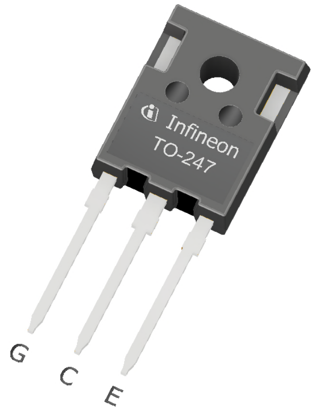
## The TRENCHSTOP™ 5 WR6 family in the TO-247-3-HCC package offers improved reliability against package contamination




### Features

- $V_{CE}$ = 650 V
- $I_C$ = 30 A
- Pin-to-pin creepage distance > 4.8 mm
- Pin-to-pin clearance distance > 3.4 mm
- Monolithic diode optimized for PFC and welding applications
- Stable temperature behavior
- Very low $V_{CEsat}$ and low $E_{off}$
- Easy parallel switching capability based on positive temperature coefficient of $V_{CEsat}$
- Low temperature dependence of $V_{CEsat}$ and $E_{sw}$
- Product spectrum and PSpice Models: http://www.infineon.com/igbt/

### Potential applications

- PFC
- Welding
- ZCS applications

### Product validation

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

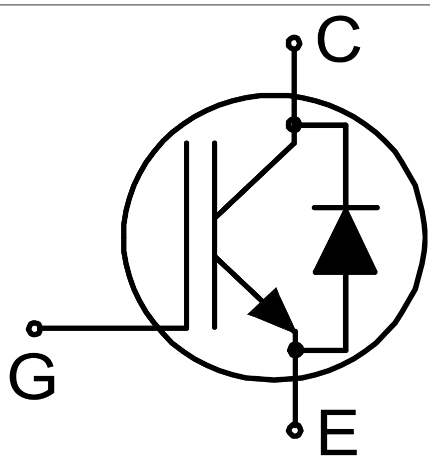
Lead-Free

Green

Halogen-Free

RoHS

### Description




| Type | Package | Marking |
| --- | --- | --- |
| IKWH30N65WR6 | PG-TO247-3-HCC | H30EWR6 |

# Table of contents

# 1 Package

**Table 1 Characteristic values**

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Internal emitter inductance measured 5 mm (0.197 in) from case | $L_E$ | | | 13.0 | | nH |
| Storage temperature | $T_{stg}$ | | -55 | | 150 | °C |
| Soldering temperature | | wave soldering 1.6 mm (0.063 in.) from case for 10 s | | | 260 | °C |
| Mounting torque, M3 screw Maximum of mounting processes: 3 | $M$ | | | | 0.6 | Nm |
| Thermal resistance, junction-ambient | $R_{th(j\text{-}a)}$ | | | | 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 | | 650 | V |
| DC collector current, limited by $T_{vjmax}$ | $I_C$ | | $T_C = 25$ °C | 60 | A |
| | | | $T_C = 100$ °C | 30 | |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$ | $I_{Cpuls}$ | | | 90 | A |
| Turn-off safe operating area | | $V_{CE} \leq 650$ V, $t_P \leq 1$ µs, $T_{vj} \leq 175$ °C | | 90 | A |
| Gate-emitter voltage | $V_{GE}$ | | | ±20 | V |
| Transient gate-emitter voltage | $V_{GE}$ | $t_p \leq 10$ µs, $D < 0.010$ | | ±20 | V |
| Power dissipation | $P_{tot}$ | | $T_C = 25$ °C | 165 | W |
| | | | $T_C = 100$ °C | 83 | |

**Table 3 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Collector-emitter breakdown voltage | $V_{BRCES}$ | $I_C = 0.2$ mA, $V_{GE} = 0$ V | | 650 | | | V |
| Collector-emitter saturation voltage | $V_{CE\,sat}$ | $I_C = 30.0$ A, $V_{GE} = 15$ V | $T_{vj} = 25$ °C | | 1.45 | 1.75 | V |
| | | | $T_{vj} = 175$ °C | | 1.70 | | |

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

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Gate-emitter threshold voltage | $V_{GEth}$ | $I_C$ = 0.30 mA, $V_{CE} = V_{GE}$ | | 3.20 | 4.00 | 4.80 | V |
| Zero gate voltage collector current | $I_{CES}$ | $V_{CE}$ = 650 V, $V_{GE}$ = 0 V | $T_{vj}$ = 25 °C | | | 40 | µA |
| | | | $T_{vj}$ = 175 °C | | 0.5 | | mA |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$ = 0 V, $V_{GE}$ = 20 V | | | | 100 | nA |
| Transconductance | $g_{fs}$ | $I_C$ = 30.0 A, $V_{CE}$ = 20 V | | | 75.0 | | S |
| Input capacitance | $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, $f$ = 100 kHz | | | 2700 | | pF |
| Output capacitance | $C_{oes}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, $f$ = 100 kHz | | | 27 | | pF |
| Reverse transfer capacitance | $C_{res}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, $f$ = 100 kHz | | | 11 | | pF |
| Gate charge | $Q_G$ | $I_C$ = 30.0 A, $V_{GE}$ = 15 V, $V_{CE}$ = 520 V | | | 111 | | nC |
| Turn-on delay time | $t_{don}$ | $V_{CE}$ = 400 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 27.0 Ω, $R_{Goff}$ = 27.0 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 23 pF | $T_{vj}$ = 25 °C, $I_C$ = 30.0 A | | 35 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 30.0 A | | 31 | | |
| Rise time (inductive load) | $t_r$ | $V_{CE}$ = 400 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 27.0 Ω, $R_{Goff}$ = 27.0 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 23 pF | $T_{vj}$ = 25 °C, $I_C$ = 30.0 A | | 18 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 30.0 A | | 20 | | |
| Turn-off delay time | $t_{doff}$ | $V_{CE}$ = 400 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 27.0 Ω, $R_{Goff}$ = 27.0 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 23 pF | $T_{vj}$ = 25 °C, $I_C$ = 30.0 A | | 334 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 30.0 A | | 375 | | |
| Fall time (inductive load) | $t_f$ | $V_{CE}$ = 400 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 27.0 Ω, $R_{Goff}$ = 27.0 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 23 pF | $T_{vj}$ = 25 °C, $I_C$ = 30.0 A | | 16 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 30.0 A | | 16 | | |
| Turn-on energy | $E_{on}$ | $V_{CE}$ = 400 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 27.0 Ω, $R_{Goff}$ = 27.0 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 23 pF | $T_{vj}$ = 25 °C, $I_C$ = 30.0 A | | 0.82 | | mJ |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 30.0 A | | 0.92 | | |
| Turn-off energy | $E_{off}$ | $V_{CE}$ = 400 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 27.0 Ω, $R_{Goff}$ = 27.0 Ω, $L_\sigma$ = 30 nH, $C_\sigma$ = 23 pF | $T_{vj}$ = 25 °C, $I_C$ = 30.0 A | | 0.38 | | mJ |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 30.0 A | | 0.63 | | |

**Table 3 Characteristic values (continued)**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Total switching energy | $E_{ts}$ | $V_{CE}$ = 400 V, $V_{GE}$ = 15 V, $R_{Gon}$ = 27.0 Ω, $R_{Goff}$ = 27.0 Ω, $L_{\sigma}$ = 30 nH, $C_{\sigma}$ = 23 pF | $T_{vj}$ = 25 °C, $I_C$ = 30.0 A | | 1.20 | | mJ |
| | | | $T_{vj}$ = 175 °C, $I_C$ = 30.0 A | | 1.55 | | |
| IGBT thermal resistance, junction-case | $R_{thjc}$ | | | | | 0.90 | K/W |
| Operating junction temperature | $T_{vj}$ | | | -40 | | 175 | °C |

*Note: Electrical Characteristic, at $T_{vj}$ = 25°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 °C | | 650 | V |
| Diode forward current, limited by $T_{vjmax}$ | $I_F$ | | $T_C$ = 25 °C | 20 | A |
| | | | $T_C$ = 100 °C | 11 | |
| Diode pulsed current, limited by $T_{vjmax}$ | $I_{Fpuls}$ | | | 30 | A |

**Table 5 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Diode forward voltage | $V_F$ | $I_F$ = 10.0 A | $T_{vj}$ = 25 °C | | 1.30 | 1.60 | V |
| | | | $T_{vj}$ = 175 °C | | 1.35 | | |
| Diode reverse recovery time | $t_{rr}$ | $V_R$ = 400 V | $T_{vj}$ = 25 °C, $I_F$ = 15.0 A, $-di_F/dt$ = 1460 A/µs | | 82 | | ns |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 15.0 A, $-di_F/dt$ = 1400 A/µs | | 94 | | |

**Table 5** **Characteristic values (continued)**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Diode reverse recovery charge | $Q_{rr}$ | $V_R$ = 400 V | $T_{vj}$ = 25 °C, $I_F$ = 15.0 A, $-di_F/dt$ = 1460 A/µs | | 1.40 | | µC |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 15.0 A, $-di_F/dt$ = 1400 A/µs | | 2.20 | | |
| Diode peak reverse recovery current | $I_{rrm}$ | $V_R$ = 400 V | $T_{vj}$ = 25 °C, $I_F$ = 15.0 A, $-di_F/dt$ = 1460 A/µs | | 24.0 | | A |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 15.0 A, $-di_F/dt$ = 1400 A/µs | | 28.8 | | |
| Diode peak rate off fall of reverse recovery current | $dI_{rr}/dt$ | $V_R$ = 400 V | $T_{vj}$ = 25 °C, $I_F$ = 15.0 A, $-di_F/dt$ = 1460 A/µs | | -700 | | A/µs |
| | | | $T_{vj}$ = 175 °C, $I_F$ = 15.0 A, $-di_F/dt$ = 1400 A/µs | | -830 | | |
| Diode thermal resistance, junction-case | $R_{thjc}$ | | | | | 4.20 | K/W |
| Operating junction temperature | $T_{vj}$ | | | -40 | | 175 | °C |

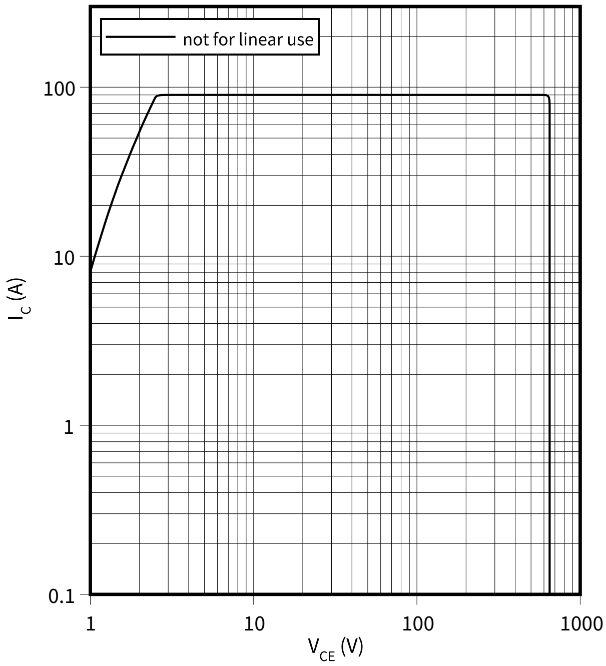
*Note:* *For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.*

# 4 Characteristics diagrams

**Forward bias safe operating area, IGBT**

$I_C = f(V_{CE})$

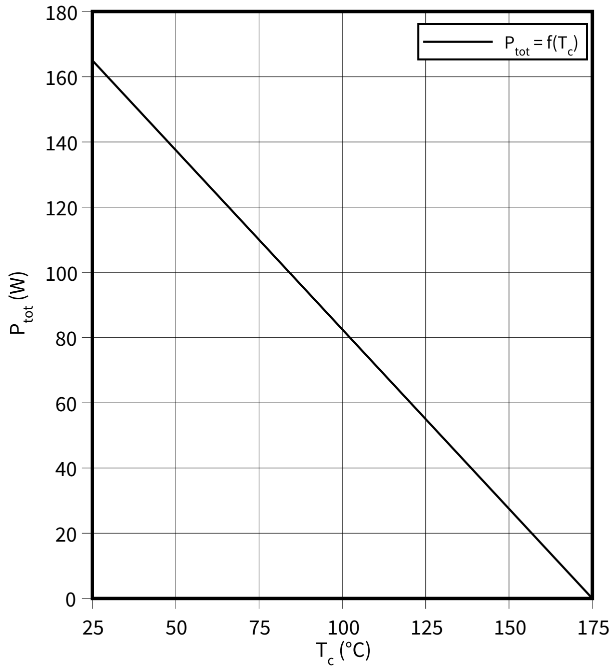
$t_p = 1$ µs, D = 0 , $T_{vj} \leq 175$ °C, $T_C = 25$ °C, $V_{GE} = 15$ V




**Power dissipation as a function of case temperature, IGBT**

$P_{tot} = f(T_c)$

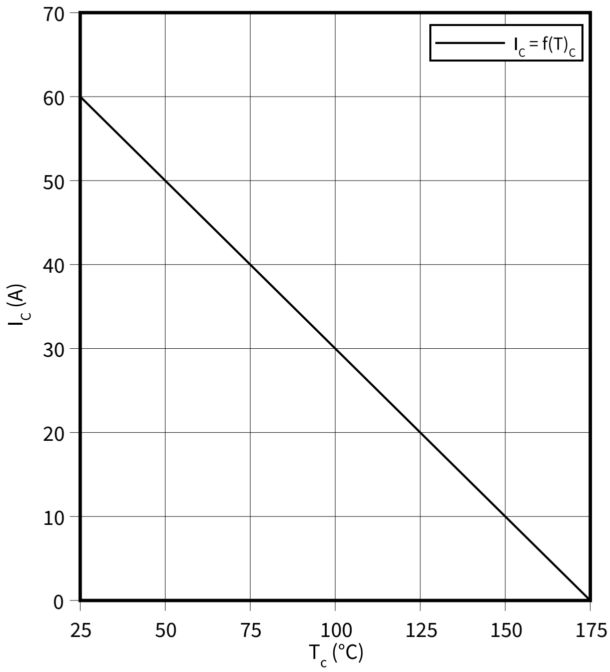
$T_{vj} \leq 175$ °C




**Collector current as a function of case temperature, IGBT**

$I_C = f(T_c)$

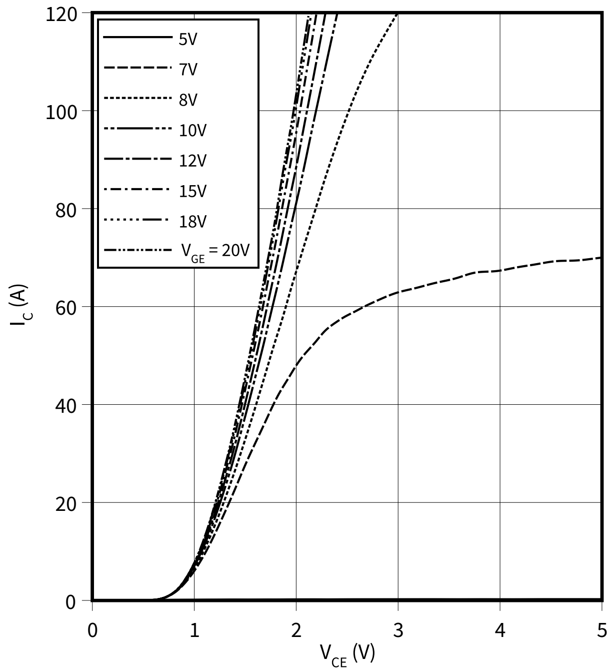
$T_{vj} \leq 175$ °C, $V_{GE} \geq 15$ V




**Typical output characteristic, IGBT**

$I_C = f(V_{CE})$

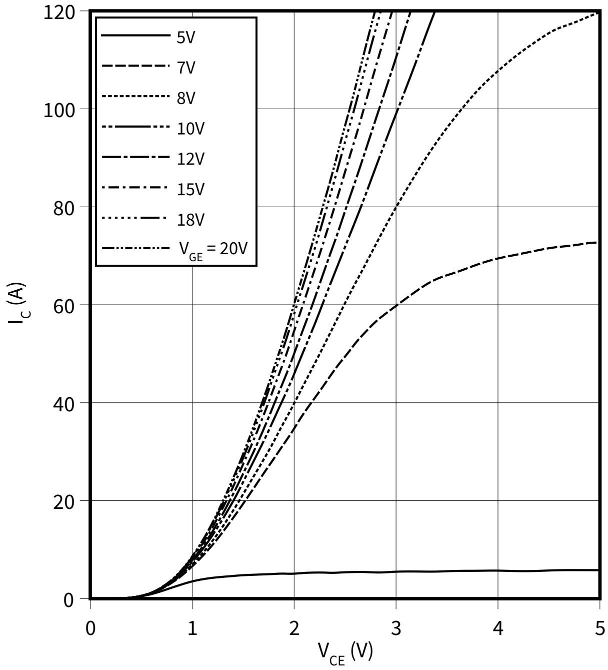
$T_{vj} = 25$ °C



## Typical output characteristic, IGBT

$I_C = f(V_{CE})$

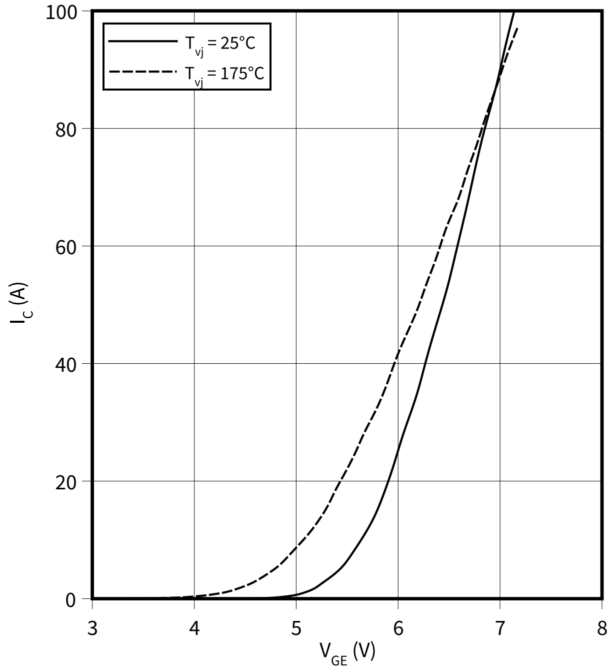
$T_{vj} = 175\ °C$




## Typical transfer characteristic, IGBT

$I_C = f(V_{GE})$

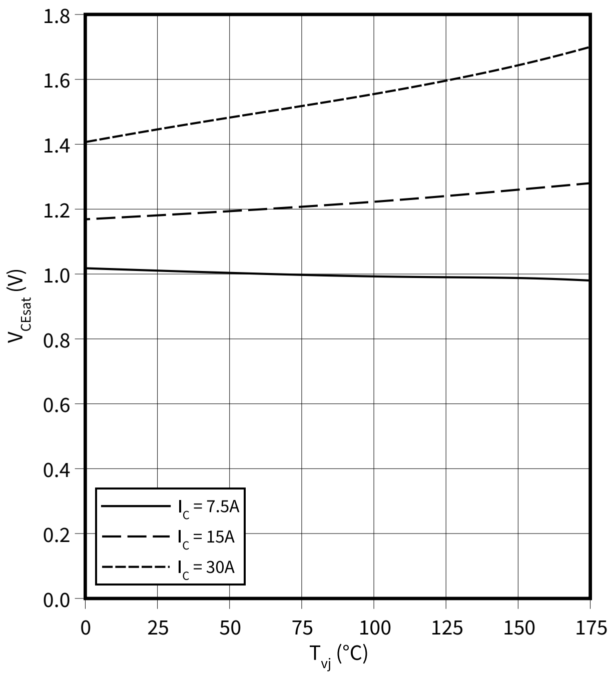
$V_{CE} = 20\ V$




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

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

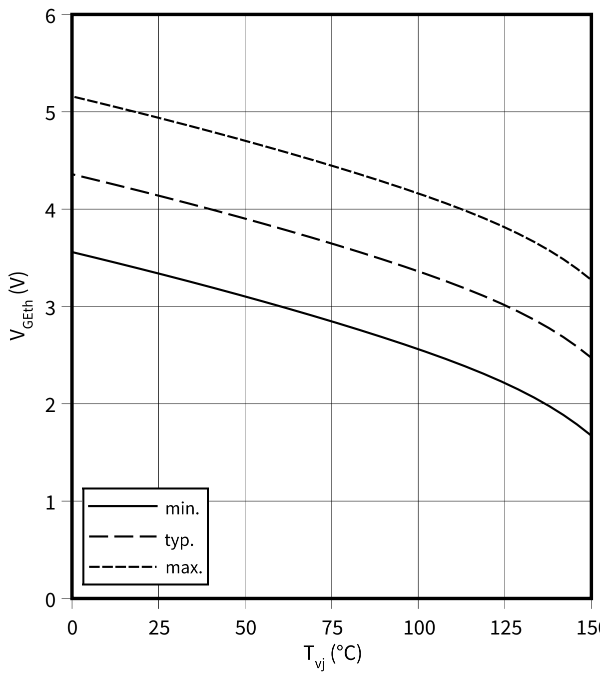
$V_{GE} = 15\ V$




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

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

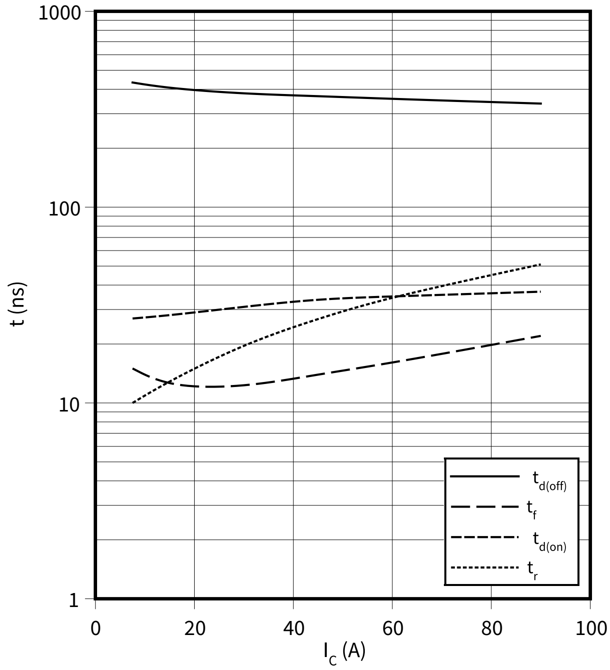
$I_C = 0.30\ mA$



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

$t = f(I_C)$

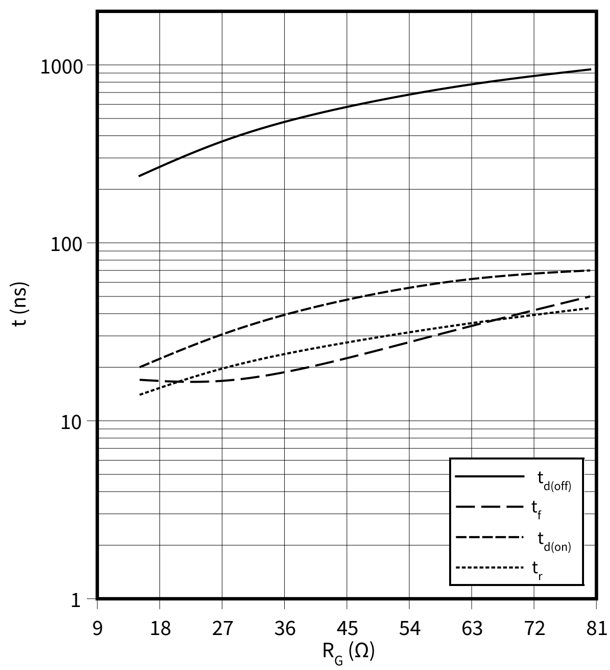
$V_{CE} = 400\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$, $R_G = 27\ \Omega$




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

$t = f(R_G)$

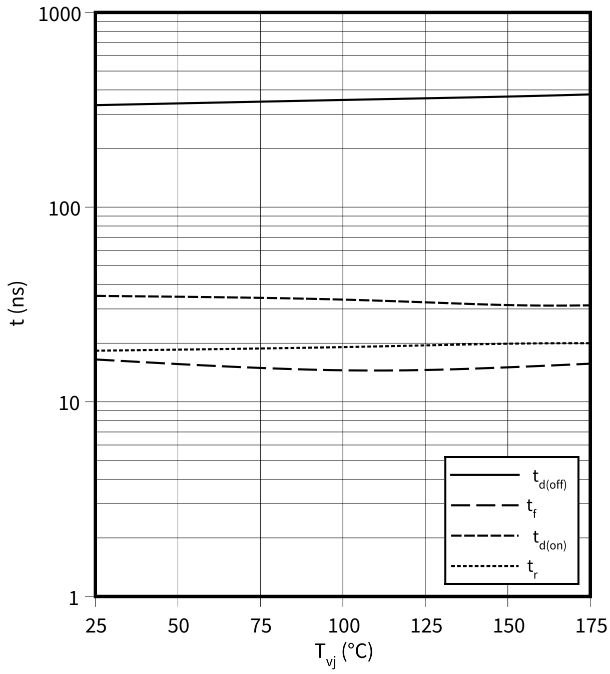
$I_C = 30.0\ A$, $V_{CE} ≤ 650\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$




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

$t = f(T_{vj})$

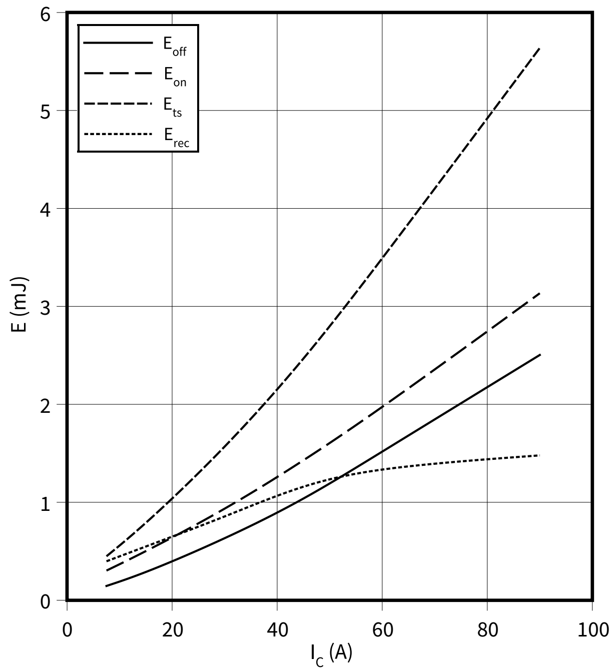
$I_C = 30.0\ A$, $V_{CE} ≤ 650\ V$, $V_{GE} = 0/15\ V$, $R_G = 27\ \Omega$




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

$E = f(I_C)$

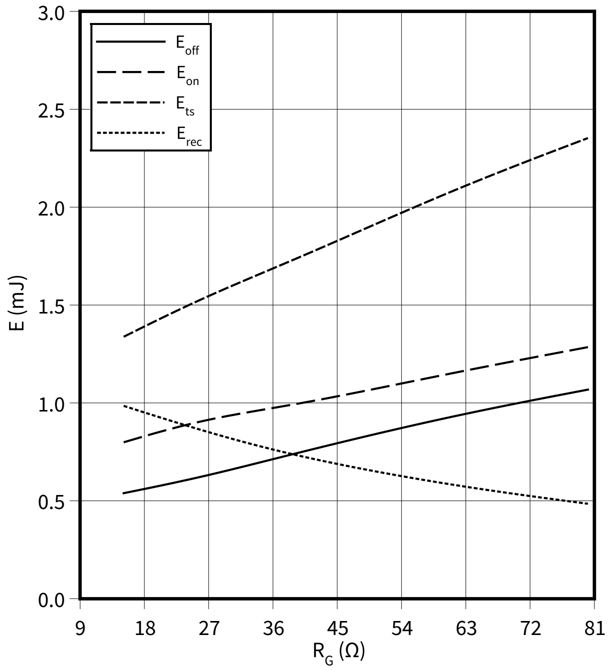
$V_{CE} ≤ 650\ V$, $T_{vj} = 175\ °C$, $V_{GE} = 0/15\ V$, $R_G = 27\ \Omega$



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

$E = f(R_G)$

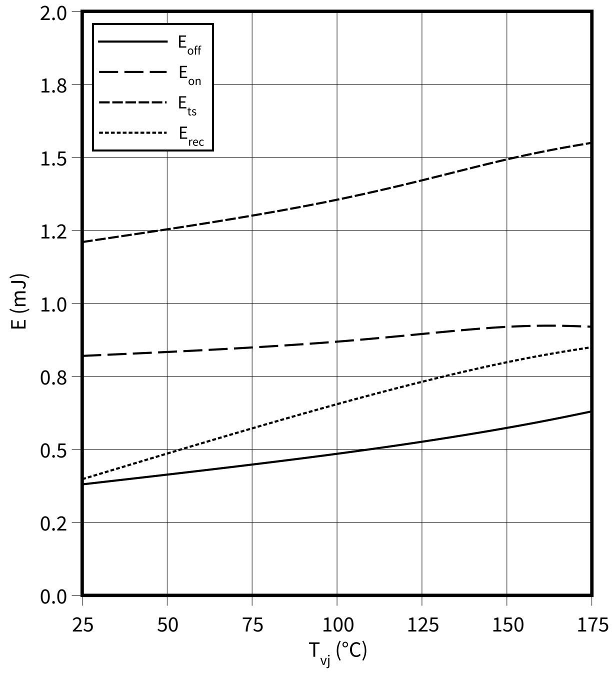
$I_C = 30.0$ A, $V_{CE} \leq 650$ V, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V




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

$E = f(T_{vj})$

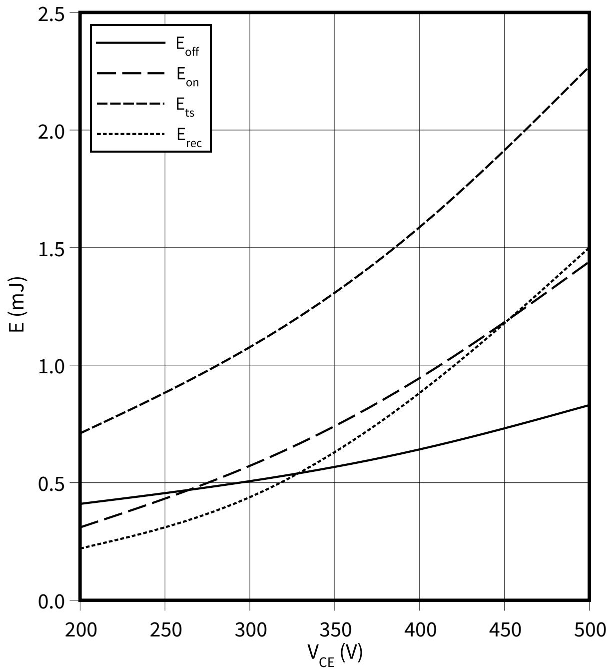
$I_C = 30.0$ A, $V_{CE} \leq 650$ V, $V_{GE} = 0/15$ V, $R_G = 27\ \Omega$




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

$E = f(V_{CE})$

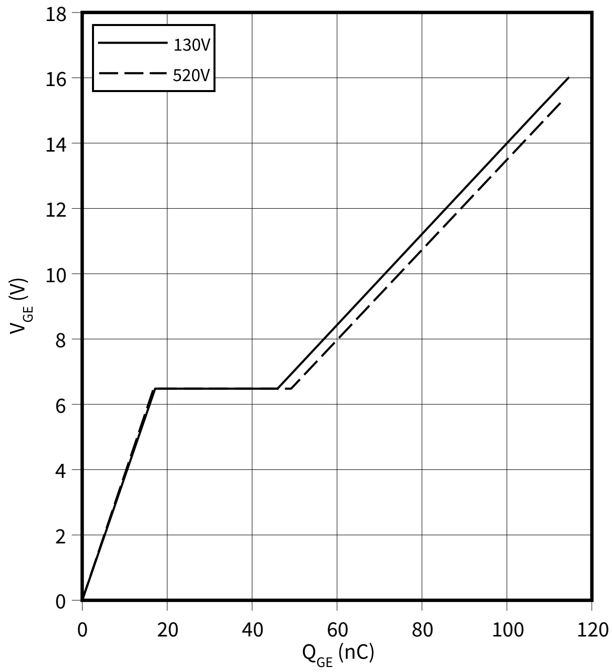
$I_C = 30.0$ A, $T_{vj} = 175$ °C, $V_{GE} = 0/15$ V, $R_G = 27\ \Omega$




### Typical gate charge, IGBT

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

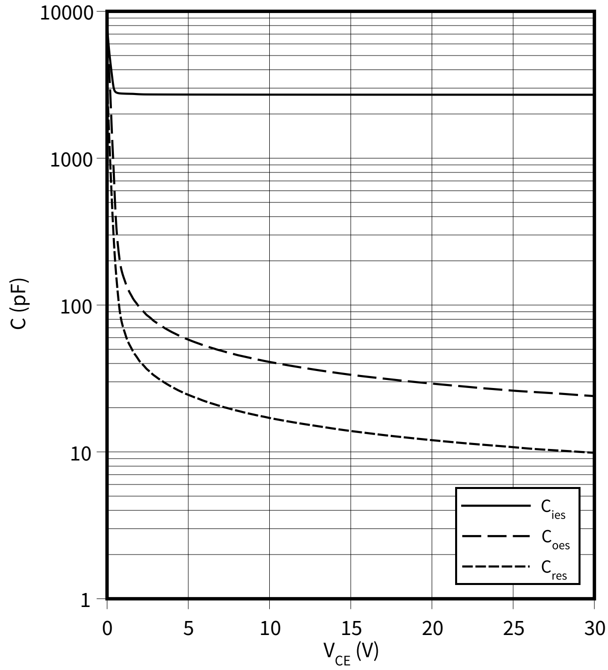
$I_C = 30.0$ A



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

$C = f(V_{CE})$

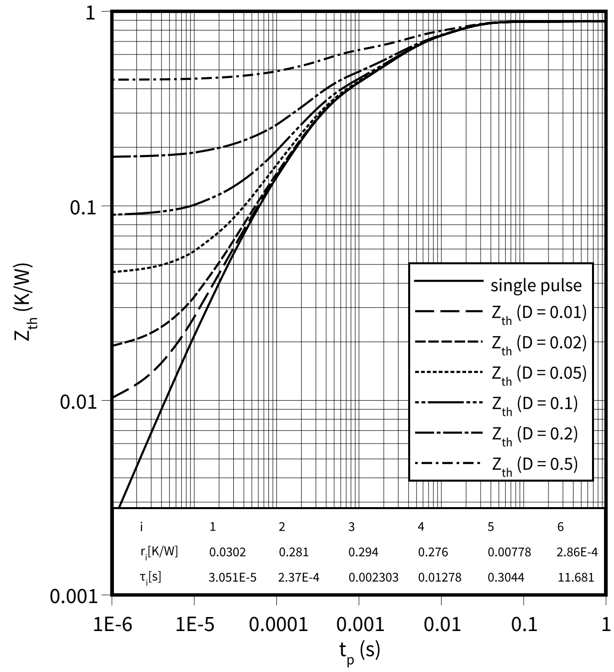
$f = 100\ kHz$, $V_{GE} = 0\ V$




### IGBT transient thermal impedance as a function of pulse width, IGBT

$Z_{th} = f(t_p)$

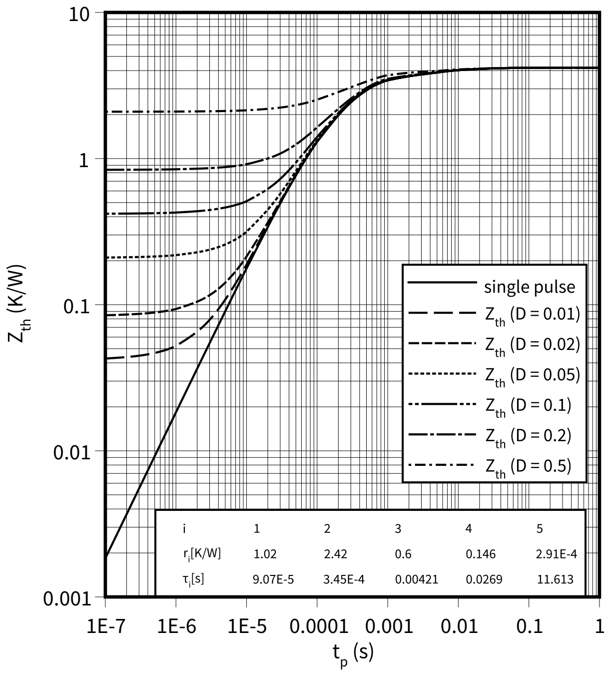
$D = t_p/T$




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

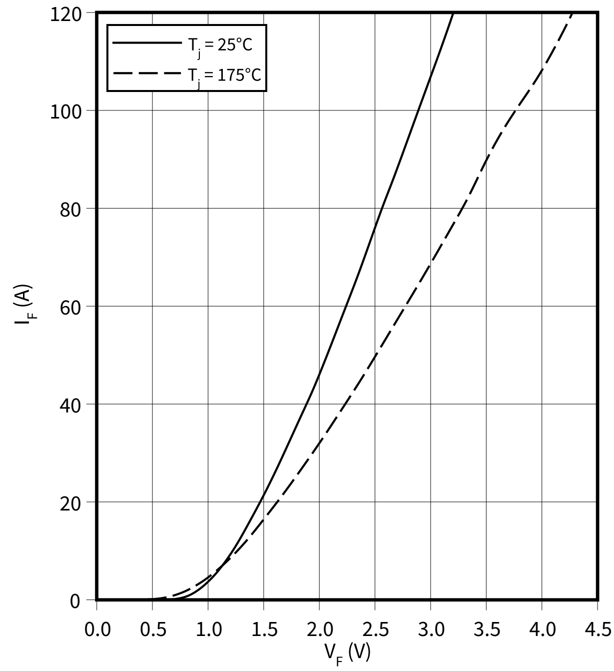
$Z_{th} = f(t_p)$

$D = t_p/T$



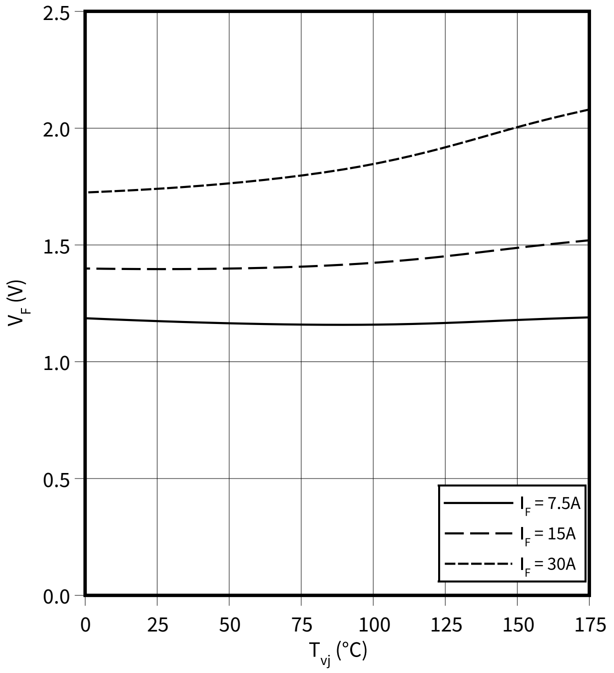

### Typical diode forward current as a function of forward voltage, Diode

$I_F = f(V_F)$



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

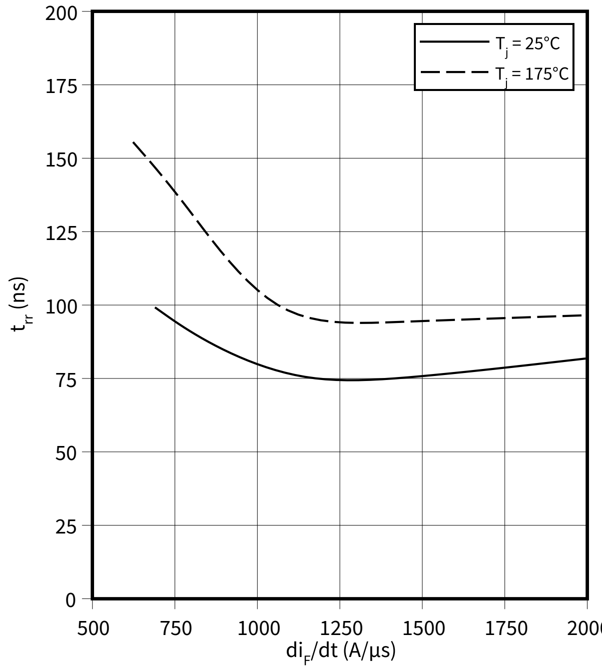
$V_F = f(T_{vj})$




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

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

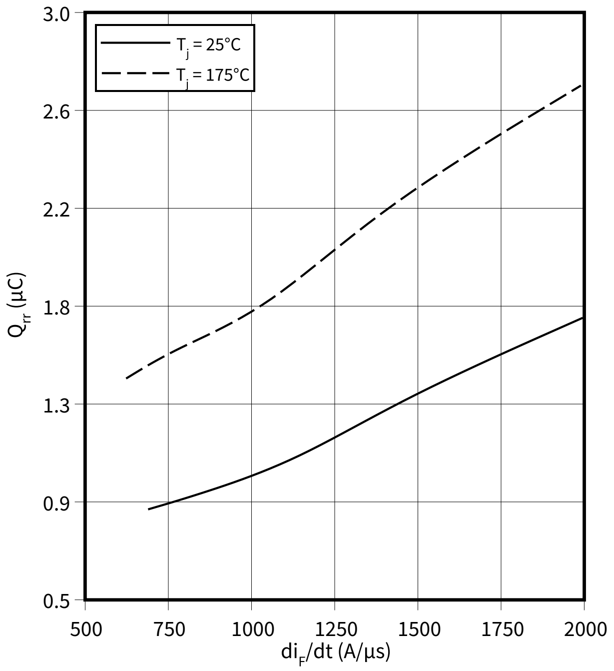
$V_R$ = 400 V, $I_F$ = 15 A




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

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

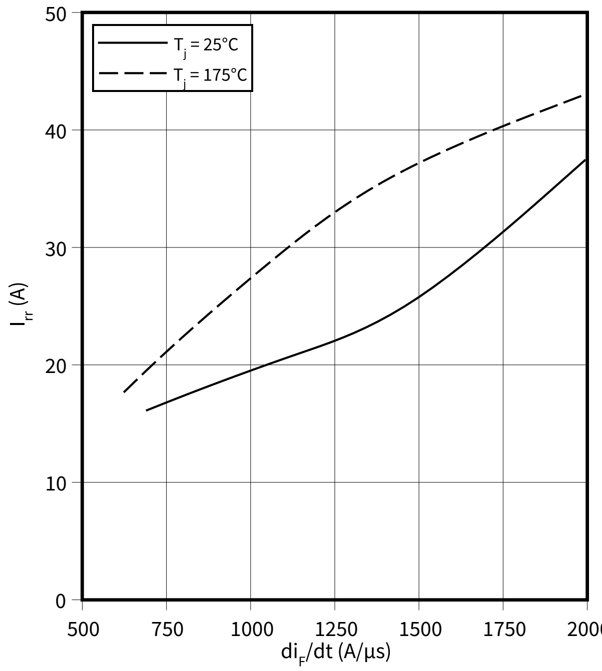
$V_R$ = 400 V, $I_F$ = 15 A




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

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

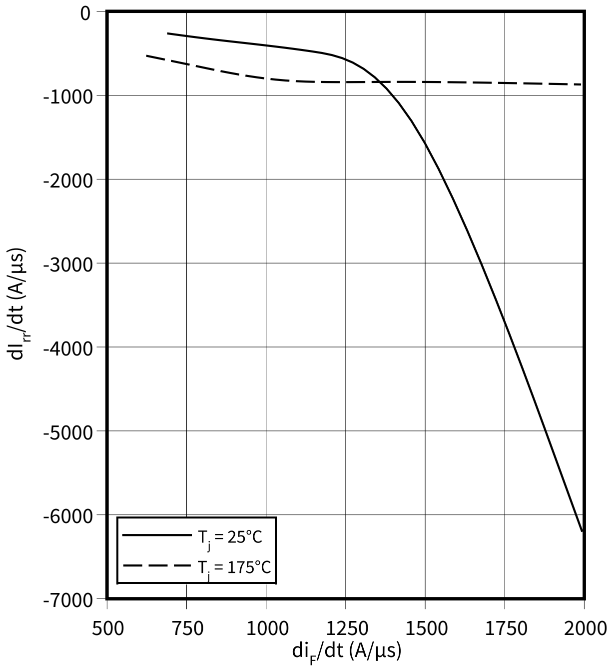
$V_R$ = 400 V, $I_F$ = 15 A



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

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

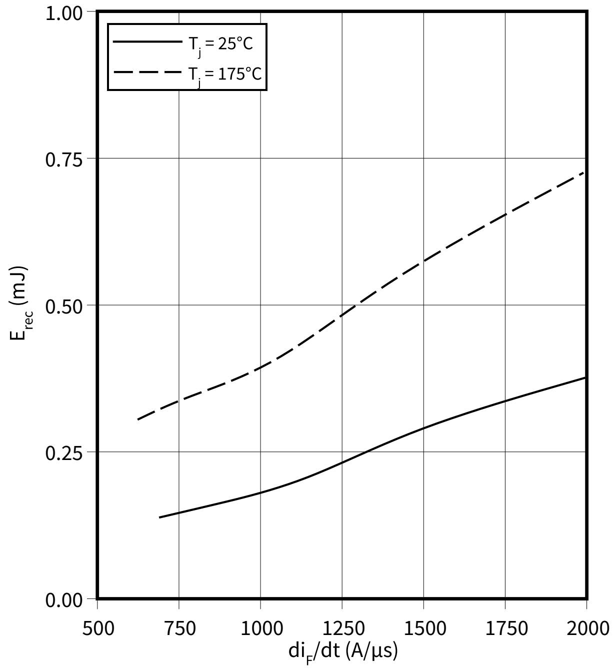
$V_R = 400$ V, $I_F = 15$ A




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

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

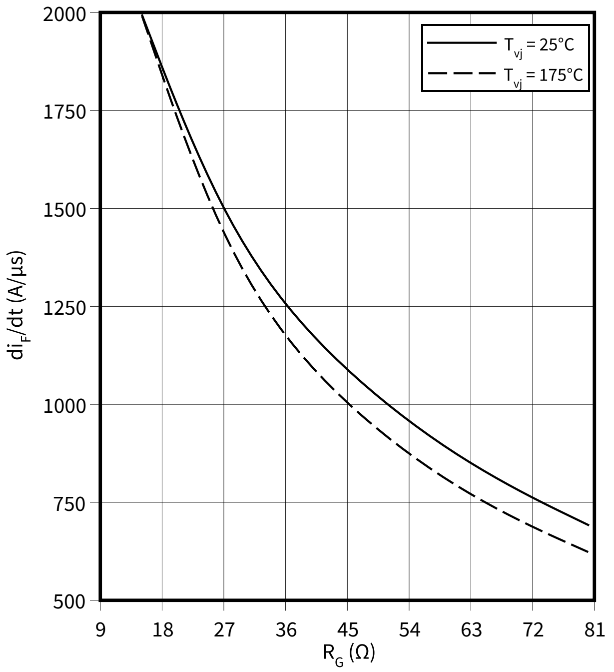
$V_R = 400$ V, $I_F = 15$ A




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

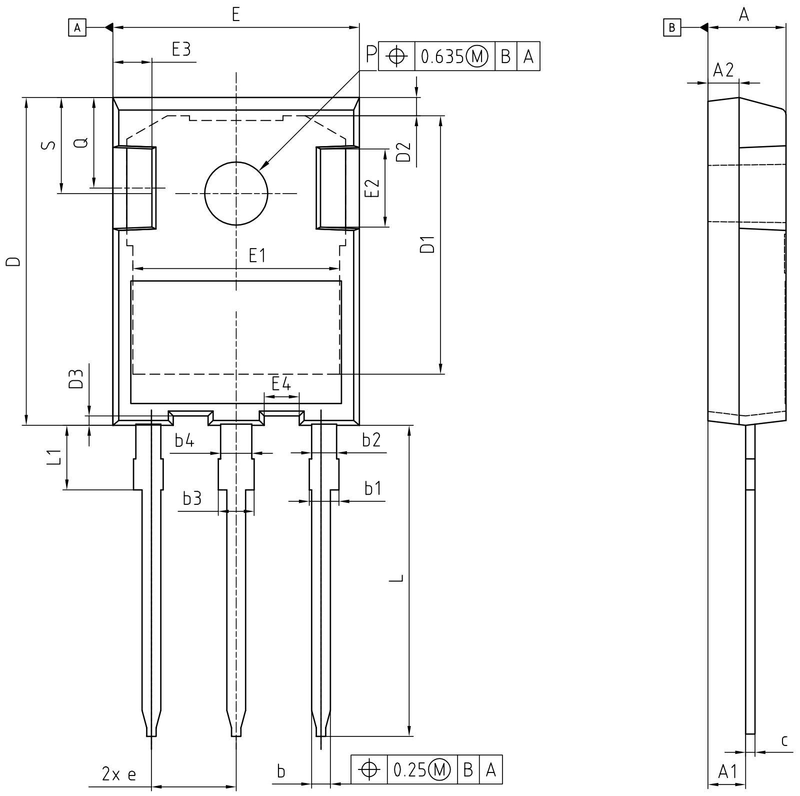
$di_F/dt = f(R_G)$

$V_R = 400$ V, $I_F = 15$ A



# 5 Package outlines

## PG-TO247-3-HCC

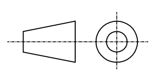



| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.83 | 5.21 | 0.190 | 0.205 |
| A1 | 2.27 | 2.54 | 0.089 | 0.100 |
| A2 | 1.85 | 2.16 | 0.073 | 0.085 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.48 | 2.02 | 0.058 | 0.080 |
| b2 | 1.48 | 1.72 | 0.058 | 0.068 |
| b3 | 1.84 | 2.42 | 0.072 | 0.095 |
| b4 | 1.84 | 2.18 | 0.072 | 0.086 |
| c | 0.55 | 0.68 | 0.022 | 0.027 |
| D | 20.80 | 21.10 | 0.819 | 0.831 |
| D1 | 16.25 | 17.65 | 0.640 | 0.695 |
| D2 | 0.95 | 1.35 | 0.037 | 0.053 |
| D3 | 0.55 | 0.65 | 0.022 | 0.026 |
| E | 15.70 | 16.13 | 0.618 | 0.635 |
| E1 | 13.10 | 14.15 | 0.516 | 0.557 |
| E2 | 3.68 | 5.10 | 0.145 | 0.201 |
| E3 | 1.00 | 2.60 | 0.039 | 0.102 |
| E4 | 3.44 | 3.76 | 0.135 | 0.148 |
| e | 5.44 (BSC) | | 0.214 (BSC) | |
| L | 19.80 | 20.32 | 0.780 | 0.800 |
| L1 | 4.90 | 5.10 | 0.161 | 0.176 |
| øP | 2.40 | 2.60 | 0.138 | 0.146 |
| Q | 5.34 | 5.54 | 0.216 | 0.236 |
| S | 2.14 | 2.34 | 0.238 | 0.248 |
| N | 3 | | 3 | |

**DOCUMENT NO.**
Z8B00205969

**SCALE 3:1**
0 1 2 3mm

**EUROPEAN PROJECTION**



**ISSUE DATE**
25.09.2020

**REVISION**
0

**Figure 6**

# 6 Testing conditions

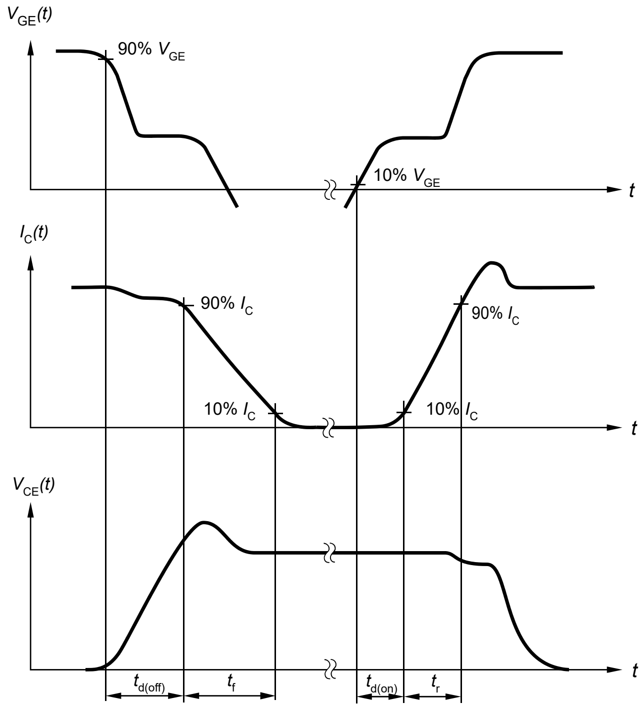



Figure A. **Definition of switching times**

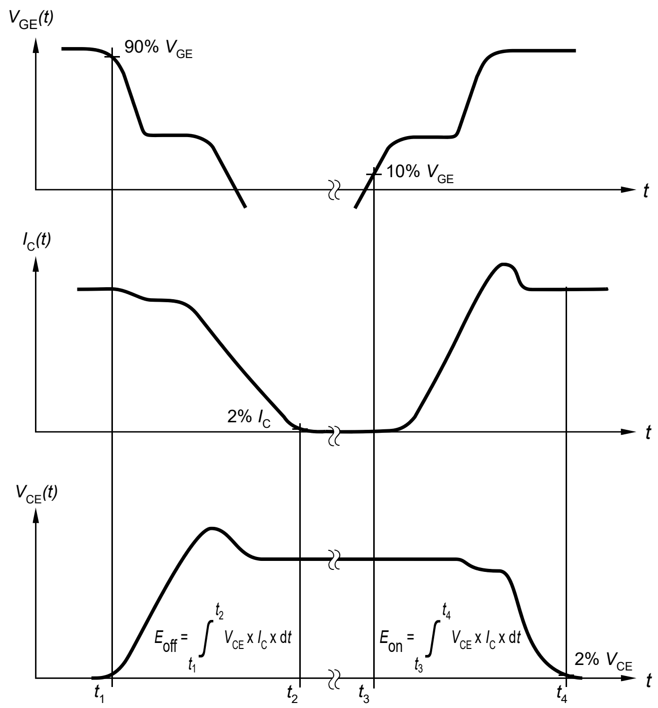



Figure B. **Definition of switching losses**

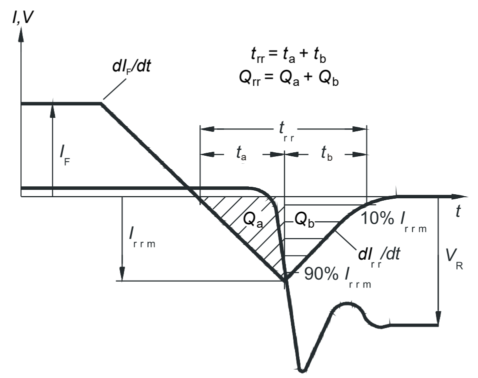



Figure C. **Definition of diode switching characteristics**

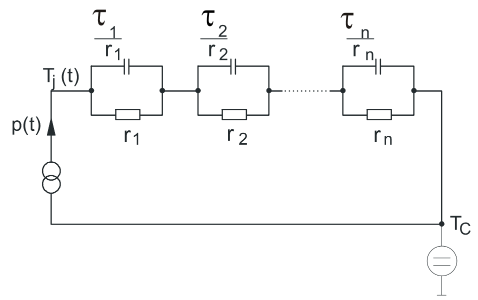



Figure D. **Thermal equivalent circuit**

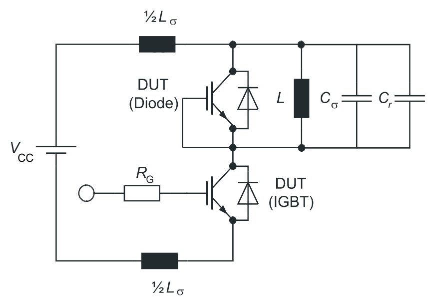



Figure E. **Dynamic test circuit**
Parasitic inductance $L_{\sigma}$,
parasitic capacitor $C_{\sigma}$,
relief capacitor $C_r$,
(only for ZVT switching)

**Figure 7**

## Revision history

| Document revision | Date of release | Description of changes |
|---|---|---|
| 1.00 | 2021-05-17 | Initial version |
| 1.10 | 2021-05-18 | Final datasheet |

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**Edition 2021-05-18**

**Published by**

**Infineon Technologies AG**

**81726 Munich, Germany**



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**Document reference**
**IFX-AAL382-004**