

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

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

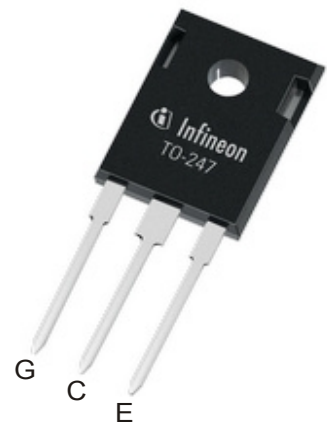
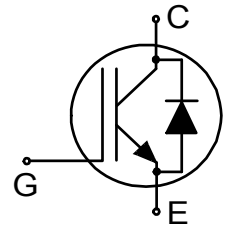
Features and Benefits:

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



Key Performance and Package Parameters

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



Table of Contents

Description 2

Table of Contents 3

Maximum Ratings 4

Thermal Resistance 4

Electrical Characteristics 5

Electrical Characteristics Diagrams 8

Package Drawing15

Testing Conditions16

Revision History17

Disclaimer17

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

Thermal Resistance

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

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

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

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

| Parameter | Symbol | Conditions | Value | | | Unit |
|--|-----------|--|-------|-------|------|------|
| | | | min. | typ. | max. | |
| Dynamic Characteristic | | | | | | |
| Input capacitance | C_{ies} | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$ | - | 3000 | - | pF |
| Output capacitance | C_{oes} | | - | 65 | - | |
| Reverse transfer capacitance | C_{res} | | - | 11 | - | |
| Gate charge | Q_G | $V_{CC} = 520\text{V}, I_C = 50.0\text{A},$ $V_{GE} = 15\text{V}$ | - | 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 $T_{vj} = 25^{\circ}\text{C}$ | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 25.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 12.0\Omega, R_{G(off)} = 12.0\Omega,$ $L_{\sigma} = 30\text{nH}, C_{\sigma} = 30\text{pF}$ L_{σ}, C_{σ} from Fig. E 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 | $t_{d(on)}$ | $T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 6.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 12.0\Omega$, $R_{G(off)} = 12.0\Omega$, $L_{\sigma} = 30\text{nH}$, $C_{\sigma} = 30\text{pF}$ L_{σ} , C_{σ} 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 $T_{vj} = 25^{\circ}\text{C}$

| | | | | | | |
|--|--------------|--|---|-------|---|------------------------|
| Diode reverse recovery time | t_{rr} | $T_{vj} = 25^{\circ}\text{C}$, $V_R = 400\text{V}$, $I_F = 25.0\text{A}$, $di_F/dt = 1200\text{A}/\mu\text{s}$ | - | 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 | - | $\text{A}/\mu\text{s}$ |
| Diode reverse recovery time | t_{rr} | $T_{vj} = 25^{\circ}\text{C}$, $V_R = 400\text{V}$, $I_F = 6.0\text{A}$, $di_F/dt = 1200\text{A}/\mu\text{s}$ | - | 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 | - | $\text{A}/\mu\text{s}$ |

Switching Characteristic, Inductive Load

| Parameter | Symbol | Conditions | Value | | | Unit |
|-----------|--------|------------|-------|------|------|------|
| | | | min. | typ. | max. | |

IGBT Characteristic, at $T_{vj} = 150^{\circ}\text{C}$

| | | | | | | |
|------------------------|--------------|--|---|------|---|----|
| Turn-on delay time | $t_{d(on)}$ | $T_{vj} = 150^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 25.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 12.0\Omega$, $R_{G(off)} = 12.0\Omega$, $L_{\sigma} = 30\text{nH}$, $C_{\sigma} = 30\text{pF}$ L_{σ} , C_{σ} 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 | $t_{d(on)}$ | $T_{vj} = 150^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 6.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(on)} = 12.0\Omega$, $R_{G(off)} = 12.0\Omega$, $L_{\sigma} = 30\text{nH}$, $C_{\sigma} = 30\text{pF}$ L_{σ} , C_{σ} 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 $T_{vj} = 150^{\circ}\text{C}$

| | | | | | | |
|--|--------------|--|---|------|---|------------------------|
| Diode reverse recovery time | t_{rr} | $T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 25.0\text{A},$ $di_F/dt = 1200\text{A}/\mu\text{s}$ | - | 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 | - | $\text{A}/\mu\text{s}$ |
| Diode reverse recovery time | t_{rr} | $T_{vj} = 150^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 6.0\text{A},$ $di_F/dt = 1200\text{A}/\mu\text{s}$ | - | 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 | - | $\text{A}/\mu\text{s}$ |

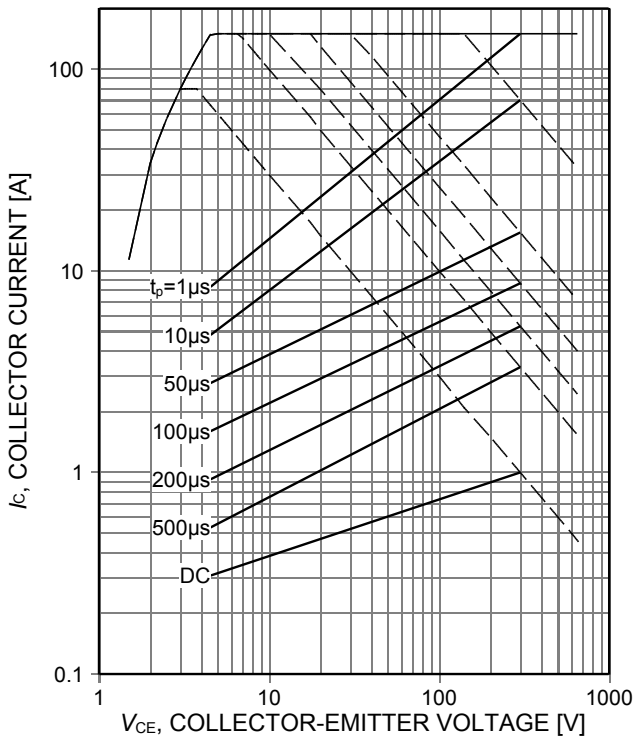


Figure 1. **Forward bias safe operating area**
 ($D=0$, $T_C=25^\circ\text{C}$, $T_{vj}\leq 175^\circ\text{C}$; $V_{GE}=15\text{V}$.
 Recommended use at $V_{GE}\geq 7.5\text{V}$)

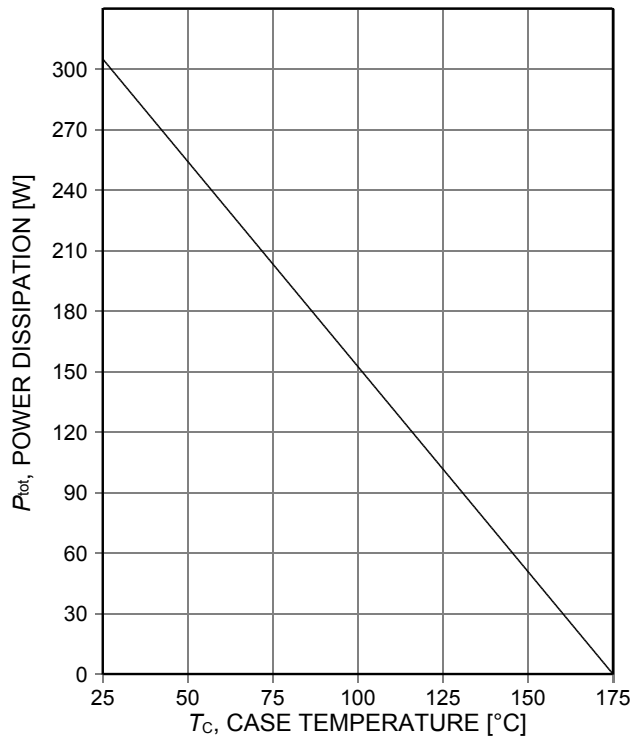


Figure 2. **Power dissipation as a function of case temperature**
 ($T_{vj}\leq 175^\circ\text{C}$)

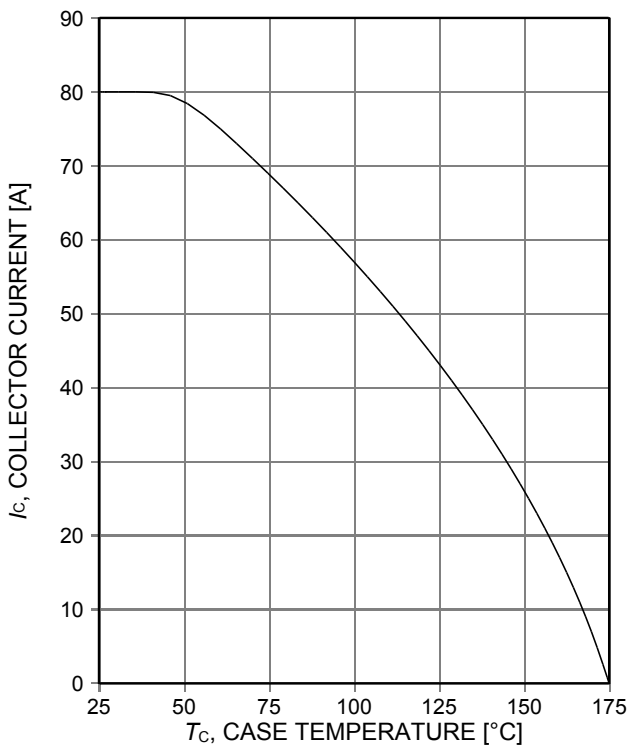


Figure 3. **Collector current as a function of case temperature**
 ($V_{GE}\geq 15\text{V}$, $T_{vj}\leq 175^\circ\text{C}$)

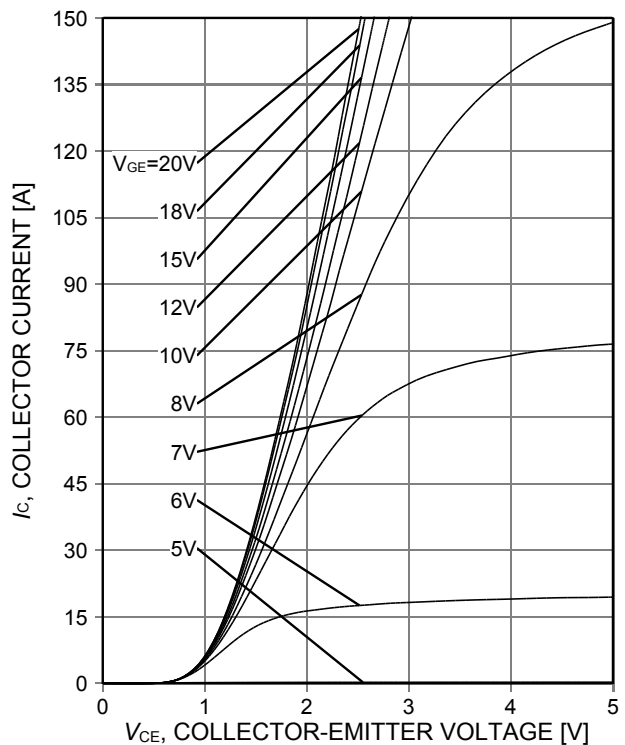


Figure 4. **Typical output characteristic**
 ($T_{vj}=25^\circ\text{C}$)

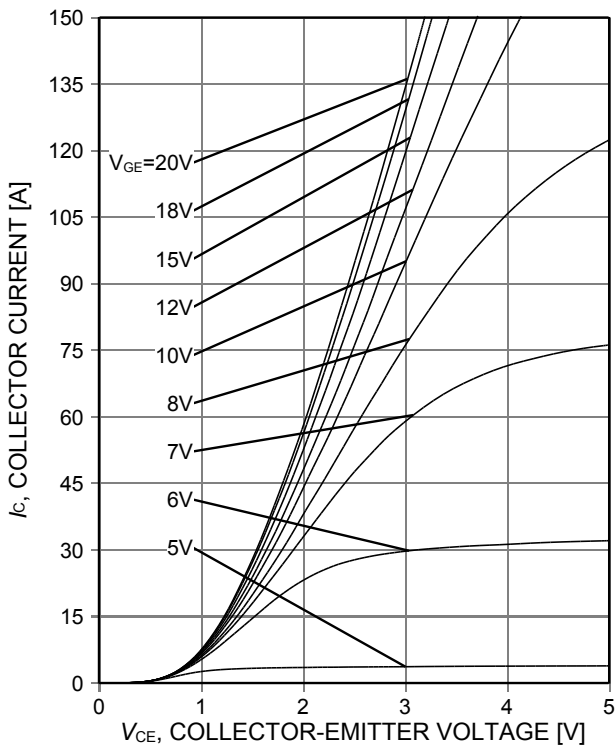


Figure 5. Typical output characteristic ($T_{vj}=150^{\circ}\text{C}$)

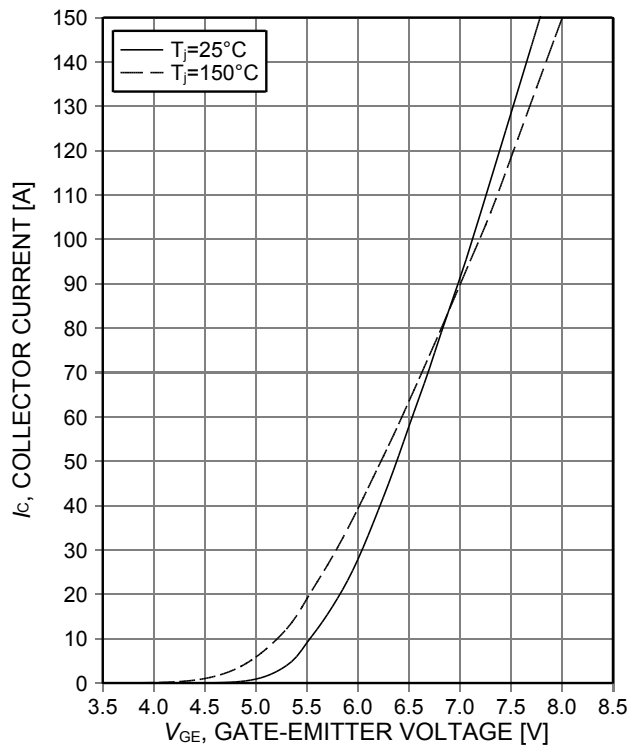


Figure 6. Typical transfer characteristic ($V_{CE}=20\text{V}$)

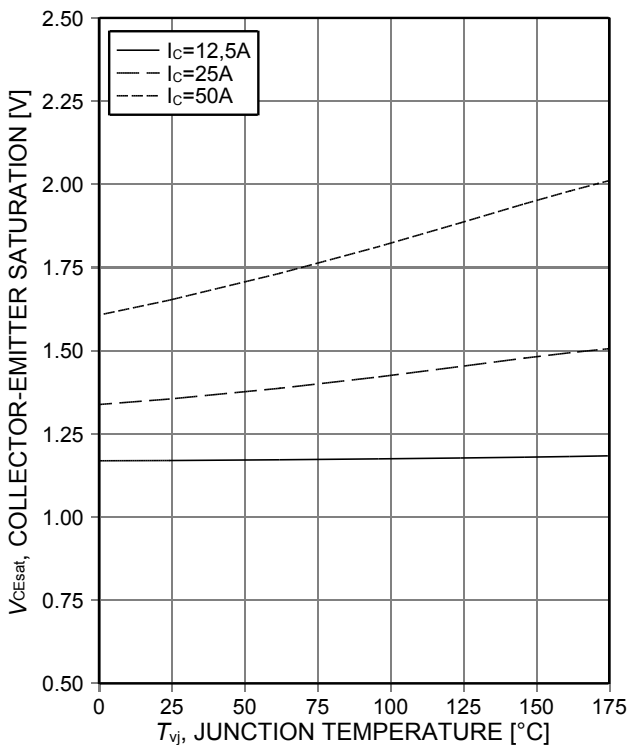


Figure 7. Typical collector-emitter saturation voltage as a function of junction temperature ($V_{GE}=15\text{V}$)

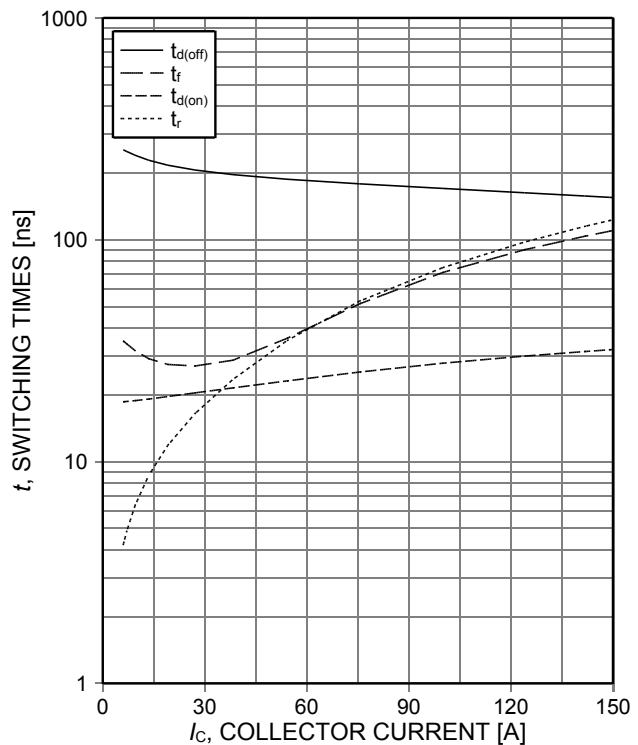


Figure 8. Typical switching times as a function of collector current (inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

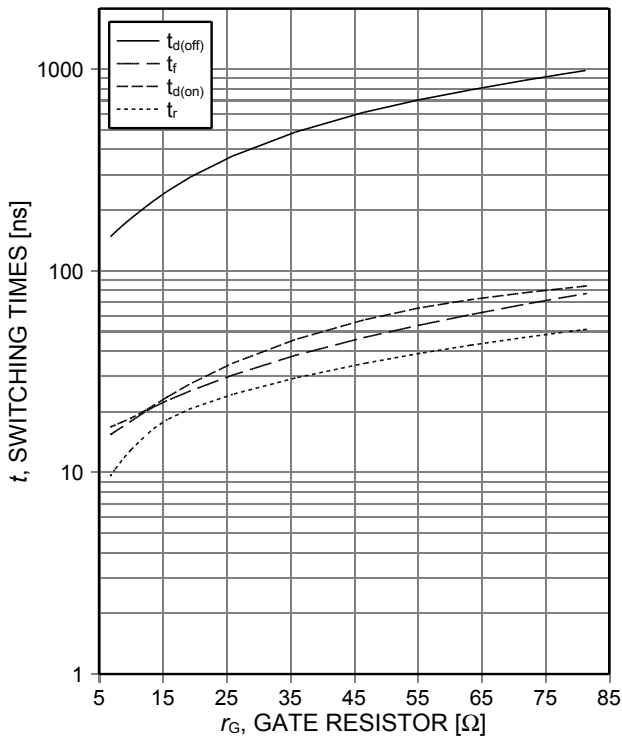


Figure 9. **Typical switching times as a function of gate resistor**
 (inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=25\text{A}$, Dynamic test circuit in Figure E)

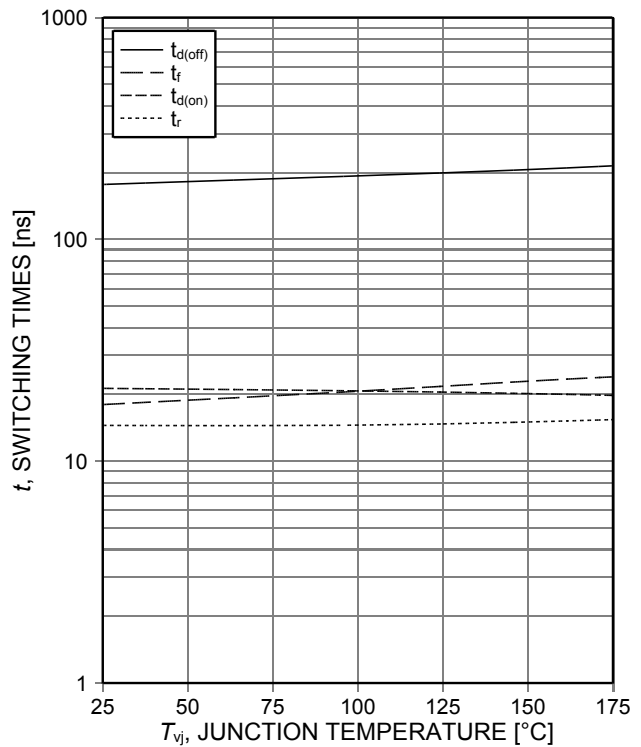


Figure 10. **Typical switching times as a function of junction temperature**
 (inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=25\text{A}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

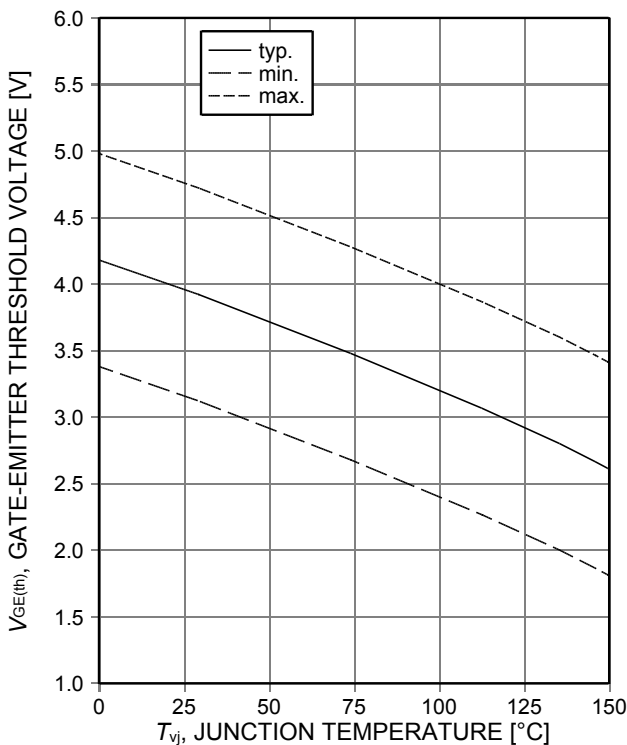


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
 ($I_C=0.5\text{mA}$)

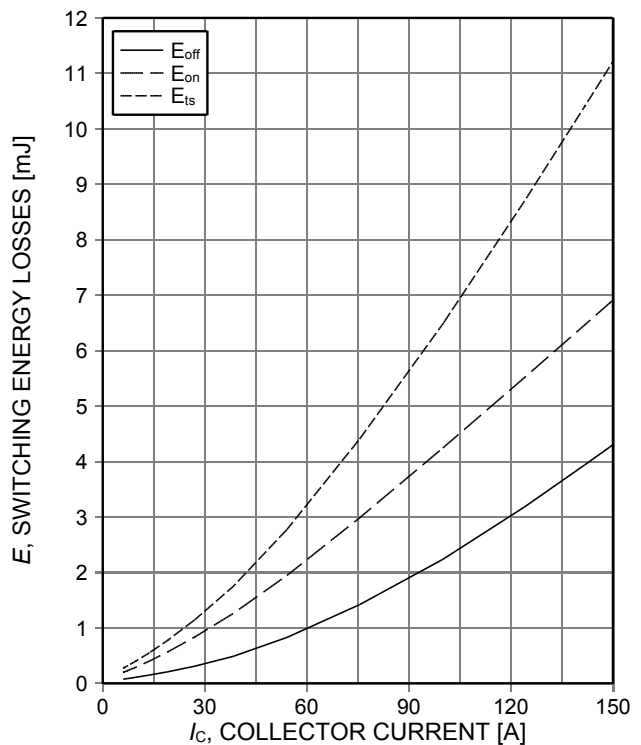


Figure 12. **Typical switching energy losses as a function of collector current**
 (inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

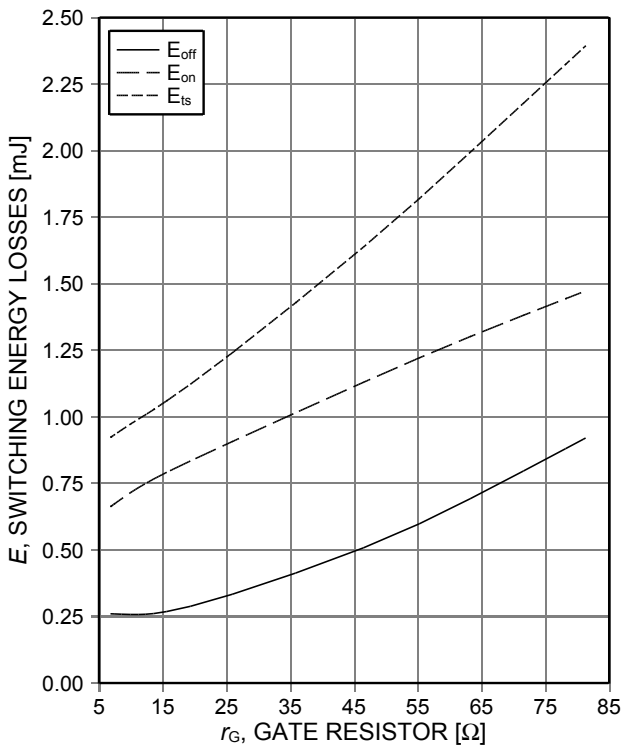


Figure 13. Typical switching energy losses as a function of gate resistor (inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=25\text{A}$, Dynamic test circuit in Figure E)

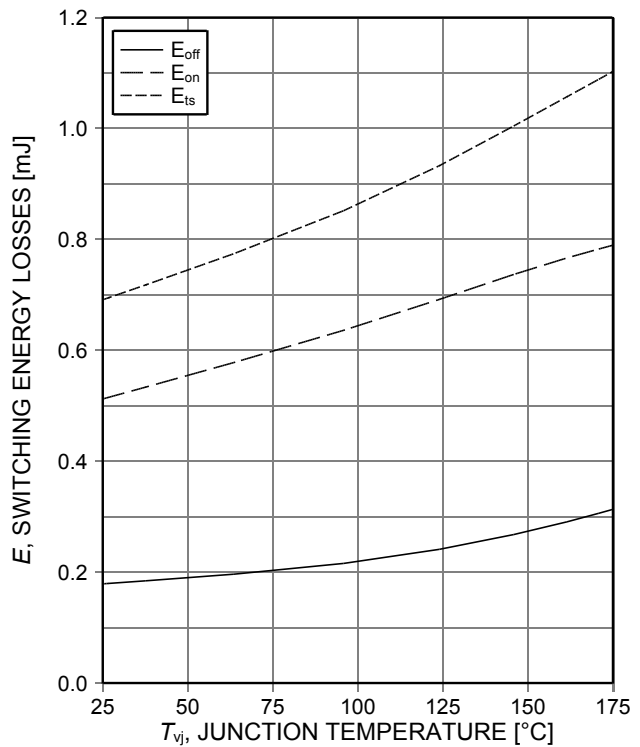


Figure 14. Typical switching energy losses as a function of junction temperature (inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=25\text{A}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

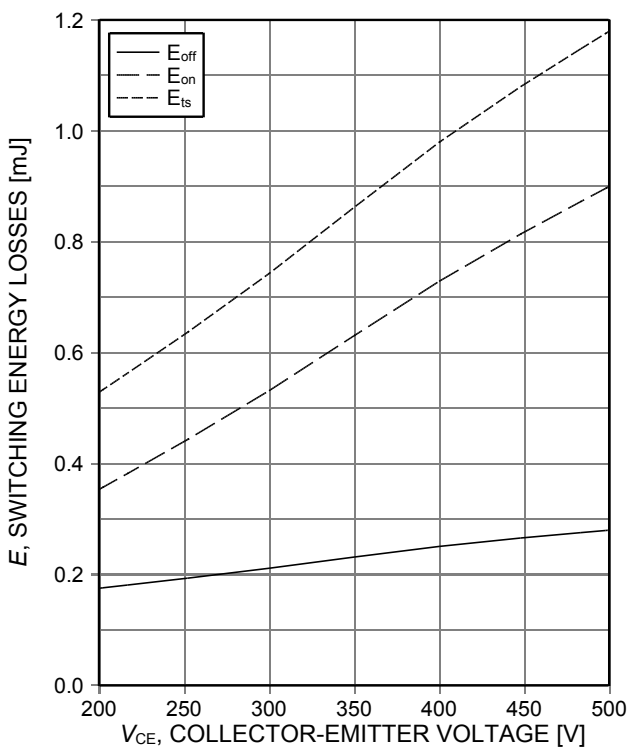


Figure 15. Typical switching energy losses as a function of collector emitter voltage (inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=25\text{A}$, $r_G=12\Omega$, Dynamic test circuit in Figure E)

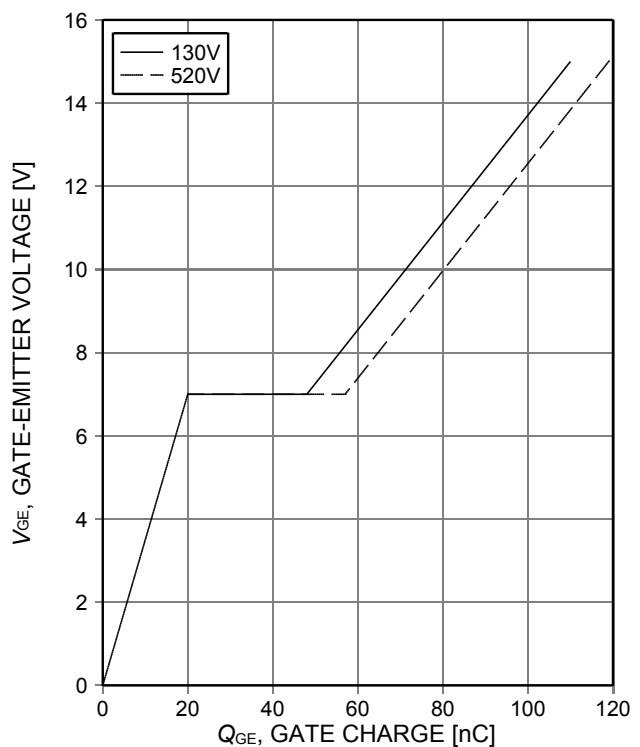


Figure 16. Typical gate charge ($I_C=50\text{A}$)

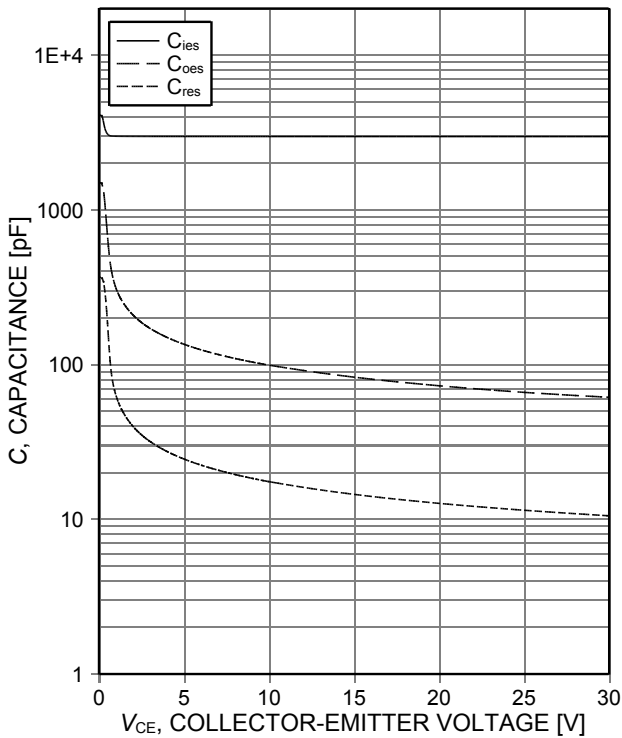


Figure 17. Typical capacitance as a function of collector-emitter voltage ($V_{GE}=0V$, $f=1MHz$)

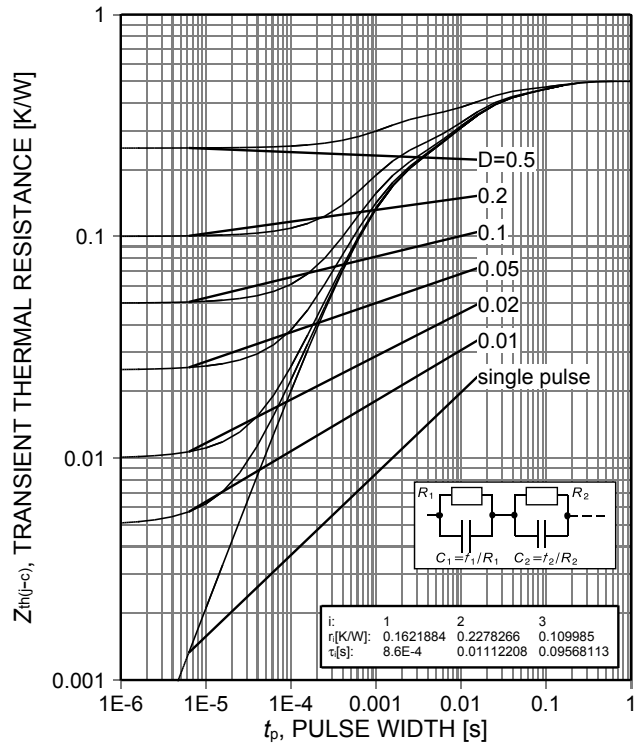


Figure 18. IGBT transient thermal resistance ($D=t_p/T$)

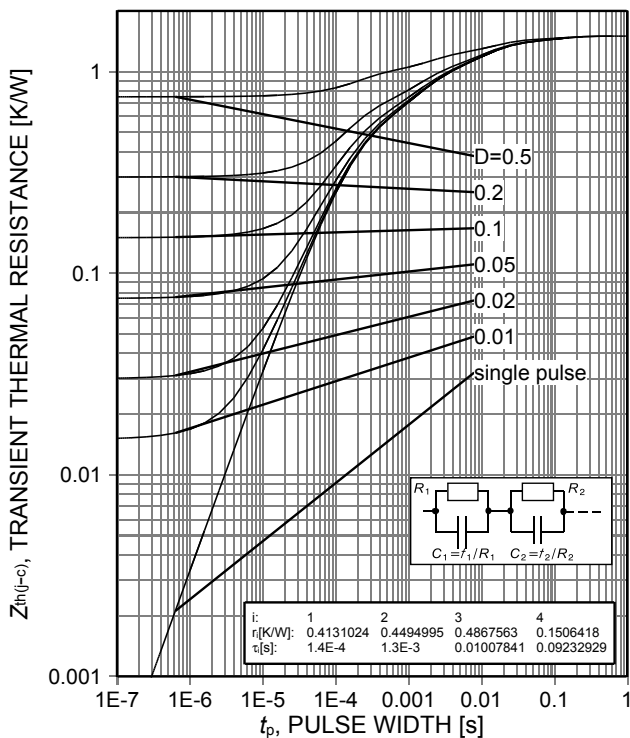


Figure 19. Diode transient thermal impedance as a function of pulse width ($D=t_p/T$)

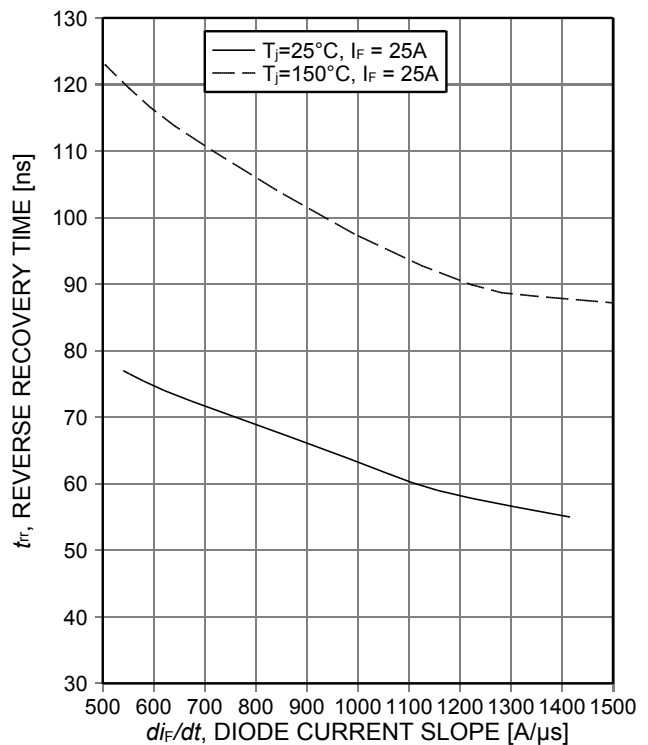


Figure 20. Typical reverse recovery time as a function of diode current slope ($V_R=400V$)

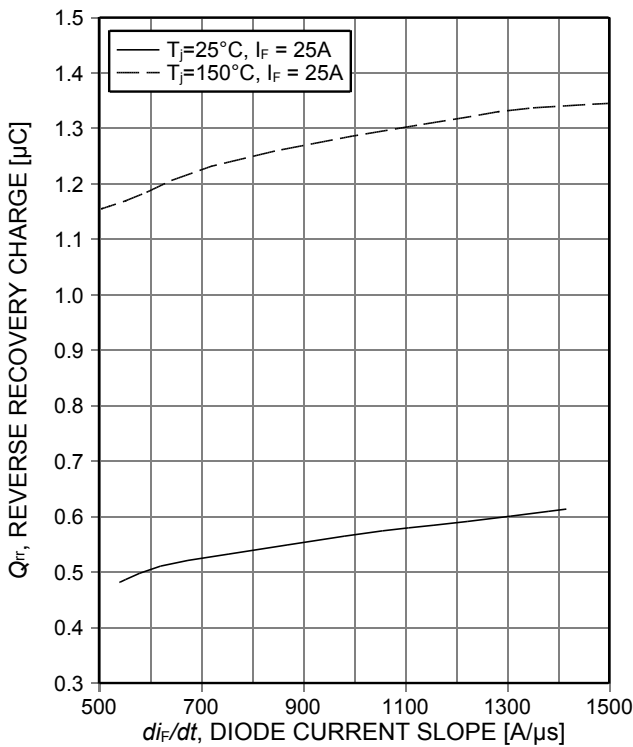


Figure 21. Typical reverse recovery charge as a function of diode current slope ($V_R=400V$)

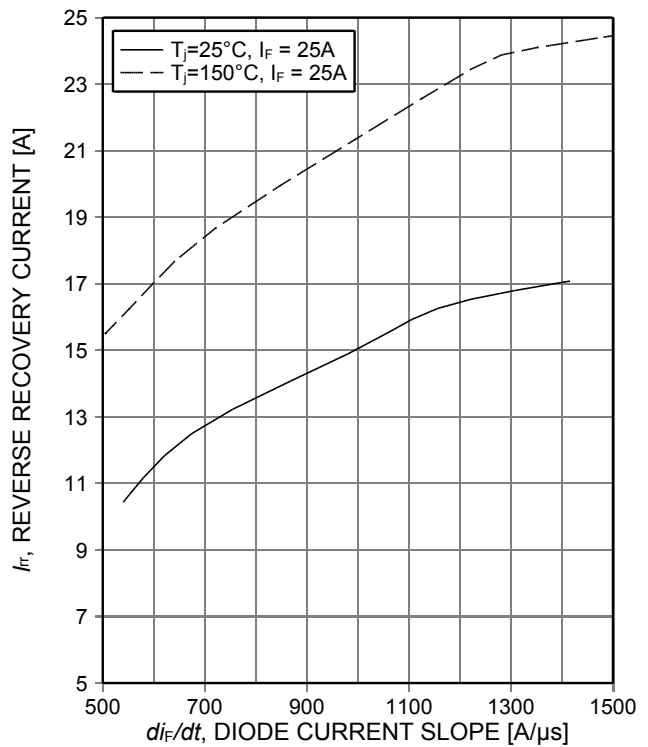


Figure 22. Typical reverse recovery current as a function of diode current slope ($V_R=400V$)

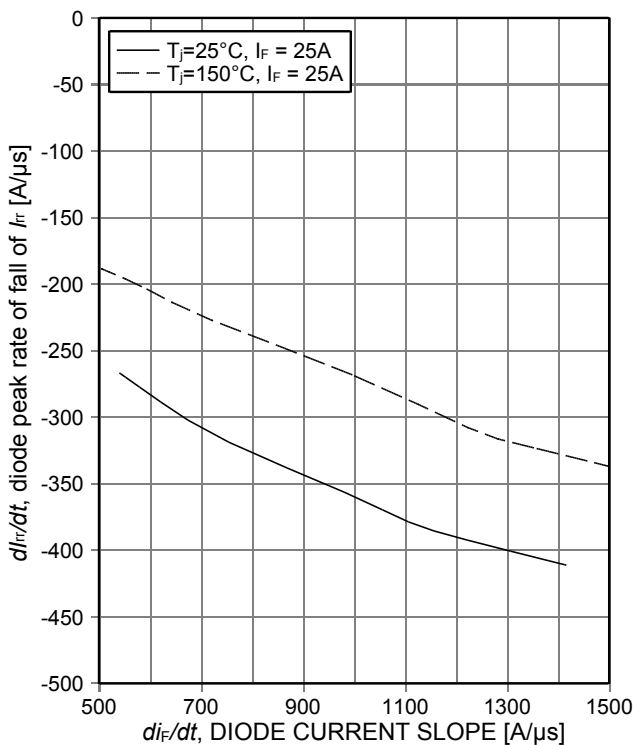


Figure 23. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope ($V_R=400V$)

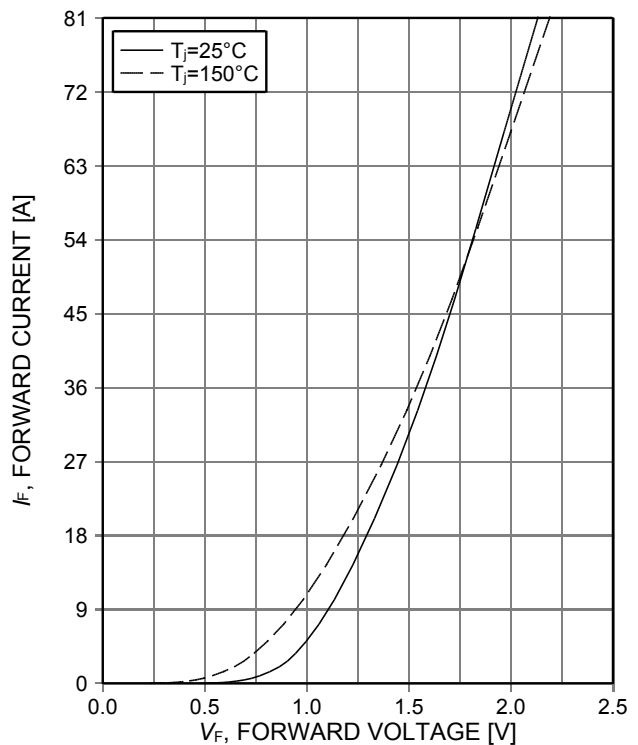


Figure 24. Typical diode forward current as a function of forward voltage

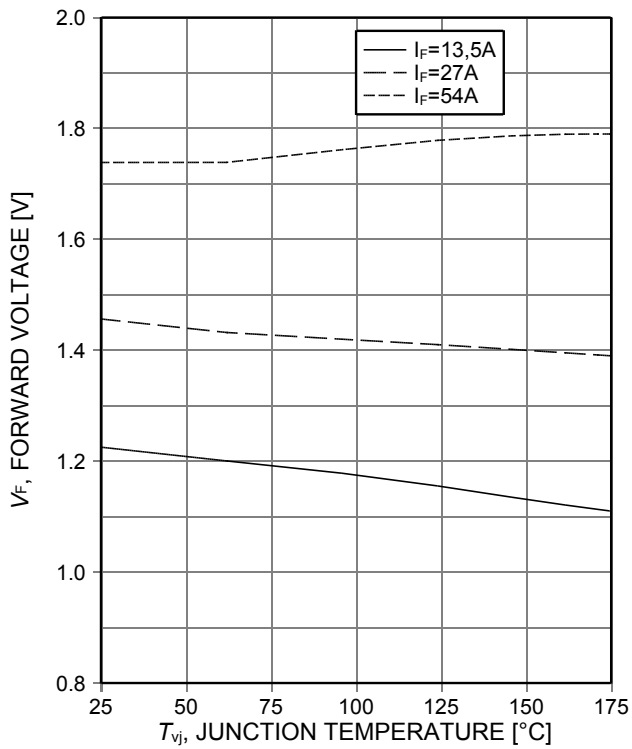
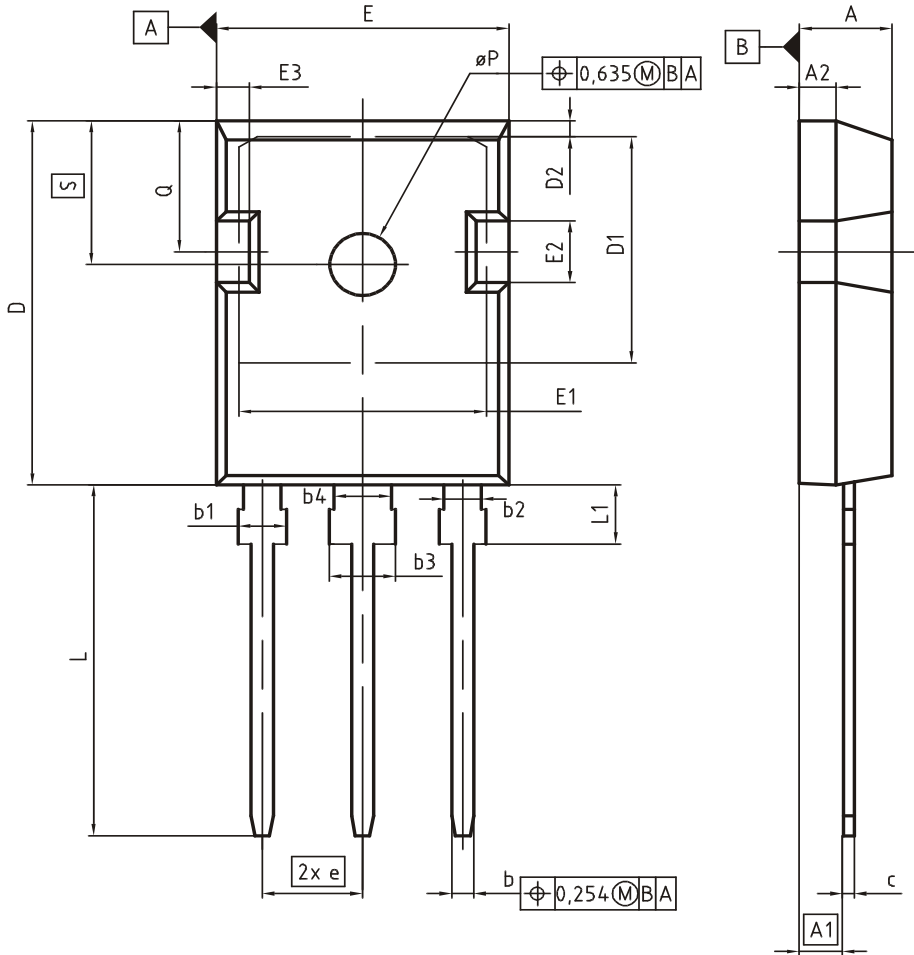


Figure 25. Typical diode forward voltage as a function of junction temperature

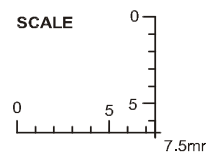
Package Drawing PG-TO247-3



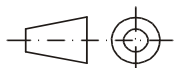
| DIM | MILLIMETERS | | INCHES | |
|----------|-------------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.83 | 5.21 | 0.190 | 0.205 |
| A1 | 2.27 | 2.54 | 0.089 | 0.100 |
| A2 | 1.85 | 2.16 | 0.073 | 0.085 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.90 | 2.41 | 0.075 | 0.095 |
| 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 |
| ϕP | 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



EUROPEAN PROJECTION



ISSUE DATE
09-07-2010

REVISION
05

Testing Conditions

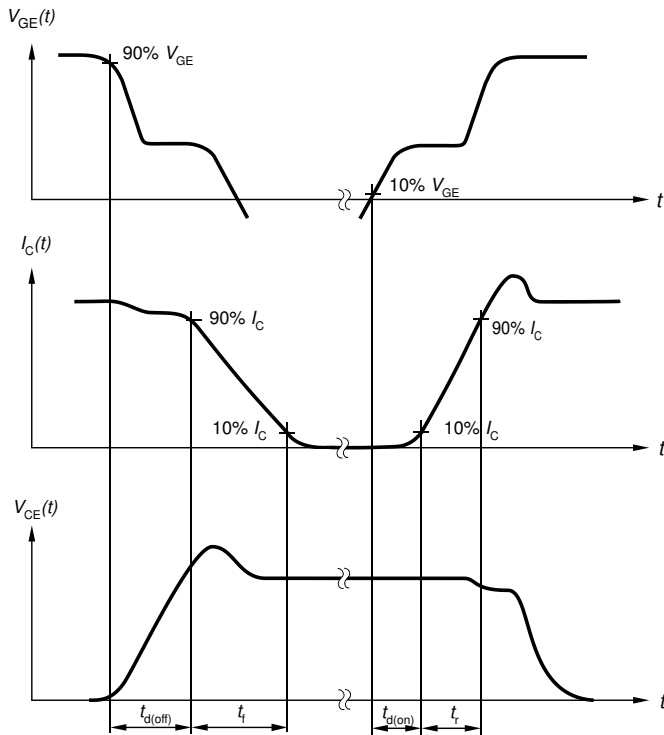


Figure A. Definition of switching times

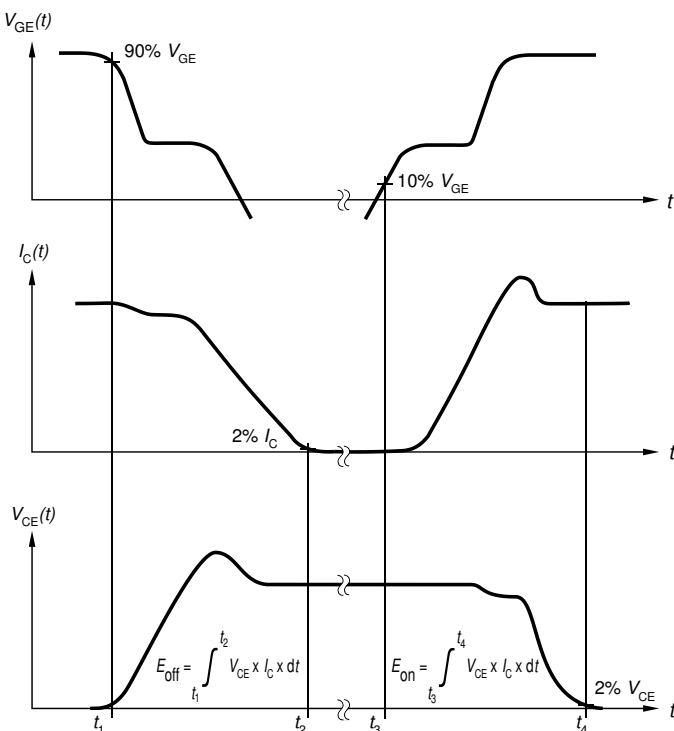


Figure B. Definition of switching losses

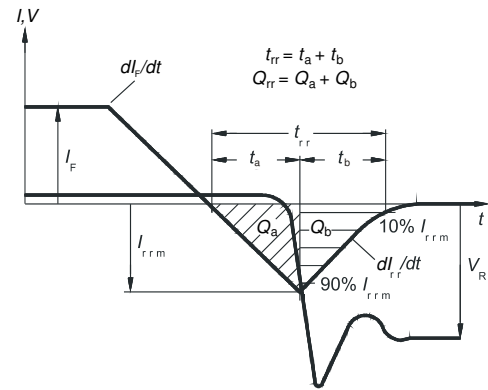


Figure C. Definition of diode switching characteristics



Figure D. Thermal equivalent circuit

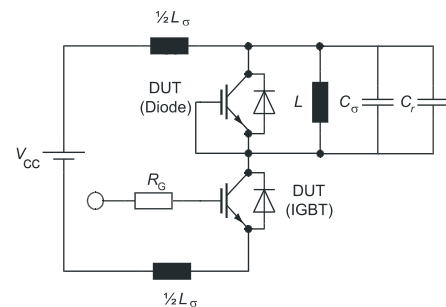


Figure E. Dynamic test circuit
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r ,
(only for ZVT switching)

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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