# IGBT

High speed 5 IGBT in TRENCHSTOP™ 5 technology copacked with RAPID 1 fast and soft antiparallel diode

# IKW50N65H5

650V DuoPack IGBT and Diode
High speed switching series fifth generation

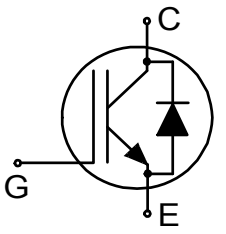
Data sheet

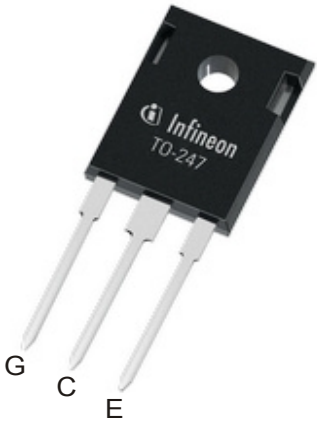
Industrial Power Control

# High speed 5 IGBT in TRENCHSTOP™ 5 technology copacked with RAPID 1 fast and soft antiparallel diode

**Features and Benefits:**

High speed H5 technology offering
• Best-in-Class efficiency in hard switching and resonant topologies
• Plug and play replacement of previous generation IGBTs
• 650V breakdown voltage
• Low gate charge $Q_G$
• IGBT copacked with RAPID 1 fast and soft antiparallel diode
• Maximum junction temperature 175°C
• Qualified according to JEDEC for target applications
• Pb-free lead plating; RoHS compliant
• Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/




**Applications:**

• Solar converters
• Uninterruptible power supplies
• Welding converters
• Mid to high range switching frequency converters

Green

Halogen-Free

RoHS

**Key Performance and Package Parameters**

| Type | $V_{CE}$ | $I_C$ | $V_{CEsat}$, $T_{vj}$=25°C | $T_{vjmax}$ | Marking | Package |
|---|---|---|---|---|---|---|
| IKW50N65H5 | 650V | 50A | 1.65V | 175°C | K50EH5 | PG-TO247-3 |

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## Maximum Ratings

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

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Collector-emitter voltage | $V_{CE}$ | 650 | V |
| DC collector current, limited by $T_{vjmax}$<br>$T_C$ = 25°C value limited by bondwire<br>$T_C$ = 100°C | $I_C$ | <br>80.0<br>56.0 | A |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$ | $I_{Cpuls}$ | 150.0 | A |
| Turn off safe operating area $V_{CE} \le 650V$, $T_{vj} \le 175°C$ | - | 150.0 | A |
| Diode forward current, limited by $T_{vjmax}$<br>$T_C$ = 25°C value limited by bondwire<br>$T_C$ = 100°C | $I_F$ | <br>40.0<br>27.0 | A |
| Diode pulsed current, $t_p$ limited by $T_{vjmax}$ | $I_{Fpuls}$ | 150.0 | A |
| Gate-emitter voltage<br>Transient Gate-emitter voltage ($t_p \le 10\mu s$, D < 0.010) | $V_{GE}$ | ±20<br>±30 | V |
| Power dissipation $T_C$ = 25°C<br>Power dissipation $T_C$ = 100°C | $P_{tot}$ | 305.0<br>152.5 | W |
| Operating junction temperature | $T_{vj}$ | -40...+175 | °C |
| Storage temperature | $T_{stg}$ | -55...+150 | °C |
| Soldering temperature,<br>wave soldering 1.6mm (0.063in.) from case for 10s | | 260 | °C |
| Mounting torque, M3 screw<br>Maximum of mounting processes: 3 | $M$ | 0.6 | Nm |

## Thermal Resistance

| Parameter | Symbol | Conditions | Max. Value | Unit |
|---|---|---|---|---|
| **Characteristic** | | | | |
| IGBT thermal resistance,<br>junction - case | $R_{th(j-c)}$ | | 0.50 | K/W |
| Diode thermal resistance,<br>junction - case | $R_{th(j-c)}$ | | 1.50 | K/W |
| Thermal resistance<br>junction - ambient | $R_{th(j-a)}$ | | 40 | K/W |

**Electrical Characteristic, at $T_{vj}$ = 25°C, unless otherwise specified**

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Static Characteristic** | | | | | | |
| Collector-emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE}$ = 0V, $I_C$ = 0.20mA | 650 | - | - | V |
| Collector-emitter saturation voltage | $V_{CEsat}$ | $V_{GE}$ = 15.0V, $I_C$ = 50.0A<br>$T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 175°C | <br>-<br>-<br>- | <br>1.65<br>1.85<br>1.95 | <br>2.10<br>-<br>- | V |
| Diode forward voltage | $V_F$ | $V_{GE}$ = 0V, $I_F$ = 27.0A<br>$T_{vj}$ = 25°C<br>$T_{vj}$ = 125°C<br>$T_{vj}$ = 175°C | <br>-<br>-<br>- | <br>1.45<br>1.40<br>1.40 | <br>1.80<br>-<br>- | V |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C$ = 0.50mA, $V_{CE}$ = $V_{GE}$ | 3.2 | 4.0 | 4.8 | V |
| Zero gate voltage collector current | $I_{CES}$ | $V_{CE}$ = 650V, $V_{GE}$ = 0V<br>$T_{vj}$ = 25°C<br>$T_{vj}$ = 175°C | <br>-<br>- | <br>-<br>- | <br>40.0<br>4000.0 | µA |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$ = 0V, $V_{GE}$ = 20V | - | - | 100 | nA |
| Transconductance | $g_{fs}$ | $V_{CE}$ = 20V, $I_C$ = 50.0A | - | 62.0 | - | S |

**Electrical Characteristic, at $T_{vj}$ = 25°C, unless otherwise specified**

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Dynamic Characteristic** | | | | | | |
| Input capacitance | $C_{ies}$ | $V_{CE}$ = 25V, $V_{GE}$ = 0V, f = 1MHz | - | 3000 | - | pF |
| Output capacitance | $C_{oes}$ | | - | 65 | - | |
| Reverse transfer capacitance | $C_{res}$ | | - | 11 | - | |
| Gate charge | $Q_G$ | $V_{CC}$ = 520V, $I_C$ = 50.0A,<br>$V_{GE}$ = 15V | - | 120.0 | - | nC |
| Internal emitter inductance measured 5mm (0.197 in.) from case | $L_E$ | | - | 13.0 | - | nH |

**Switching Characteristic, Inductive Load**

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **IGBT Characteristic, at $T_{vj}$ = 25°C** | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj}$ = 25°C,<br>$V_{CC}$ = 400V, $I_C$ = 25.0A,<br>$V_{GE}$ = 0.0/15.0V,<br>$R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω,<br>$L\sigma$ = 30nH, $C\sigma$ = 30pF<br>$L\sigma$, $C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery. | - | 21 | - | ns |
| Rise time | $t_r$ | | - | 15 | - | ns |
| Turn-off delay time | $t_{d(off)}$ | | - | 180 | - | ns |
| Fall time | $t_f$ | | - | 18 | - | ns |
| Turn-on energy | $E_{on}$ | | - | 0.52 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.18 | - | mJ |
| Total switching energy | $E_{ts}$ | | - | 0.70 | - | mJ |

| | | | | | | |
|---|---|---|---|---|---|---|
| Turn-on delay time | $t_{d(on)}$ | $T_{vj}$ = 25°C, $V_{CC}$ = 400V, $I_C$ = 6.0A, $V_{GE}$ = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery. | - | 20 | - | ns |
| Rise time | $t_r$ | | - | 4 | - | ns |
| Turn-off delay time | $t_{d(off)}$ | | - | 200 | - | ns |
| Fall time | $t_f$ | | - | 25 | - | ns |
| Turn-on energy | $E_{on}$ | | - | 0.11 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.05 | - | mJ |
| Total switching energy | $E_{ts}$ | | - | 0.16 | - | mJ |

**Diode Characteristic, at $T_{vj}$ = 25°C**

| | | | | | | |
|---|---|---|---|---|---|---|
| Diode reverse recovery time | $t_{rr}$ | $T_{vj}$ = 25°C, $V_R$ = 400V, $I_F$ = 25.0A, $di_F/dt$ = 1200A/µs | - | 57 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 0.57 | - | µC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 16.7 | - | A |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | -415 | - | A/µs |

| | | | | | | |
|---|---|---|---|---|---|---|
| Diode reverse recovery time | $t_{rr}$ | $T_{vj}$ = 25°C, $V_R$ = 400V, $I_F$ = 6.0A, $di_F/dt$ = 1200A/µs | - | 32 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 0.27 | - | µC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 13.0 | - | A |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | -1150 | - | A/µs |

**Switching Characteristic, Inductive Load**

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **IGBT Characteristic, at $T_{vj}$ = 150°C** | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj}$ = 150°C, $V_{CC}$ = 400V, $I_C$ = 25.0A, $V_{GE}$ = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery. | - | 20 | - | ns |
| Rise time | $t_r$ | | - | 15 | - | ns |
| Turn-off delay time | $t_{d(off)}$ | | - | 205 | - | ns |
| Fall time | $t_f$ | | - | 26 | - | ns |
| Turn-on energy | $E_{on}$ | | - | 0.75 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.27 | - | mJ |
| Total switching energy | $E_{ts}$ | | - | 1.02 | - | mJ |

| | | | | | | |
|---|---|---|---|---|---|---|
| Turn-on delay time | $t_{d(on)}$ | $T_{vj}$ = 150°C, $V_{CC}$ = 400V, $I_C$ = 6.0A, $V_{GE}$ = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery. | - | 18 | - | ns |
| Rise time | $t_r$ | | - | 5 | - | ns |
| Turn-off delay time | $t_{d(off)}$ | | - | 250 | - | ns |
| Fall time | $t_f$ | | - | 35 | - | ns |
| Turn-on energy | $E_{on}$ | | - | 0.20 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.08 | - | mJ |
| Total switching energy | $E_{ts}$ | | - | 0.28 | - | mJ |

**Diode Characteristic, at $T_{vj}$ = 150°C**

| | | | | | | |
|---|---|---|---|---|---|---|
| Diode reverse recovery time | $t_{rr}$ | $T_{vj}$ = 150°C, $V_R$ = 400V, $I_F$ = 25.0A, $di_F/dt$ = 1200A/µs | - | 90 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 1.31 | - | µC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 22.6 | - | A |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | -300 | - | A/µs |

| | | | | | | |
|---|---|---|---|---|---|---|
| Diode reverse recovery time | $t_{rr}$ | $T_{vj}$ = 150°C, $V_R$ = 400V, $I_F$ = 6.0A, $di_F/dt$ = 1200A/µs | - | 50 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 0.64 | - | µC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 19.8 | - | A |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | -600 | - | A/µs |

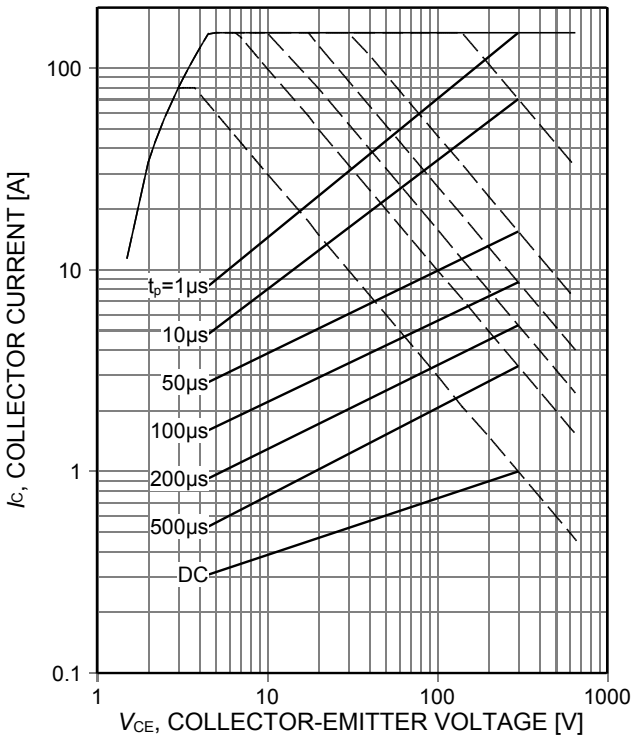



Figure 1. **Forward bias safe operating area**
($D$=0, $T_C$=25°C, $T_{vj}$≤175°C; $V_{GE}$=15V.
Recommended use at $V_{GE}$≥7.5V)

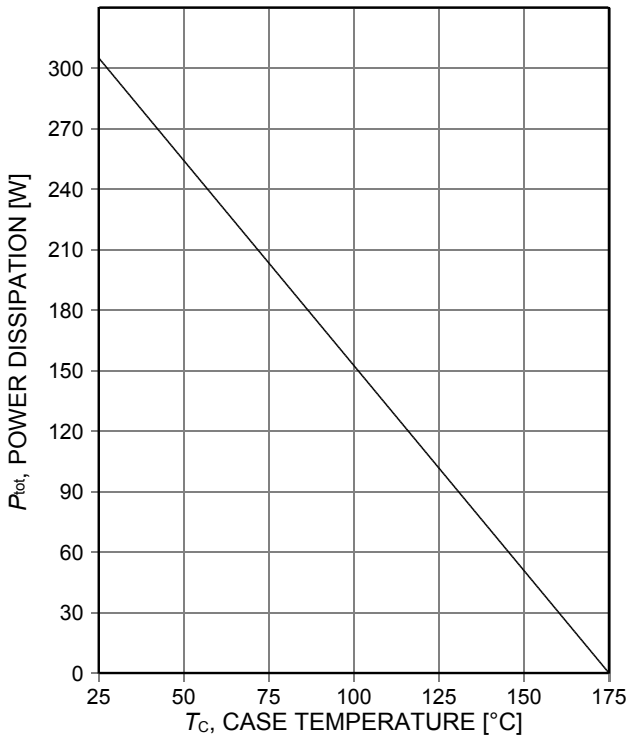



Figure 2. **Power dissipation as a function of case temperature**
($T_{vj}$≤175°C)

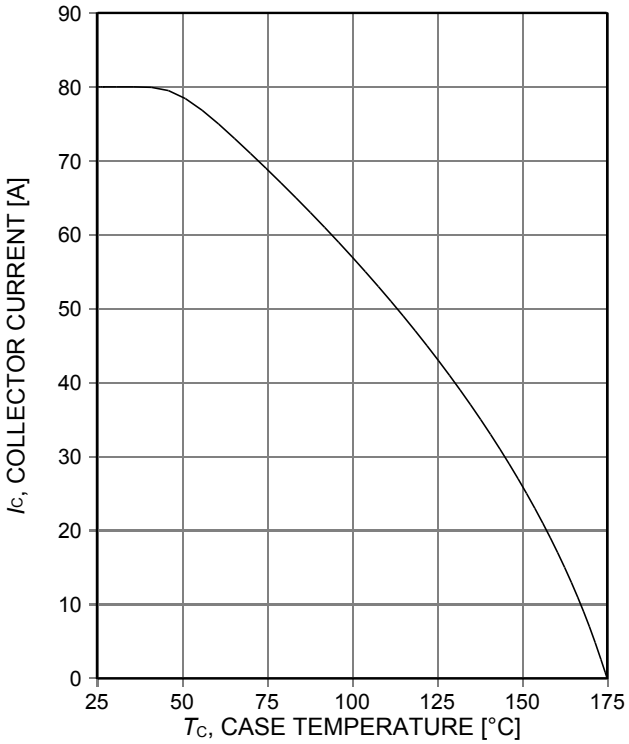



Figure 3. **Collector current as a function of case temperature**
($V_{GE}$≥15V, $T_{vj}$≤175°C)

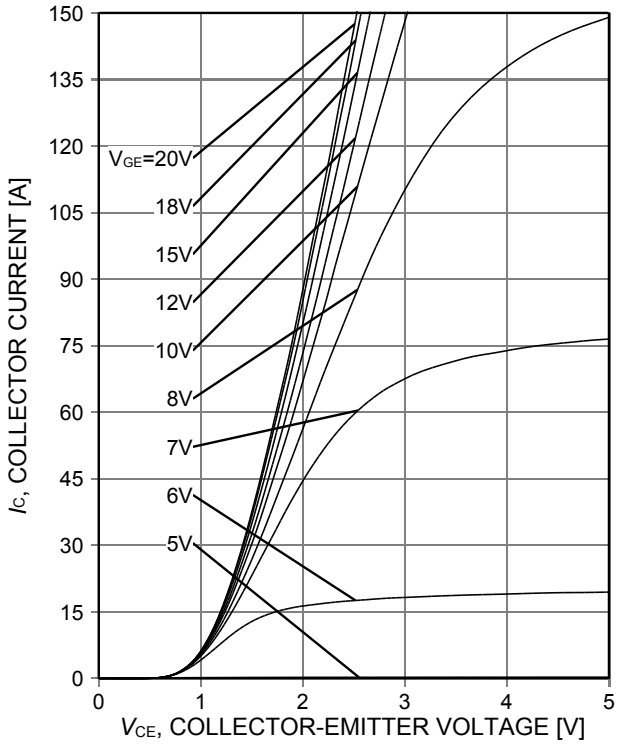



Figure 4. **Typical output characteristic**
($T_{vj}$=25°C)

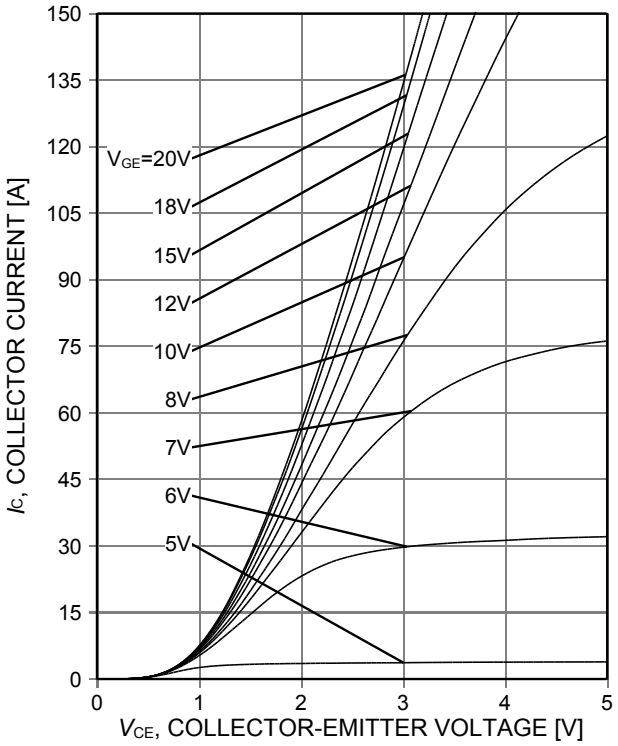



Figure 5. **Typical output characteristic**
($T_{vj}$=150°C)

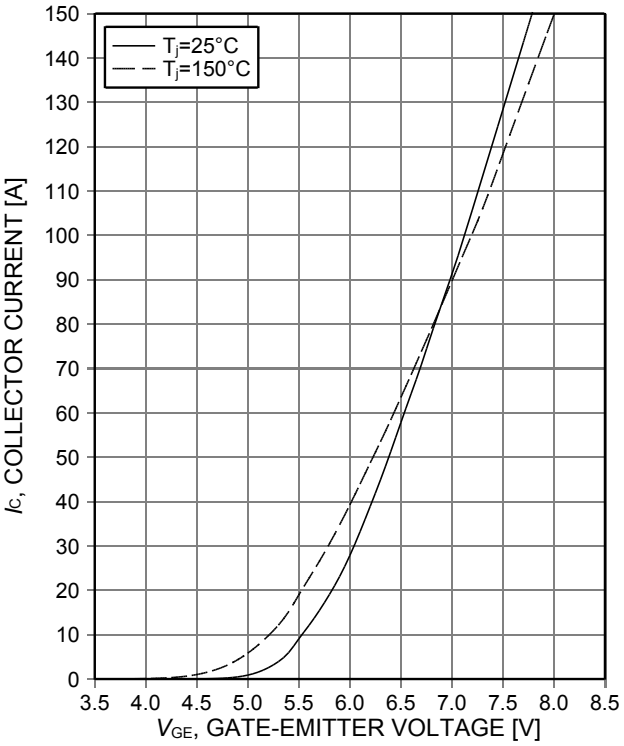



Figure 6. **Typical transfer characteristic**
($V_{CE}$=20V)

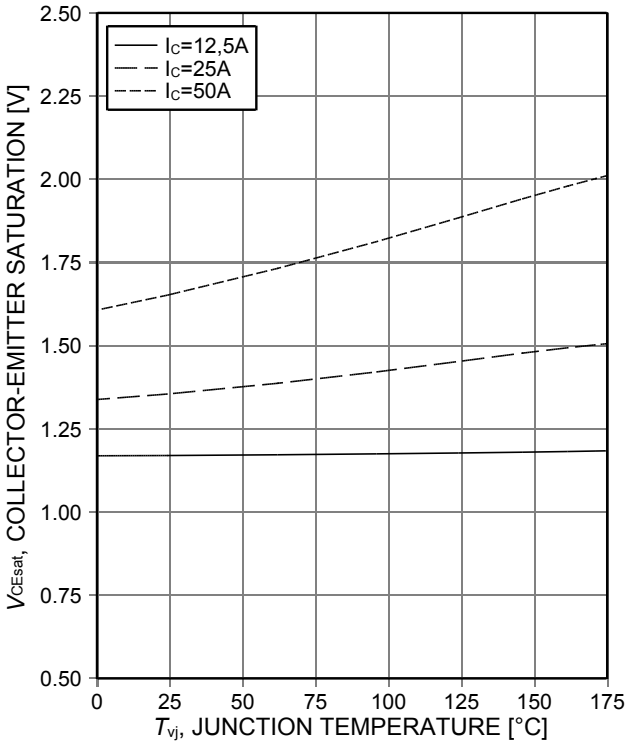



Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}$=15V)

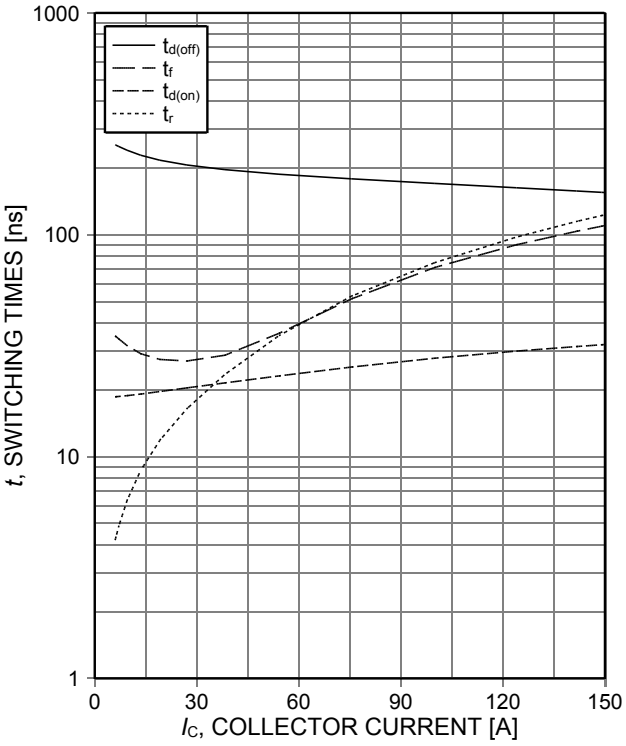



Figure 8. **Typical switching times as a function of collector current**
(inductive load, $T_{vj}$=150°C, $V_{CE}$=400V, $V_{GE}$=15/0V, $r_G$=12Ω, Dynamic test circuit in Figure E)

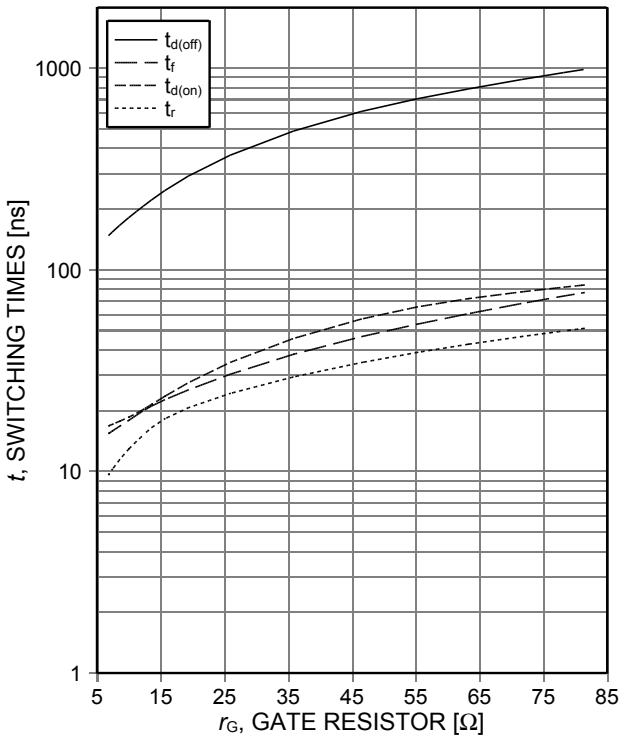



Figure 9. **Typical switching times as a function of gate resistor**
(inductive load, $T_{vj}$=150°C, $V_{CE}$=400V, $V_{GE}$=15/0V, $I_C$=25A,Dynamic test circuit in Figure E)

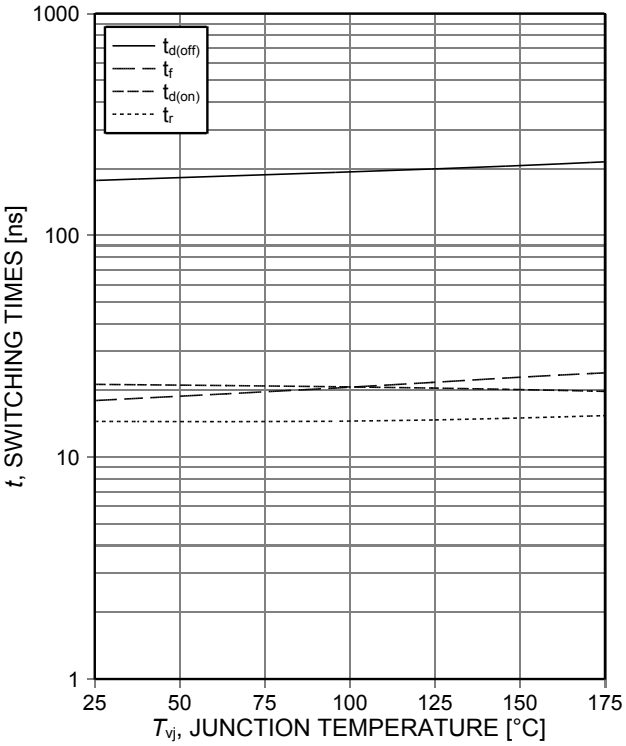



Figure 10. **Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}$=400V, $V_{GE}$=15/0V, $I_C$=25A, $r_G$=12Ω,Dynamic test circuit in Figure E)

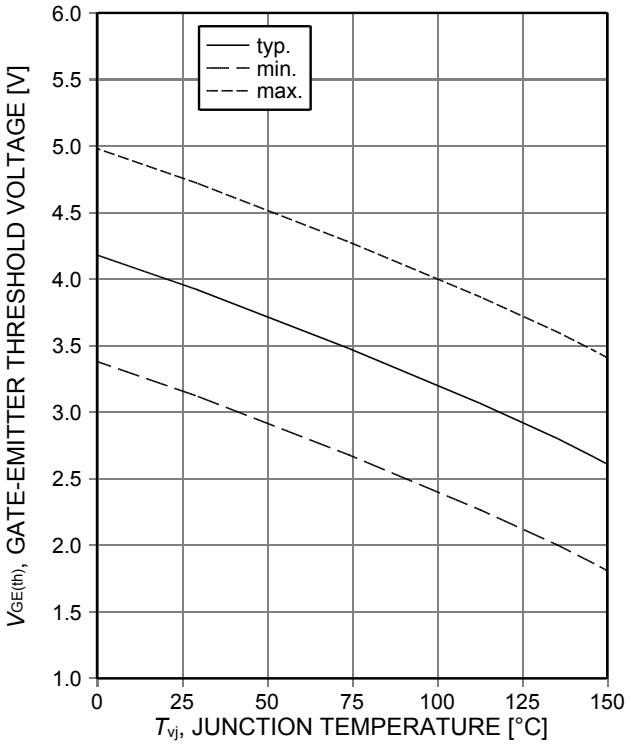



Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C$=0.5mA)

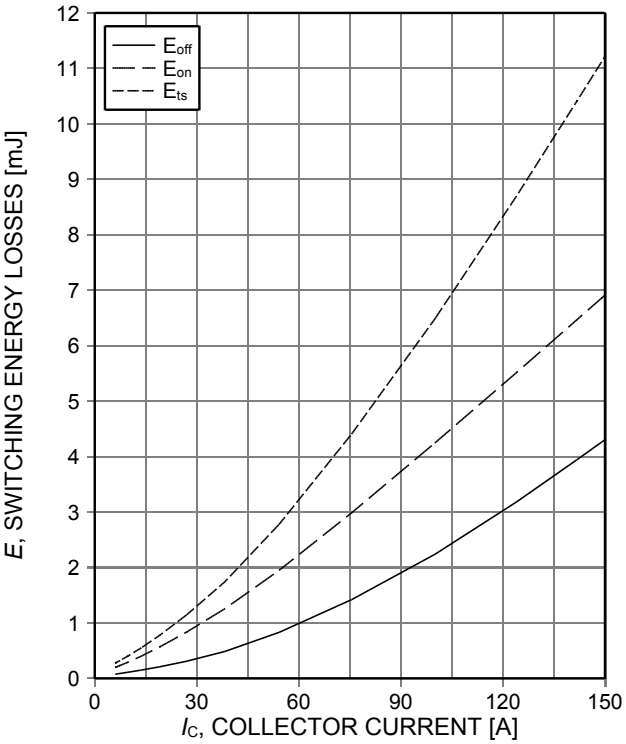



Figure 12. **Typical switching energy losses as a function of collector current**
(inductive load, $T_{vj}$=150°C, $V_{CE}$=400V, $V_{GE}$=15/0V, $r_G$=12Ω,Dynamic test circuit in Figure E)

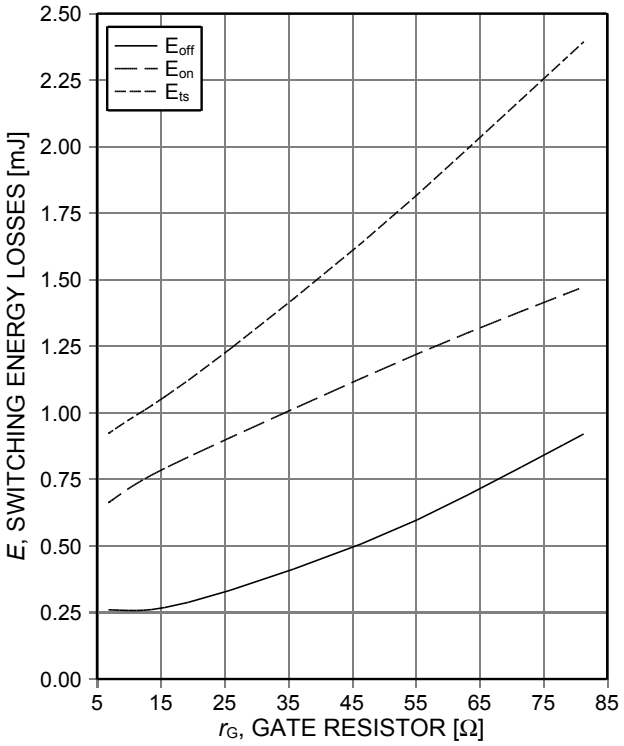



Figure 13. **Typical switching energy losses as a function of gate resistor** (inductive load, $T_{vj}$=150°C, $V_{CE}$=400V, $V_{GE}$=15/0V, $I_C$=25A, Dynamic test circuit in Figure E)

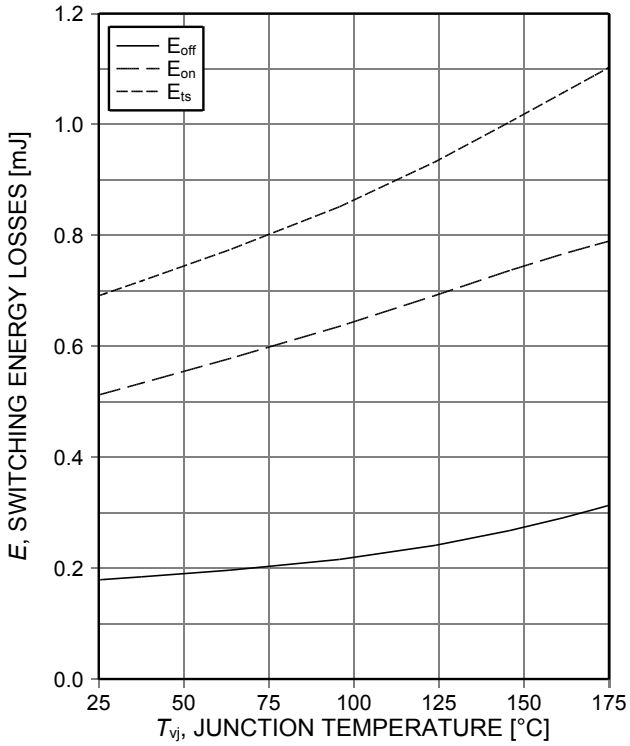



Figure 14. **Typical switching energy losses as a function of junction temperature** (inductive load, $V_{CE}$=400V, $V_{GE}$=15/0V, $I_C$=25A, $r_G$=12Ω,Dynamic test circuit in Figure E)

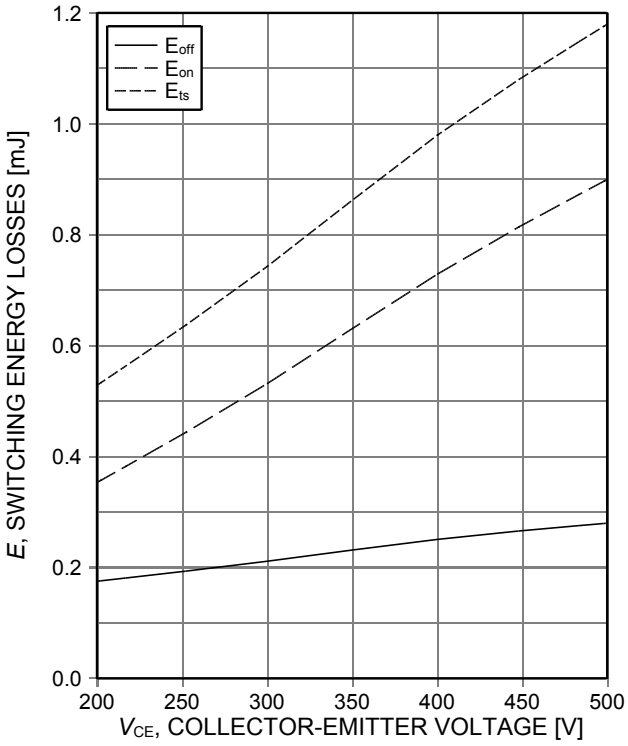



Figure 15. **Typical switching energy losses as a function of collector emitter voltage** (inductive load, $T_{vj}$=150°C, $V_{GE}$=15/0V, $I_C$=25A, $r_G$=12Ω,Dynamic test circuit in Figure E)

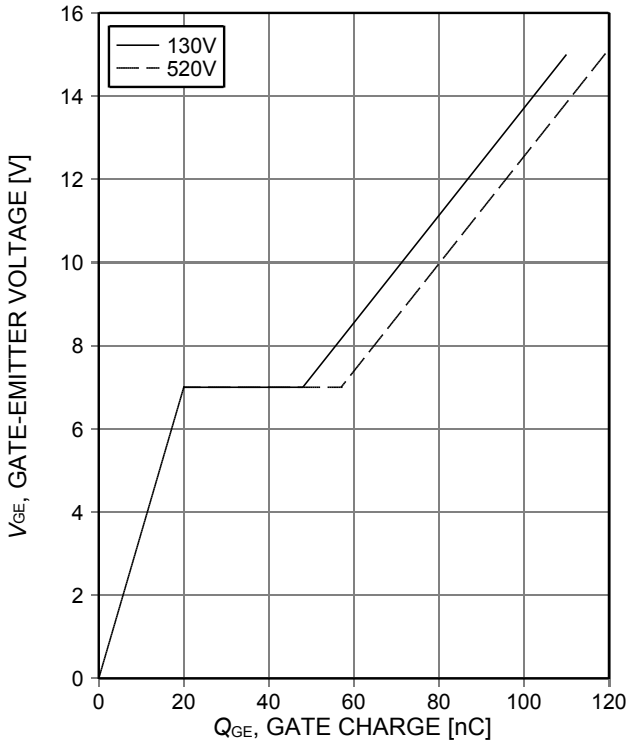



Figure 16. **Typical gate charge** ($I_C$=50A)

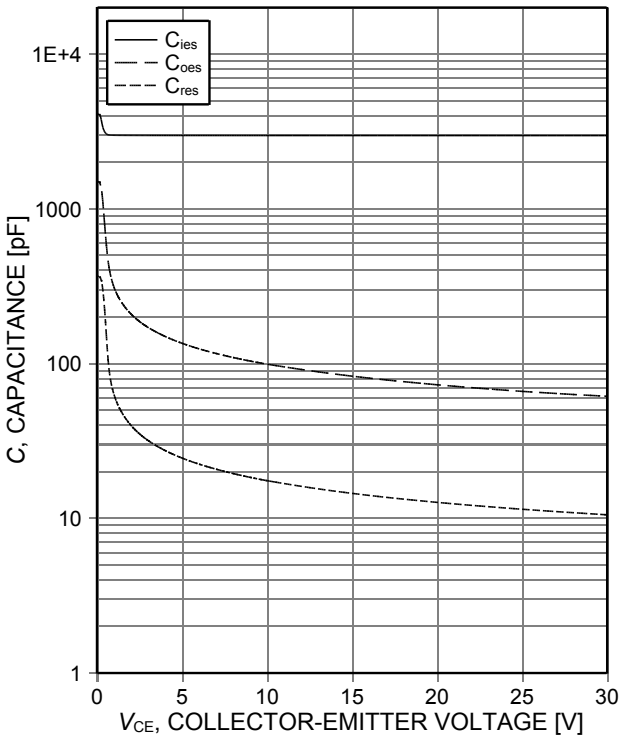



Figure 17. **Typical capacitance as a function of collector-emitter voltage**
($V_{GE}$=0V, f=1MHz)

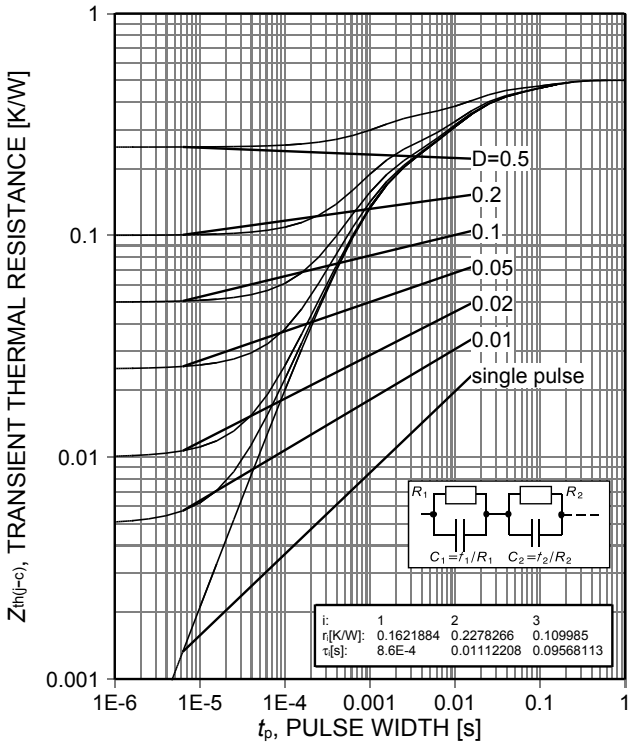



Figure 18. **IGBT transient thermal resistance**
($D=t_p/T$)

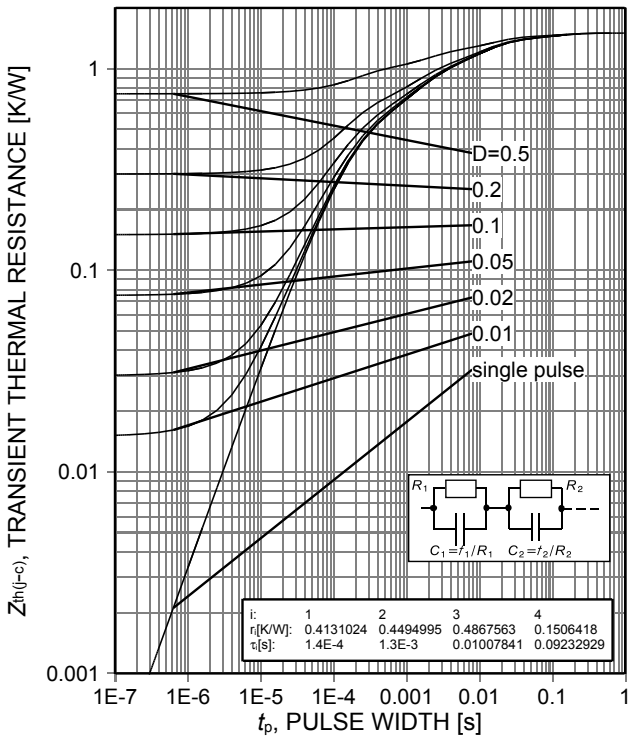



Figure 19. **Diode transient thermal impedance as a function of pulse width**
($D=t_p/T$)

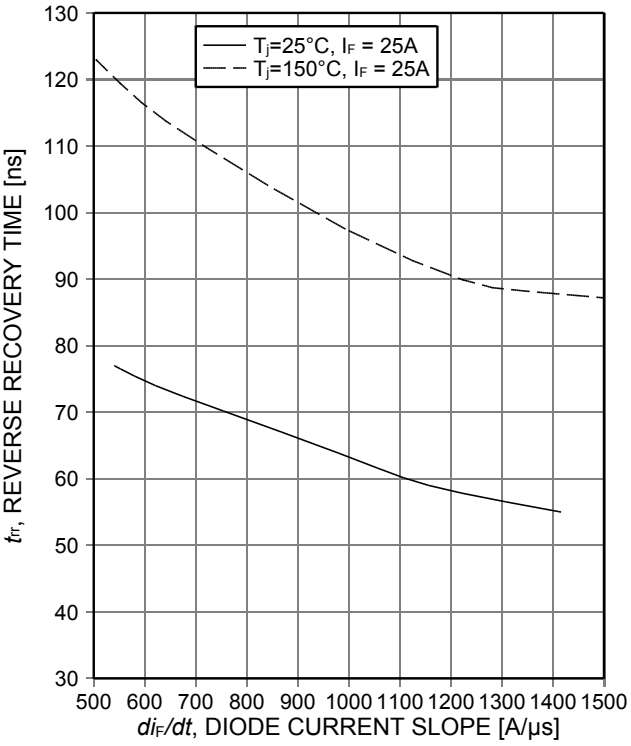



Figure 20. **Typical reverse recovery time as a function of diode current slope**
($V_R$=400V)

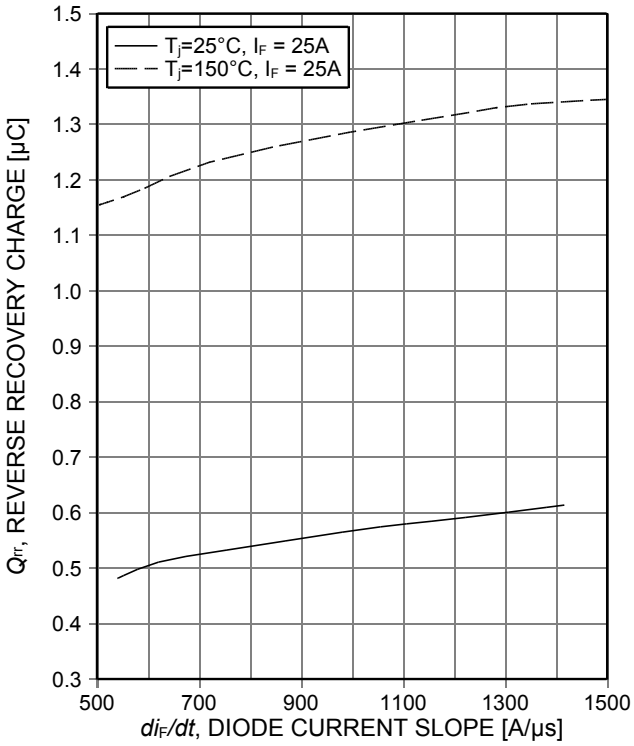



Figure 21. **Typical reverse recovery charge as a function of diode current slope** ($V_R$=400V)

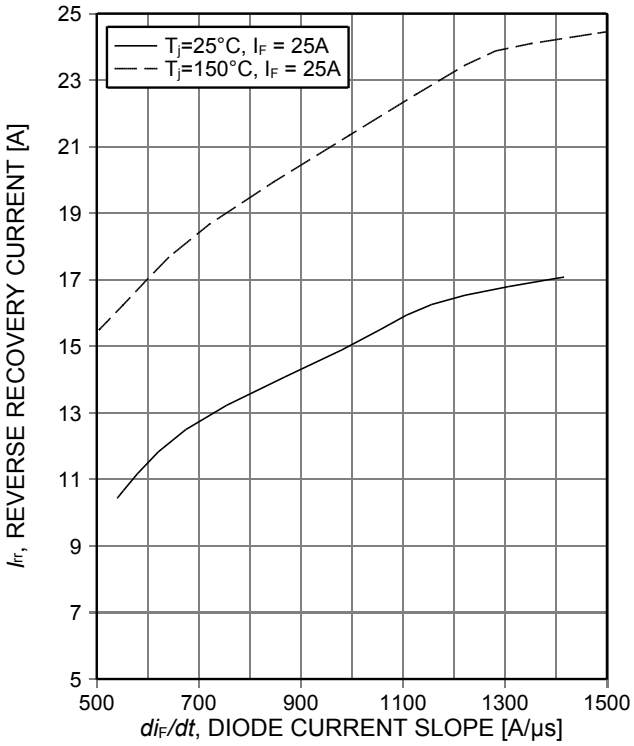



Figure 22. **Typical reverse recovery current as a function of diode current slope** ($V_R$=400V)

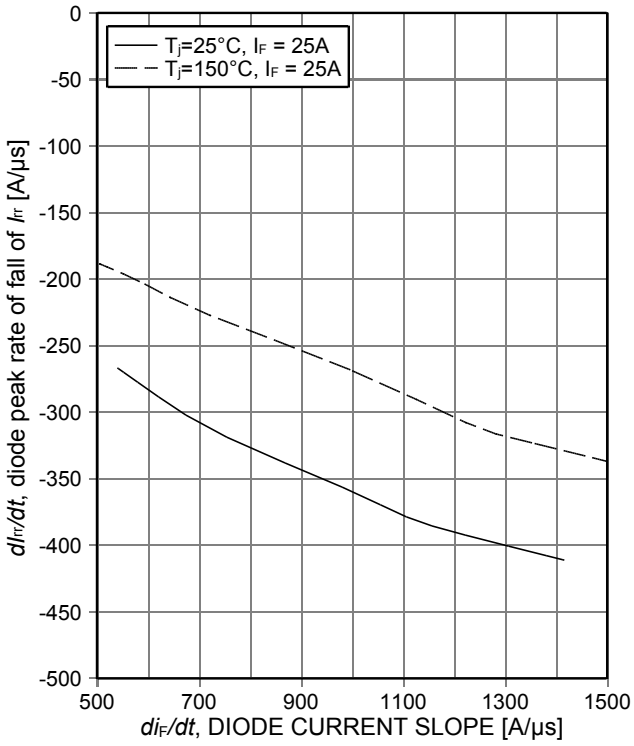



Figure 23. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope** ($V_R$=400V)

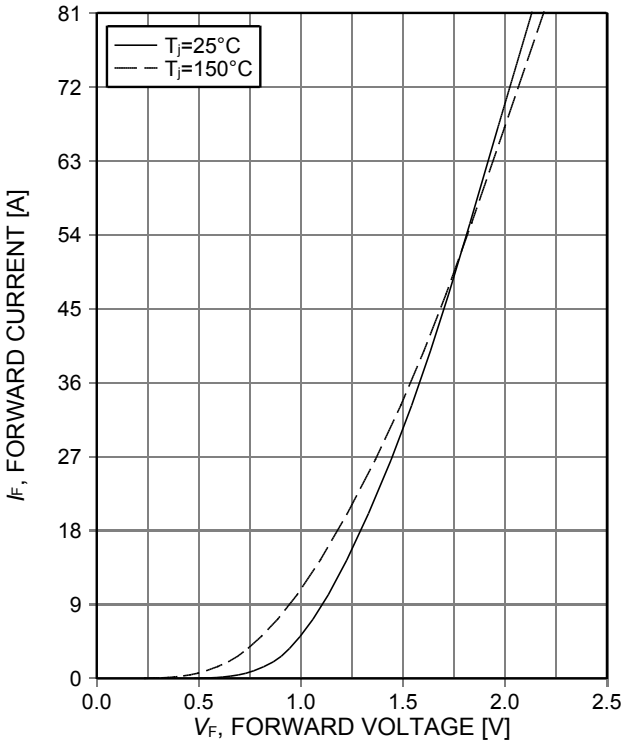



Figure 24. **Typical diode forward current as a function of forward voltage**

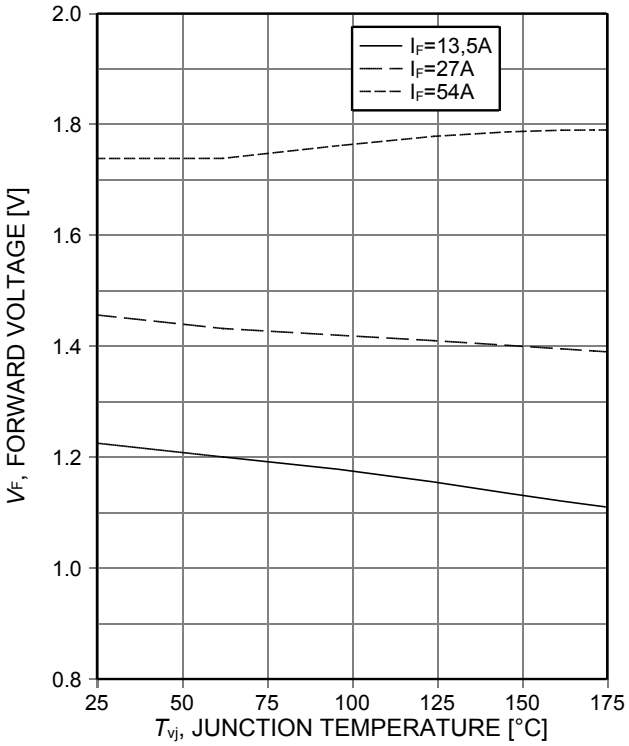
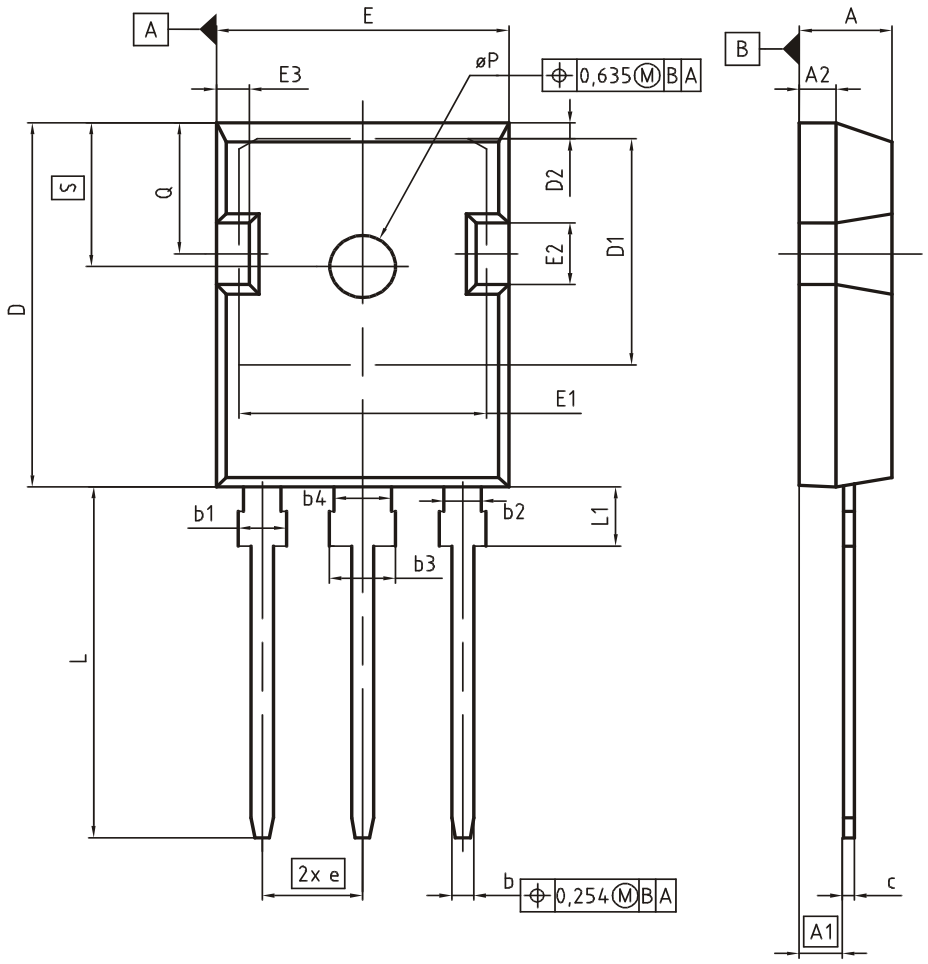



Figure 25. **Typical diode forward voltage as a function of junction temperature**

## Package Drawing PG-TO247-3

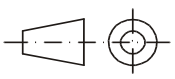



| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.83 | 5.21 | 0.190 | 0.205 |
| A1 | 2.27 | 2.54 | 0.089 | 0.100 |
| A2 | 1.85 | 2.16 | 0.073 | 0.085 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.90 | 2.41 | 0.075 | 0.095 |
| b2 | 1.90 | 2.16 | 0.075 | 0.085 |
| b3 | 2.87 | 3.38 | 0.113 | 0.133 |
| b4 | 2.87 | 3.13 | 0.113 | 0.123 |
| 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 |
| 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 |
| e | 5.44 (BSC) | | 0.214 (BSC) | |
| N | 3 | | 3 | |
| L | 19.80 | 20.32 | 0.780 | 0.800 |
| L1 | 4.10 | 4.47 | 0.161 | 0.176 |
| øP | 3.50 | 3.70 | 0.138 | 0.146 |
| Q | 5.49 | 6.00 | 0.216 | 0.236 |
| S | 6.04 | 6.30 | 0.238 | 0.248 |

**DOCUMENT NO.**
Z8B00003327

**SCALE**
0 5 5 7.5mm

**EUROPEAN PROJECTION**



**ISSUE DATE**
09-07-2010

**REVISION**
05

**Testing Conditions**

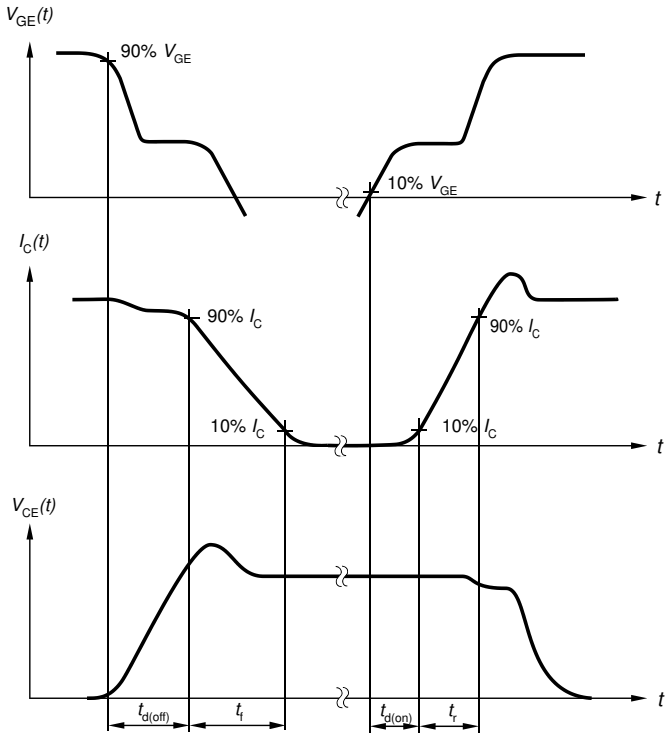



Figure A. **Definition of switching times**

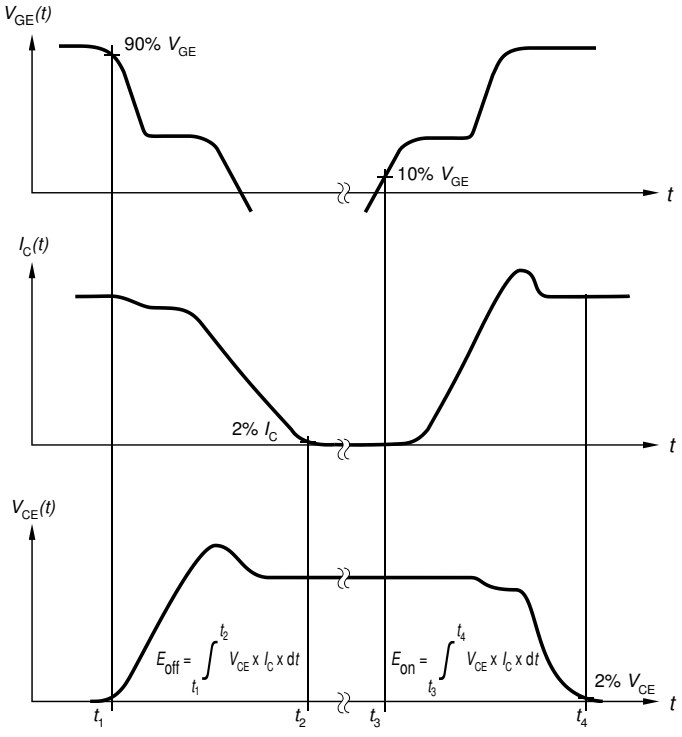



Figure B. **Definition of switching losses**

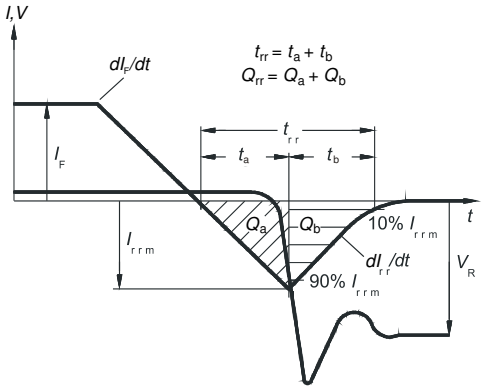



Figure C. **Definition of diode switching characteristics**

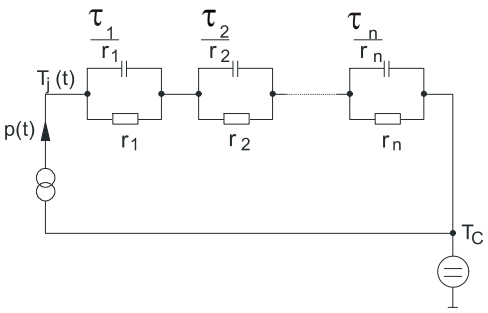



Figure D. **Thermal equivalent circuit**

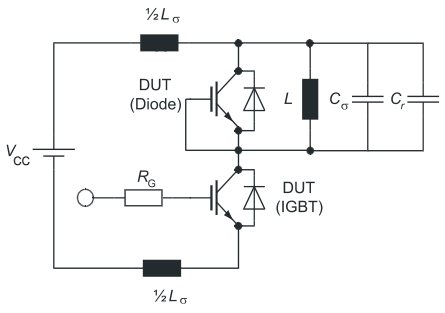



Figure E. **Dynamic test circuit**
Parasitic inductance $L_\sigma$,
parasitic capacitor $C_\sigma$,
relief capacitor $C_r$,
(only for ZVT switching)

## Revision History

IKW50N65H5

**Revision: 2015-05-06, Rev. 2.1**

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|---|---|---|
| 1.1 | 2012-11-09 | Preliminary data sheet |
| 1.2 | 2013-12-18 | New Marking Pattern |
| 2.1 | 2015-05-06 | Final data sheet |

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- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
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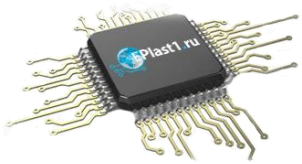
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

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