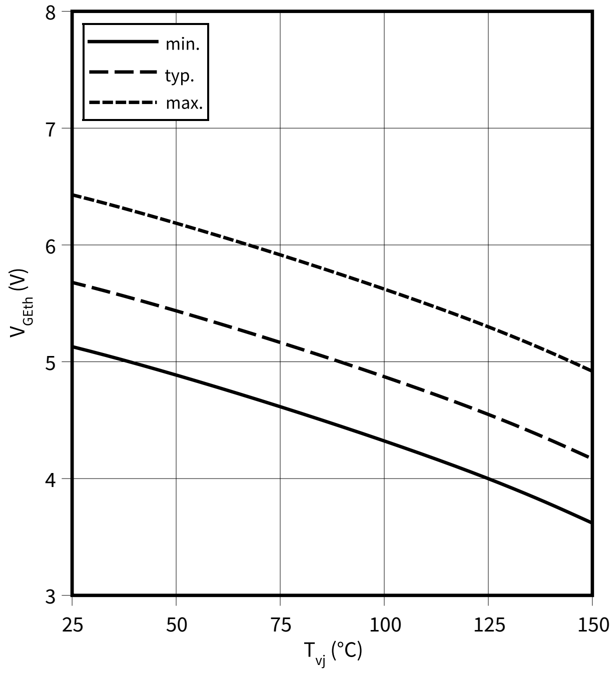
$V_{GE} = 15\ V$




**Gate-emitter threshold voltage as a function of junction temperature, IGBT**

$V_{GEth} = f(T_{vj})$

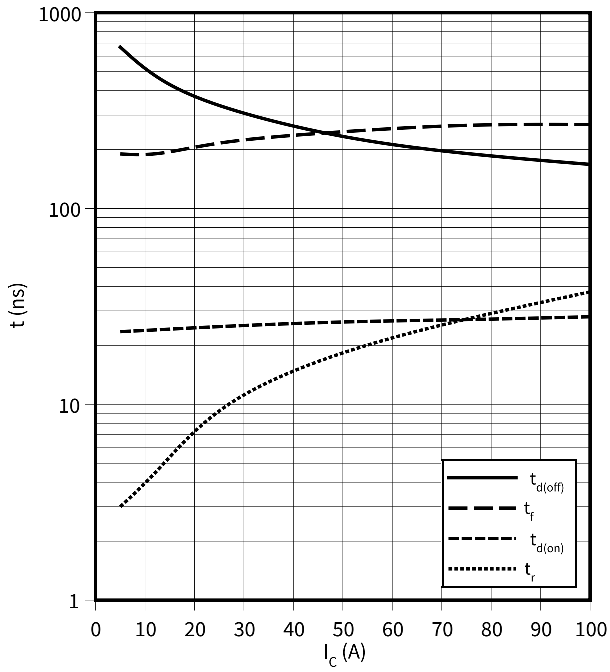
$I_C = 0.98\ mA$




**Typical switching times as a function of collector current, IGBT**

$t = f(I_C)$

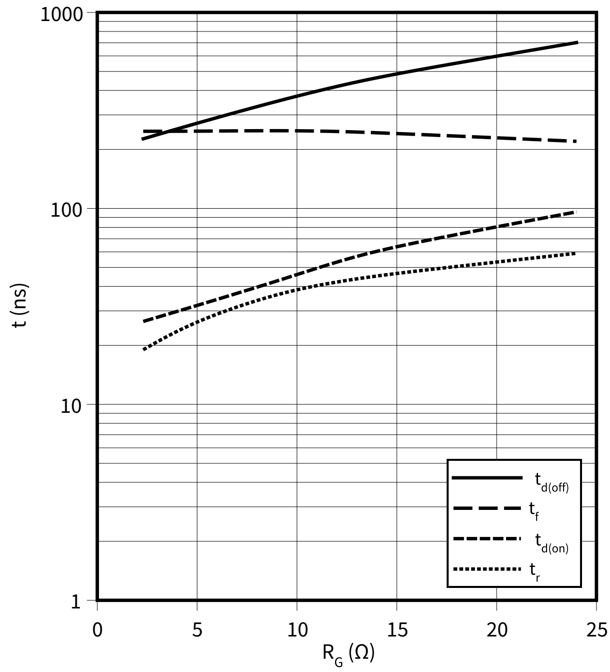
$V_{CE} = 600\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$, $R_G = 2.3\ \Omega$




**Typical switching times as a function of gate resistor, IGBT**

$t = f(R_G)$

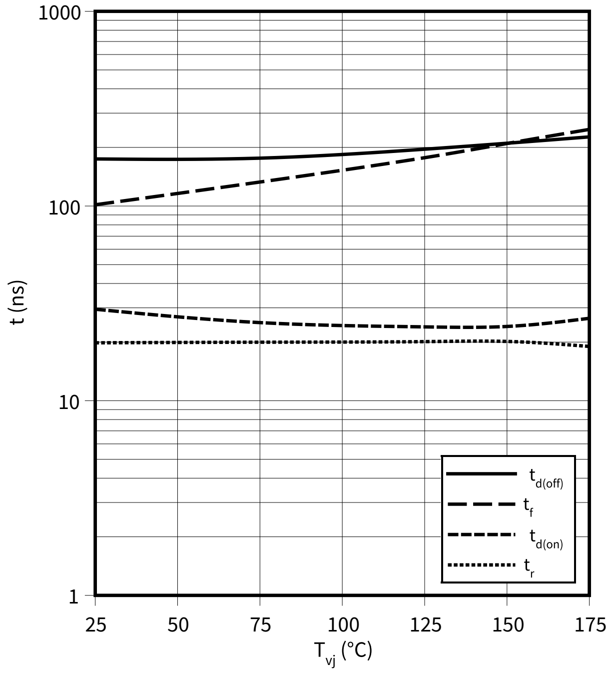
$I_C = 50.0\ A$, $V_{CE} = 600\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$



### Typical switching times as a function of junction temperature, IGBT

$t = f(T_{vj})$

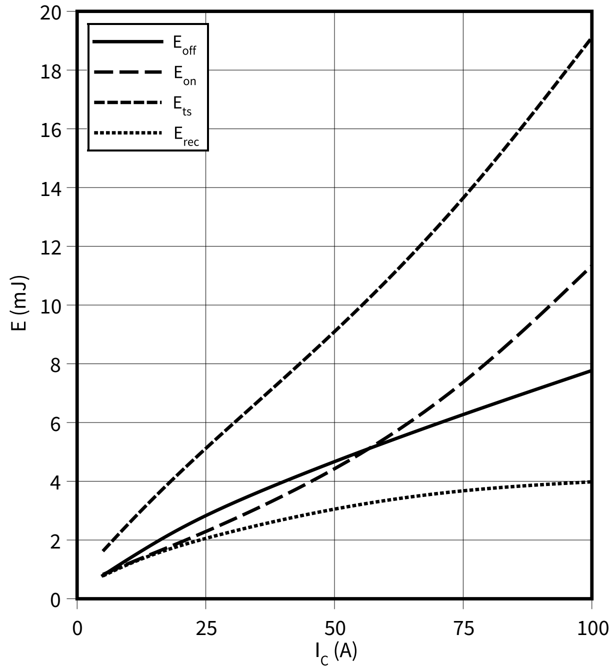
$I_C$ = 50.0 A, $V_{CE}$ = 600 V, $V_{GE}$ = 0/15 V, $R_G$ = 2.3 Ω




### Typical switching energy losses as a function of collector current, IGBT

$E = f(I_C)$

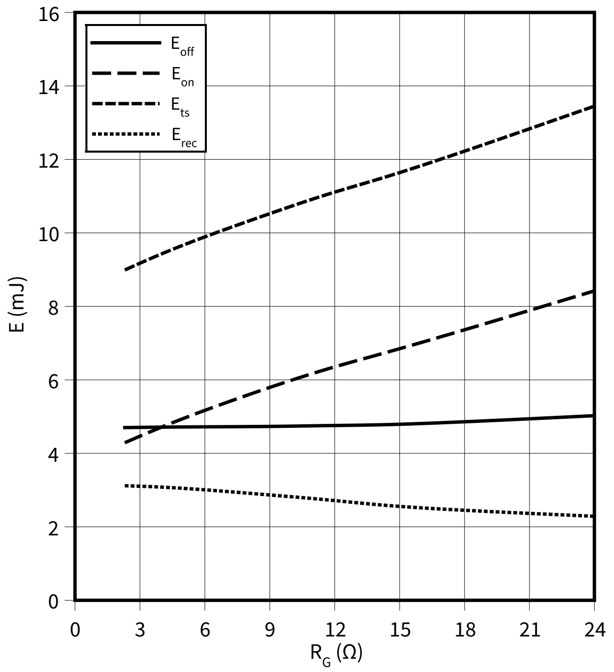
$V_{CE}$ = 600 V, $T_{vj}$ = 175 °C, $V_{GE}$ = 0/15 V, $R_G$ = 2.3 Ω




### Typical switching energy losses as a function of gate resistor, IGBT

$E = f(R_G)$

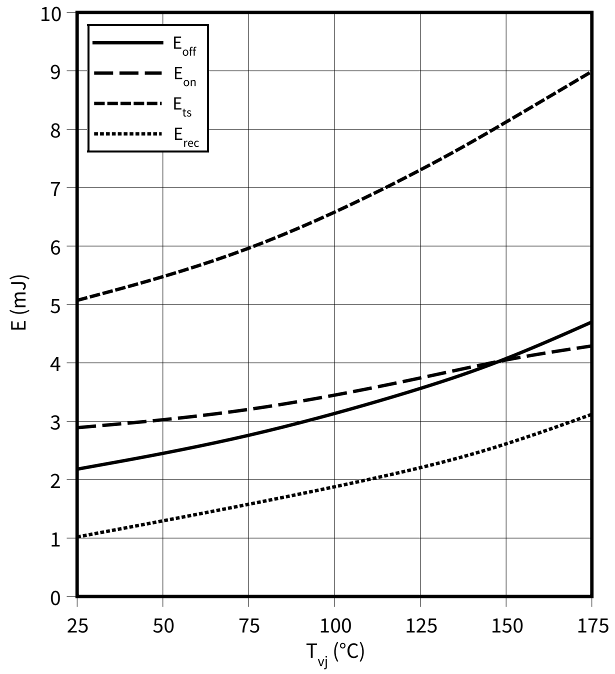
$I_C$ = 50.0 A, $V_{CE}$ = 600 V, $T_{vj}$ = 175 °C, $V_{GE}$ = 0/15 V




### Typical switching energy losses as a function of junction temperature, IGBT

$E = f(T_{vj})$

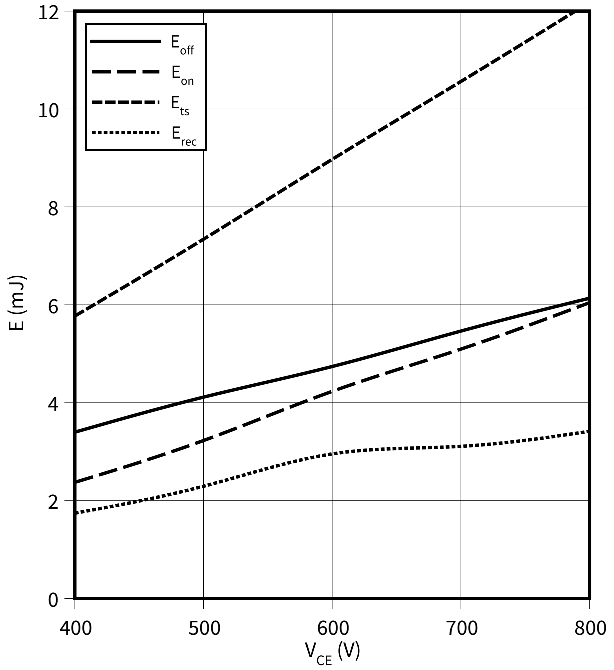
$I_C$ = 50.0 A, $V_{CE}$ = 600 V, $V_{GE}$ = 0/15 V, $R_G$ = 2.3 Ω



**Typical switching energy losses as a function of collector emitter voltage, IGBT**

$E = f(V_{CE})$

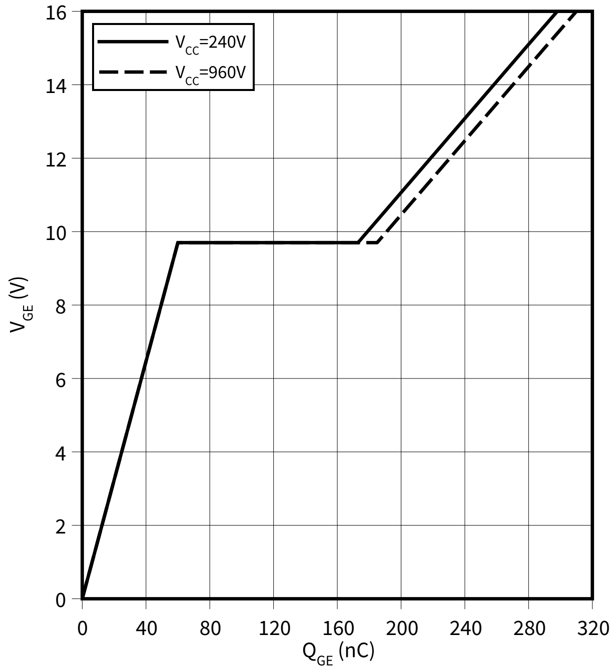
$I_C = 50.0$ A, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 2.3\ \Omega$




**Typical gate charge, IGBT**

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

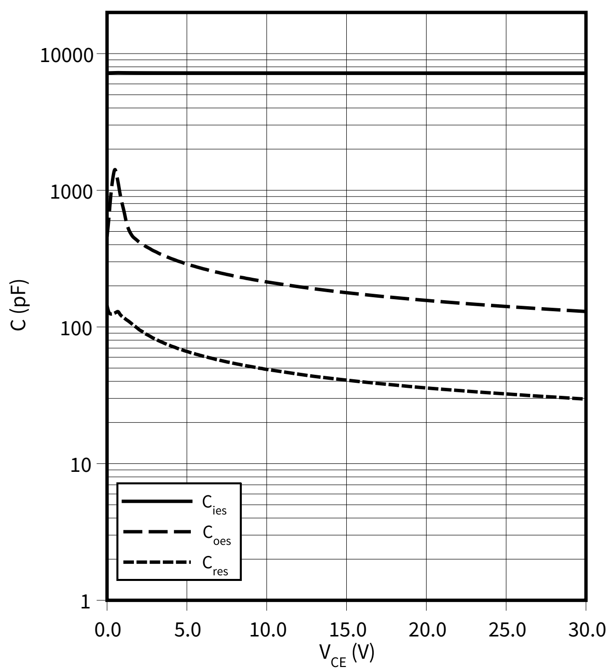
$I_C = 50.0$ A




**Typical capacitance as a function of collector-emitter voltage, IGBT**

$C = f(V_{CE})$

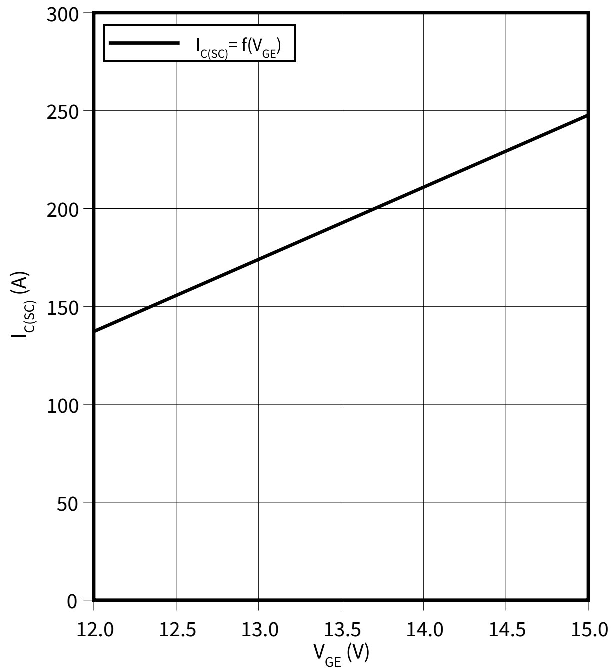
$f = 100$ kHz, $V_{GE} = 0$ V




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

$I_{C(SC)} = f(V_{GE})$

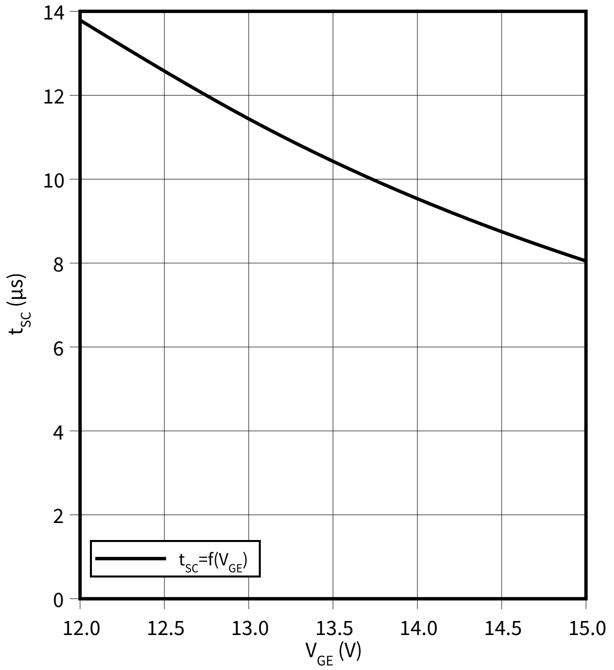
$T_{vj} = 150$ °C, $V_{CC} = 600$ V



**Short circuit withstand time as a function of gate-emitter voltage, IGBT**

$t_{SC} = f(V_{GE})$

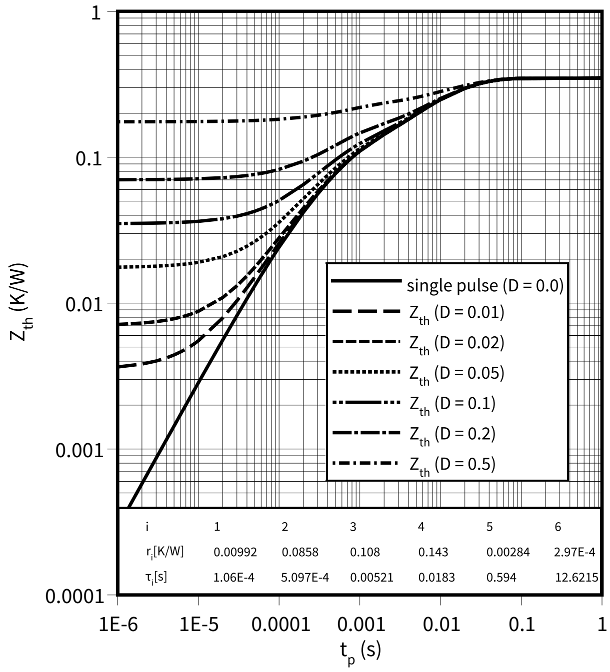
$T_{vj} \leq 150$ °C, $V_{CC} = 600$ V




**IGBT transient thermal impedance, IGBT**

$Z_{th} = f(t_p)$

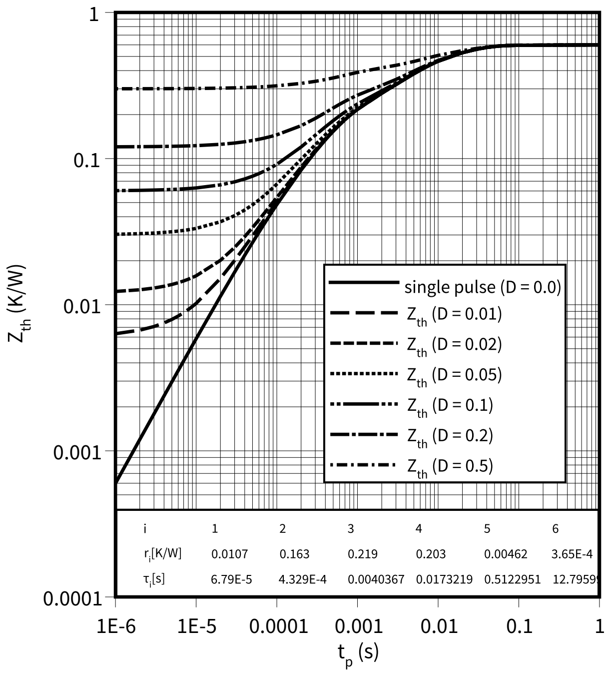
$D = t_p/T$




**Diode transient thermal impedance as a function of pulse width, Diode**

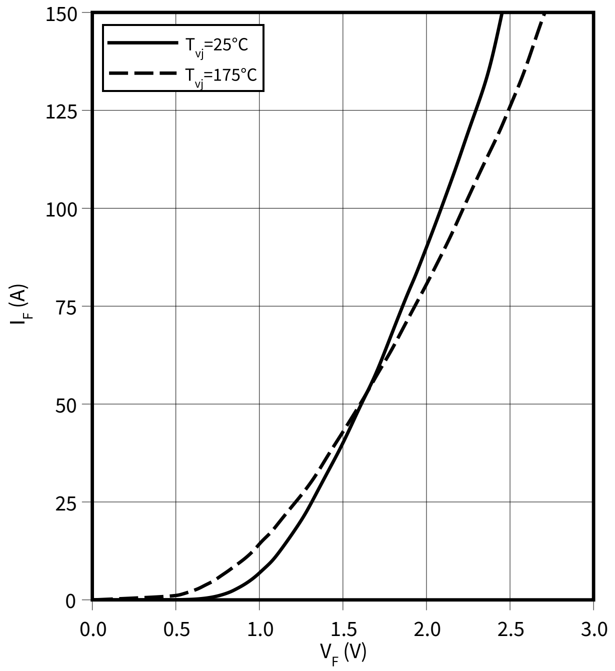
$Z_{th} = f(t_p)$

$D = t_p/T$



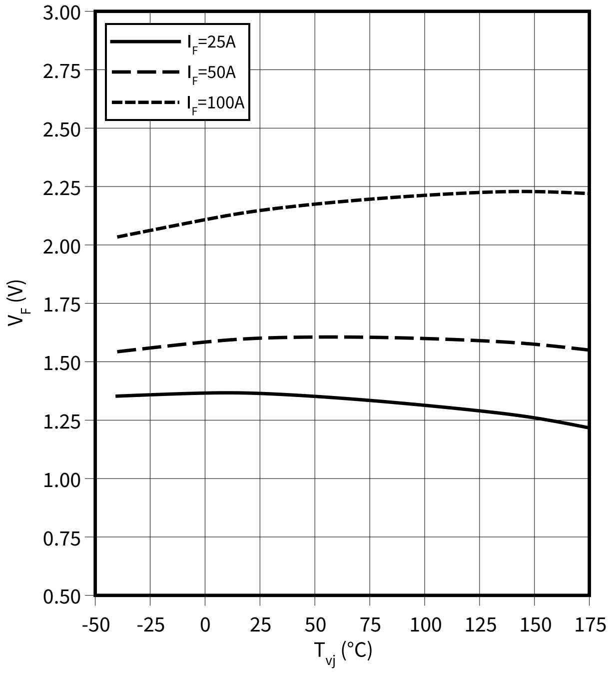

**Typical diode forward current as a function of forward voltage, Diode**

$I_F = f(V_F)$



**Typical diode forward voltage as a function of junction temperature, Diode**

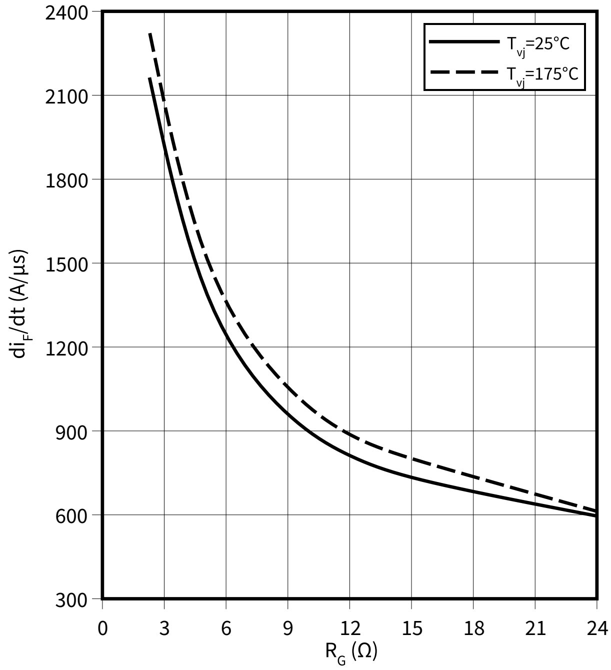
$V_F = f(T_{vj})$




**Typical diode current slope as a function of gate resistor, Diode**

$di_F/dt = f(R_G)$

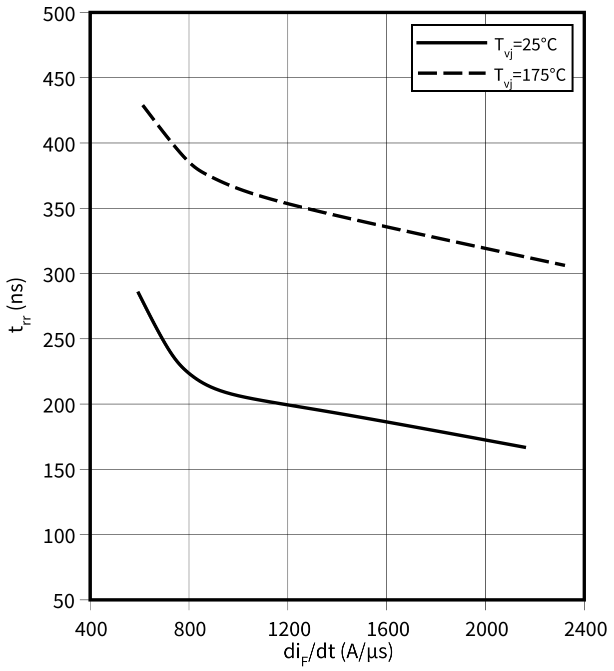
$I_C = 50.0$ A, $V_{CE} = 600$ V, $V_{GE} = 0/15$ V




**Typical reverse recovery time as a function of diode current slope, Diode**

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

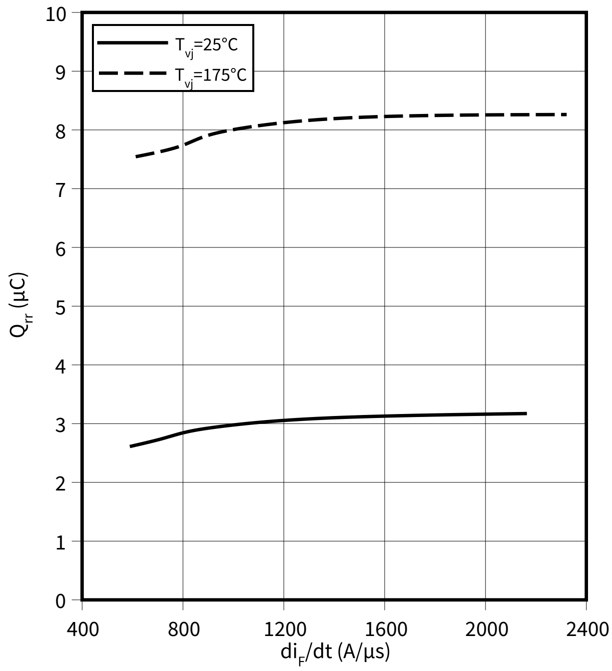
$V_R = 600$ V, $I_F = 50.0$ A




**Typical reverse recovery charge as a function of diode current slope, Diode**

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

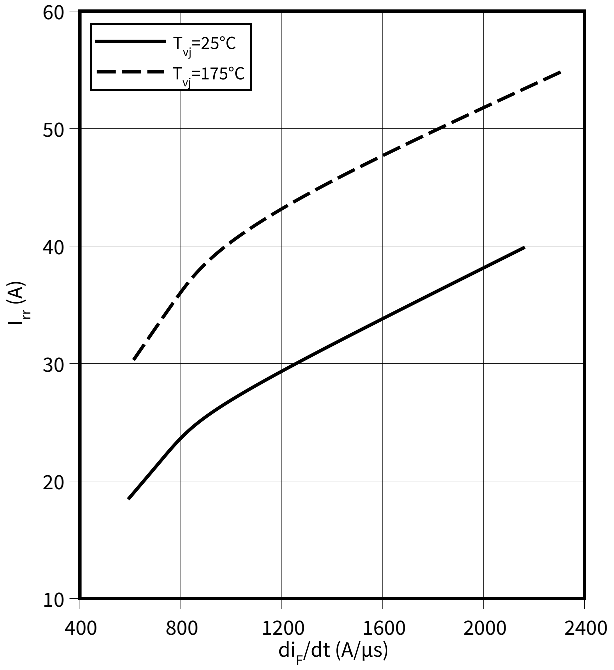
$V_R = 600$ V, $I_F = 50.0$ A



**Typical reverse recovery current as a function of diode current slope, Diode**

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

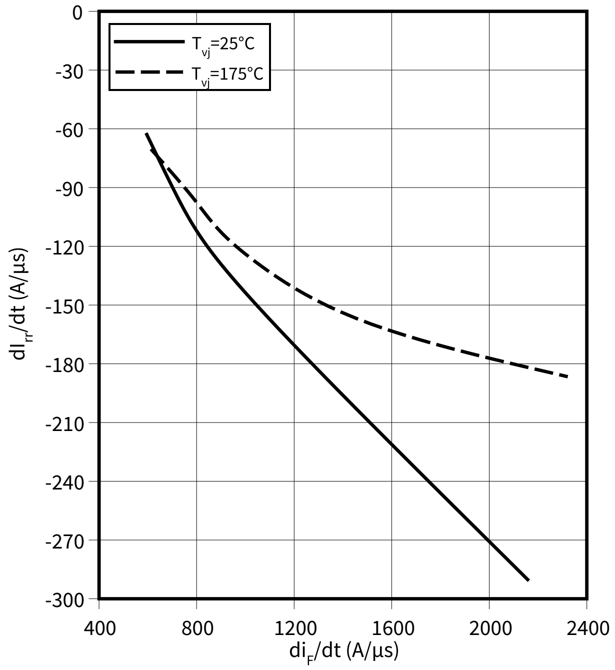
$V_R = 600\ V$, $I_F = 50.0\ A$




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

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

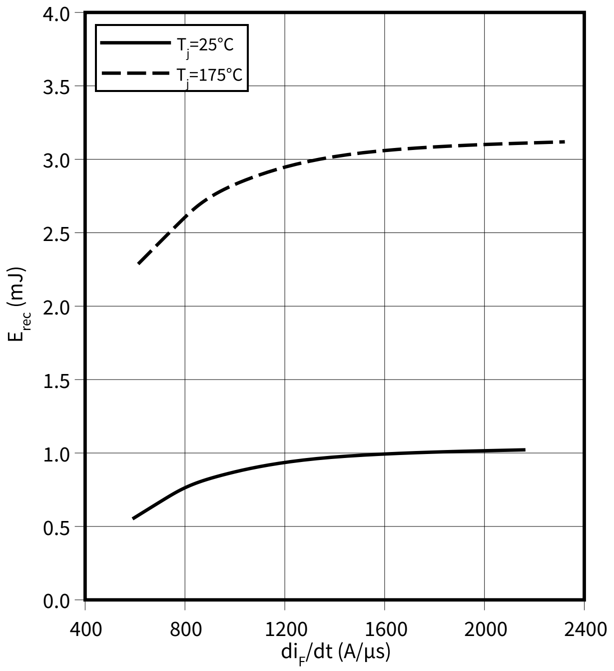
$V_R = 600\ V$, $I_F = 50.0\ A$




**Typical reverse energy losses as a function of diode current slope, Diode**

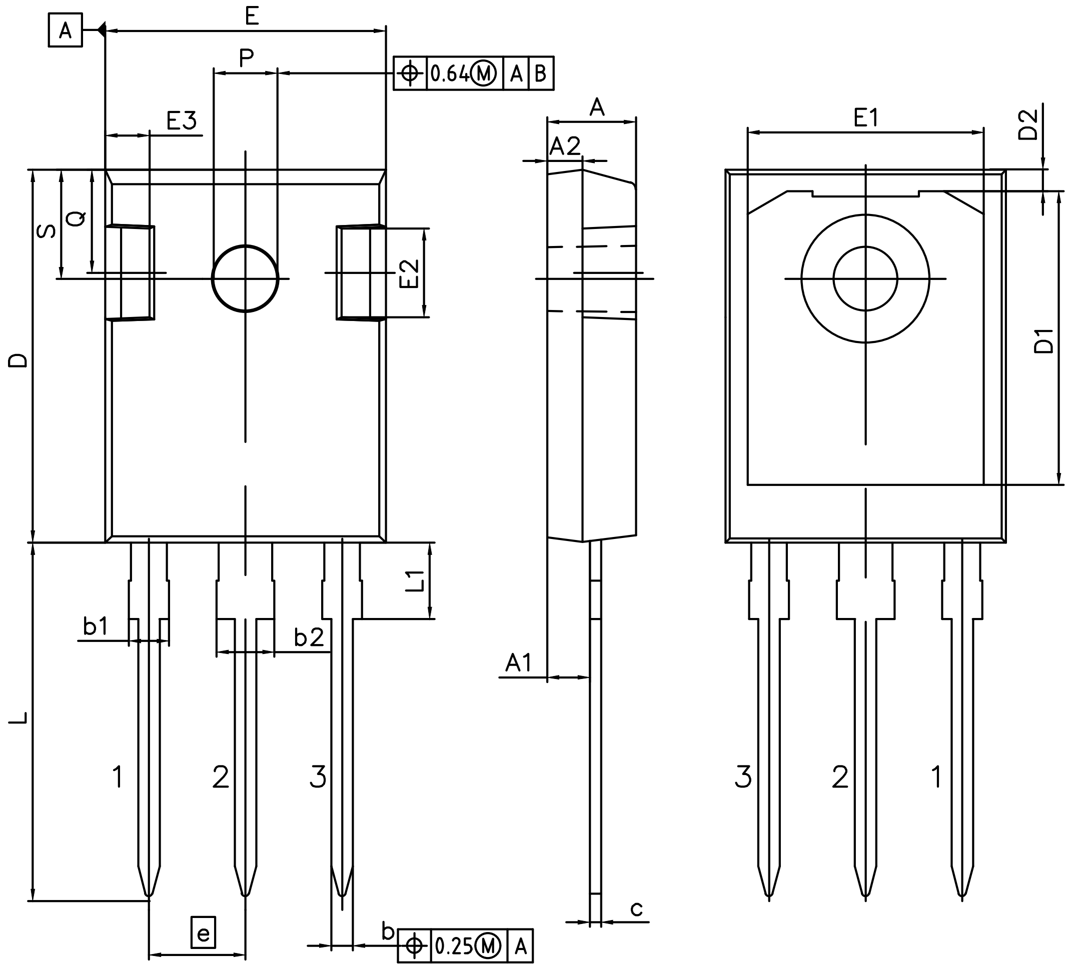
$E_{rec} = f(di_F/dt)$

$V_R = 600\ V$, $I_F = 50.0\ A$



# 5 Package outlines

## Package Drawing PG-TO247-3




| DIMENSIONS | MILLIMETERS | |
|---|---|---|
| | MIN. | MAX. |
| **A** | 4.70 | 5.30 |
| **A1** | 2.20 | 2.60 |
| **A2** | 1.50 | 2.50 |
| **b** | 1.00 | 1.40 |
| **b1** | 1.60 | 2.41 |
| **b2** | 2.57 | 3.43 |
| **c** | 0.38 | 0.89 |
| **D** | 20.70 | 21.50 |
| **D1** | 13.08 | 17.65 |
| **D2** | 0.51 | 1.35 |
| **E** | 15.50 | 16.30 |
| **E1** | 12.38 | 14.15 |
| **E2** | 3.40 | 5.10 |
| **E3** | 1.00 | 2.60 |
| **e** | 5.44 | |
| **L** | 19.80 | 20.40 |
| **L1** | 3.85 | 4.50 |
| **P** | 3.50 | 3.70 |
| **Q** | 5.35 | 6.25 |
| **S** | 6.04 | 6.30 |

| |
|---|
| **DOCUMENT NO.** Z8B00003327 |
| **REVISION** 06 |
| **SCALE 3:1** 0 1 2 3 4 5mm |
| **EUROPEAN PROJECTION** |
| **ISSUE DATE** 25.07.2018 |

**Figure 6**

# 6 Testing conditions

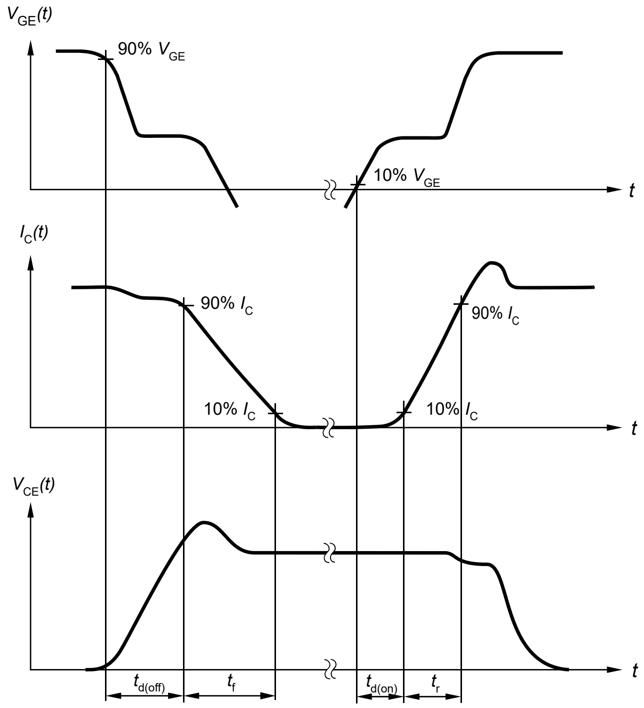



Figure A. **Definition of switching times**

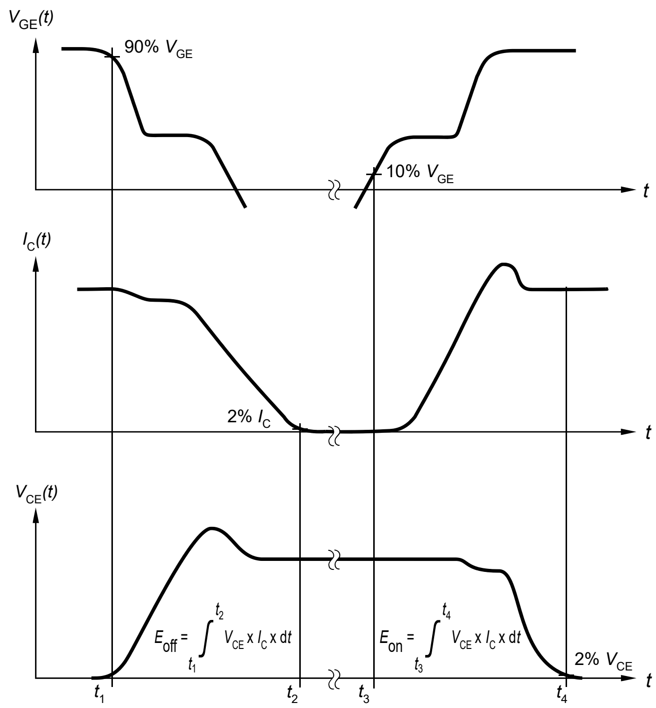



Figure B. **Definition of switching losses**

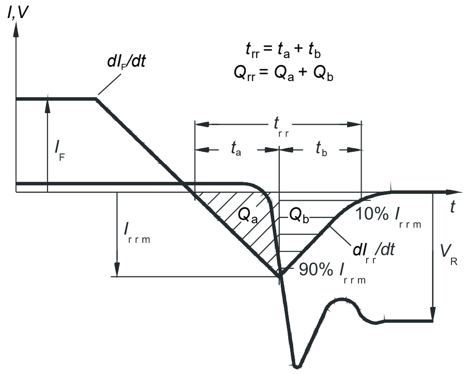



Figure C. **Definition of diode switching characteristics**

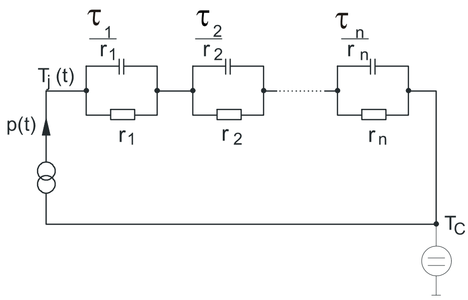



Figure D. **Thermal equivalent circuit**

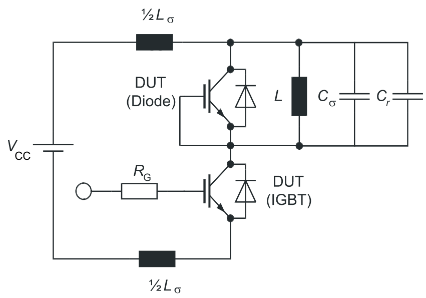



Figure E. **Dynamic test circuit**
Parasitic inductance $L_{\sigma}$,
parasitic capacitor $C_{\sigma}$,
relief capacitor $C_r$,
(only for ZVT switching)

**Figure 7**

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