# IKW40T120

**TrenchStop®** Series

Low Loss DuoPack :   IGBT in **TrenchStop®** and Fieldstop technology with soft, fast recovery anti-parallel Emitter Controlled HE diode

- Best in class TO247
- Short circuit withstand time – 10μs
- Designed for :
    - Frequency Converters
    - Uninterrupted Power Supply
- **TrenchStop®**  and Fieldstop technology for 1200 V applications offers :
    - very tight parameter distribution
    - high ruggedness, temperature stable behavior
- NPT technology offers easy parallel switching capability due to positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Very soft, fast recovery anti-parallel Emitter Controlled HE diode
- Qualified according to JEDEC[1] for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/
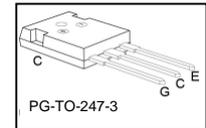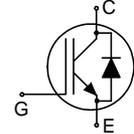
PG-TO-247-3

| Type | $V_{CE}$ | $I_C$ | $V_{CE(sat),Tj=25°C}$ | $T_{j,max}$ | Marking Code | Package |
|---|---|---|---|---|---|---|
| IKW40T120 | 1200V | 40A | 1.7V | 150°C | K40T120 | PG-TO-247-3 |

**Maximum Ratings**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Collector-emitter voltage | $V_{CE}$ | 1200 | V |
| DC collector current | $I_C$ | | A |
| $T_C = 25°C$ | | 75 | |
| $T_C = 100°C$ | | 40 | |
| Pulsed collector current, $t_p$ limited by $T_{jmax}$ | $I_{Cpuls}$ | 105 | |
| Turn off safe operating area | - | 105 | |
| $V_{CE} \leq 1200V$, $T_j \leq 150°C$ | | | |
| Diode forward current | $I_F$ | | |
| $T_C = 25°C$ | | 80 | |
| $T_C = 100°C$ | | 40 | |
| Diode pulsed current, $t_p$ limited by $T_{jmax}$ | $I_{Fpuls}$ | 105 | |
| Gate-emitter voltage | $V_{GE}$ | $\pm20$ | V |
| Short circuit withstand time[2] | $t_{SC}$ | 10 | μs |
| $V_{GE} = 15V$, $V_{CC} \leq 1200V$, $T_j \leq 150°C$ | | | |
| Power dissipation | $P_{tot}$ | 270 | W |
| $T_C = 25°C$ | | | |
| Operating junction temperature | $T_j$ | -40...+150 | °C |
| Storage temperature | $T_{stg}$ | -55...+150 | |

[1] J-STD-020 and JESD-022
[2] Allowed number of short circuits: <1000; time between short circuits: >1s.

| Soldering temperature, 1.6mm (0.063 in.) from case for 10s | - | 260 | |

**Thermal Resistance**

| Parameter | Symbol | Conditions | Max. Value | Unit |
|---|---|---|---|---|
| **Characteristic** | | | | |
| IGBT thermal resistance, junction – case | $R_{thJC}$ | | 0.45 | K/W |
| Diode thermal resistance, junction – case | $R_{thJCD}$ | | 0.81 | |
| Thermal resistance, junction – ambient | $R_{thJA}$ | | 40 | |

**Electrical Characteristic,** at $T_j$ = 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, $I_C$=1.5mA | 1200 | - | - | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $V_{GE}$ = 15V, $I_C$=40A | | | | |
| | | $T_j$=25°C | - | 1.7 | 2.3 | |
| | | $T_j$=125°C | - | 2.1 | - | |
| | | $T_j$=150°C | - | 2.3 | - | |
| Diode forward voltage | $V_F$ | $V_{GE}$=0V, $I_F$=40A | | | | |
| | | $T_j$=25°C | - | 1.75 | 2.3 | |
| | | $T_j$=125°C | - | 1.75 | - | |
| | | $T_j$=150°C | - | 1.75 | - | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C$=1.5mA, $V_{CE}=V_{GE}$ | 5.0 | 5.8 | 6.5 | |
| Zero gate voltage collector current | $I_{CES}$ | $V_{CE}$=1200V, $V_{GE}$=0V | | | | mA |
| | | $T_j$=25°C | - | - | 0.4 | |
| | | $T_j$=150°C | - | - | 4.0 | |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$=0V, $V_{GE}$=20V | - | - | 600 | nA |
| Transconductance | $g_{fs}$ | $V_{CE}$=20V, $I_C$=40A | - | 21 | - | S |
| Integrated gate resistor | $R_{Gint}$ | | | 6 | | Ω |

**Dynamic Characteristic**

| | | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{iss}$ | $V_{CE}$=25V, | - | 2500 | - | pF |
| Output capacitance | $C_{oss}$ | $V_{GE}$=0V, | - | 130 | - | |
| Reverse transfer capacitance | $C_{rss}$ | $f$=1MHz | - | 110 | - | |
| Gate charge | $Q_{Gate}$ | $V_{CC}$=960V, $I_C$=40A $V_{GE}$=15V | - | 203 | - | nC |
| Internal emitter inductance measured 5mm (0.197 in.) from case | $L_E$ | | - | 13 | - | nH |
| Short circuit collector current[1] | $I_{C(SC)}$ | $V_{GE}$=15V, $t_{SC} \leq 10\mu s$ $V_{CC}$ = 600V, $T_j$ = 25°C | - | 210 | - | A |

**Switching Characteristic, Inductive Load,** at $T_j$=25 °C

| Parameter | Symbol | Conditions | Value min. | Value typ. | Value max. | Unit |
|---|---|---|---|---|---|---|
| **IGBT Characteristic** | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j$=25°C, $V_{CC}$=600V, $I_C$=40A, $V_{GE}$=0/15V, $R_G$=15Ω, $L_\sigma$[2]=180nH, $C_\sigma$[2]=39pF Energy losses include "tail" and diode reverse recovery. | - | 48 | - | ns |
| Rise time | $t_r$ | | - | 34 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 480 | - | |
| Fall time | $t_f$ | | - | 70 | - | |
| Turn-on energy | $E_{on}$ | | - | 3.3 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 3.2 | - | |
| Total switching energy | $E_{ts}$ | | - | 6.5 | - | |
| **Anti-Parallel Diode Characteristic** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $T_j$=25°C, $V_R$=600V, $I_F$=40A, $di_F/dt$=800A/μs | - | 240 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 3.8 | | μC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 28 | | A |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | 370 | - | A/μs |

[1] Allowed number of short circuits: <1000; time between short circuits: >1s.
[2] Leakage inductance $L_\sigma$ and Stray capacity $C_\sigma$ due to dynamic test circuit in Figure E.

**Switching Characteristic, Inductive Load,** at $T_j$=150 °C

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **IGBT Characteristic** | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j$=150°C $V_{CC}$=600V, $I_C$=40A, $V_{GE}$=0/15V, $R_G$= 15Ω, $L_\sigma{}^{1)}$=180nH, $C_\sigma{}^{1)}$=39pF Energy losses include "tail" and diode reverse recovery. | - | 52 | - | ns |
| Rise time | $t_r$ | | - | 40 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 580 | - | |
| Fall time | $t_f$ | | - | 120 | - | |
| Turn-on energy | $E_{on}$ | | - | 5.0 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 5.4 | - | |
| Total switching energy | $E_{ts}$ | | - | 10.4 | - | |
| **Anti-Parallel Diode Characteristic** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $T_j$=150°C $V_R$=600V, $I_F$=40A, $di_F/dt$=800A/µs | - | 410 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 8.8 | - | µC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 36 | - | A |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | 330 | | A/µs |

[1] Leakage inductance $L_\sigma$ and Stray capacity $C_\sigma$ due to dynamic test circuit in Figure E.
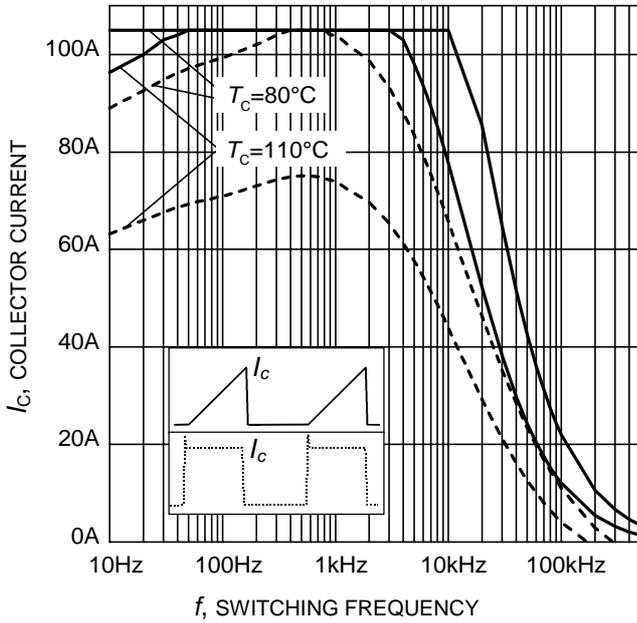
**Figure 1.** **Collector current as a function of switching frequency**
($T_j \leq 150°C$, $D = 0.5$, $V_{CE} = 600V$, $V_{GE} = 0/+15V$, $R_G = 15\Omega$)
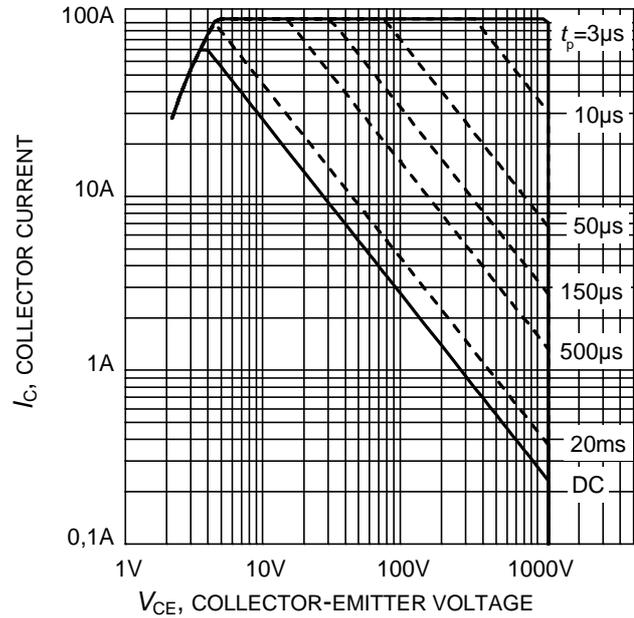


**Figure 2.** **Safe operating area**
($D = 0$, $T_C = 25°C$, $T_j \leq 150°C$; $V_{GE} = 15V$)
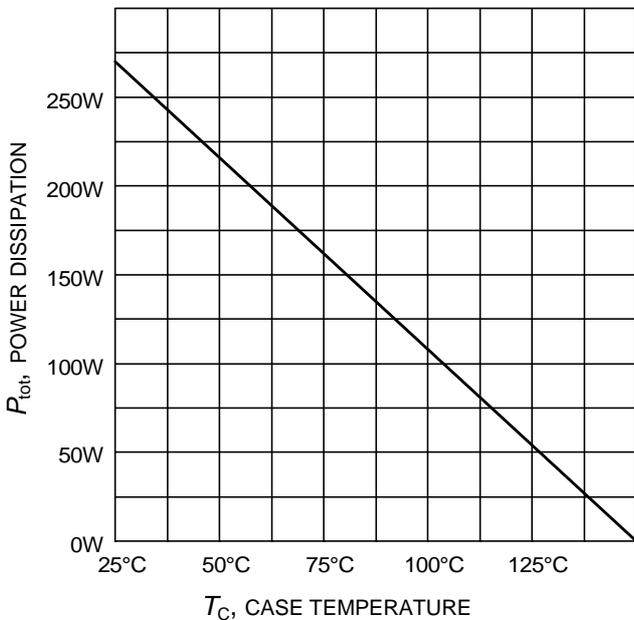


**Figure 3.** **Power dissipation as a function of case temperature**
($T_j \leq 150°C$)
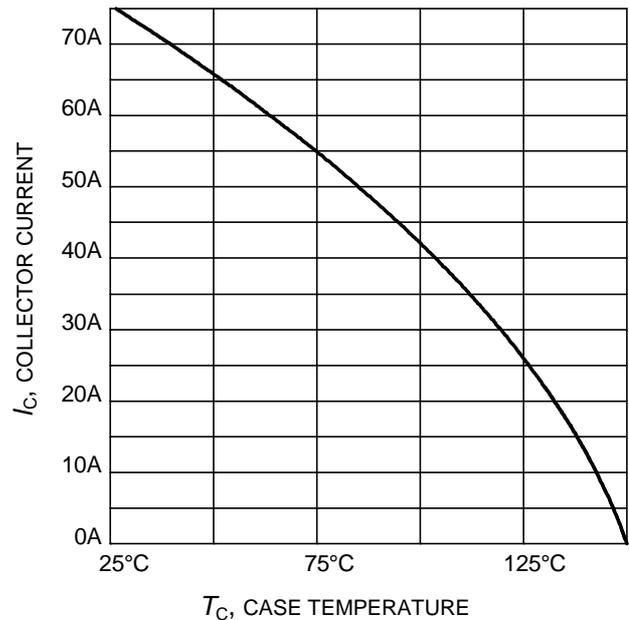


**Figure 4.** **Collector current as a function of case temperature**
($V_{GE} \geq 15V$, $T_j \leq 150°C$)
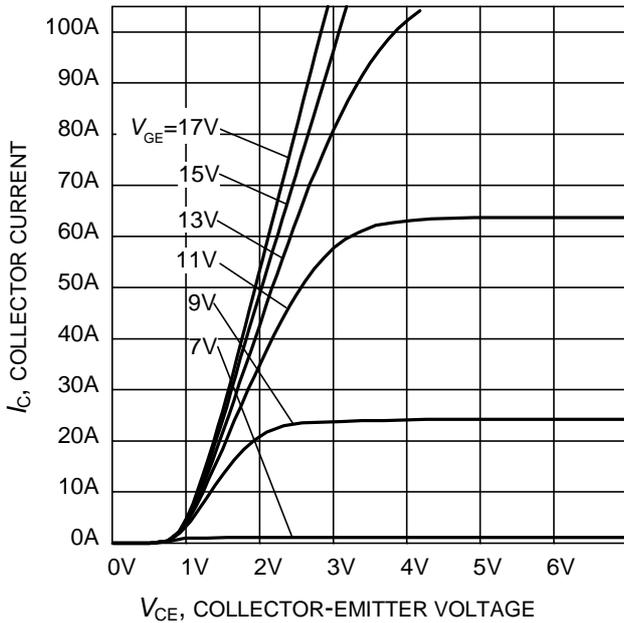
**Figure 5. Typical output characteristic**
($T_j$ = 25°C)
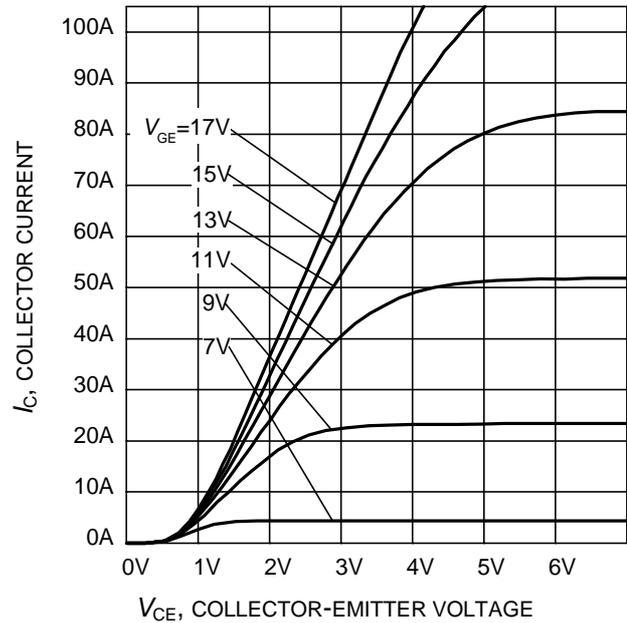


**Figure 6. Typical output characteristic**
($T_j$ = 150°C)
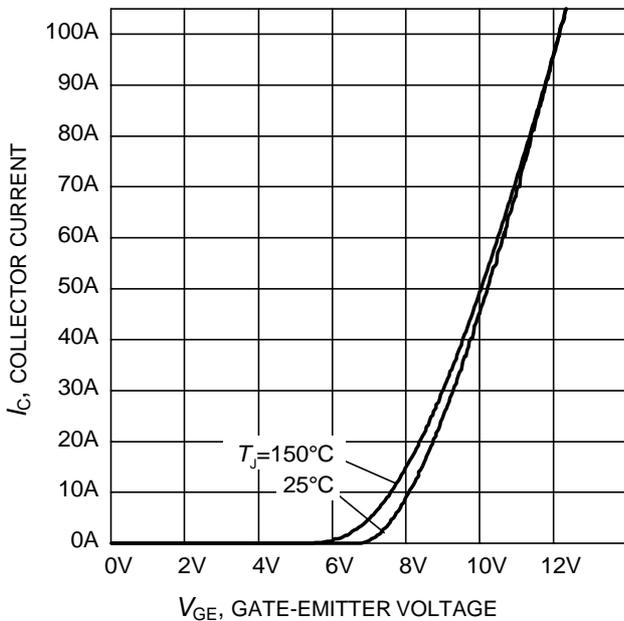


**Figure 7. Typical transfer characteristic**
($V_{CE}$=20V)
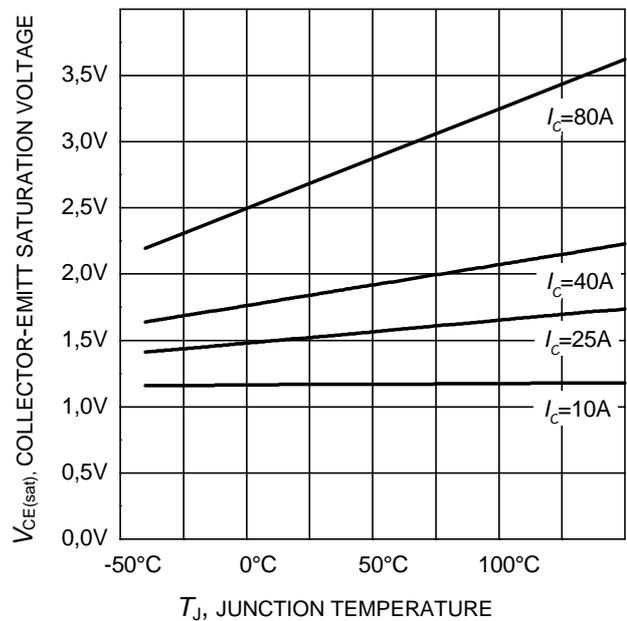


**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}$ = 15V)
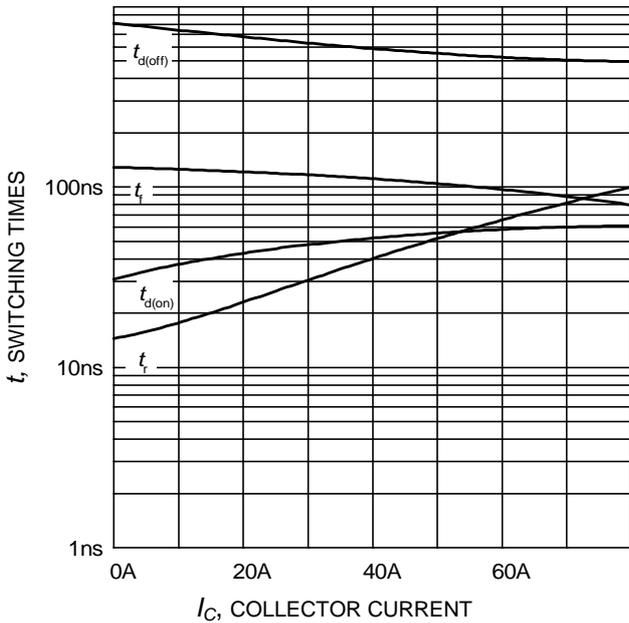
**Figure 9. Typical switching times as a function of collector current**
(inductive load, $T_J$=150°C, $V_{CE}$=600V, $V_{GE}$=0/15V, $R_G$=15Ω, Dynamic test circuit in Figure E)
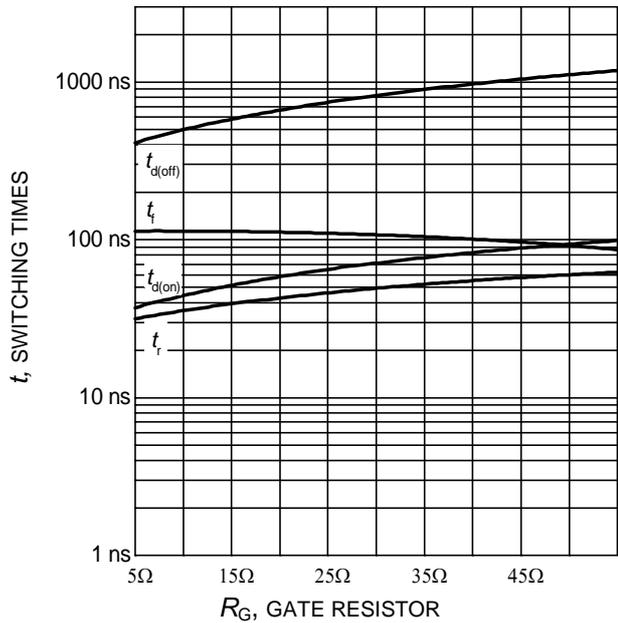


**Figure 10. Typical switching times as a function of gate resistor**
(inductive load, $T_J$=150°C, $V_{CE}$=600V, $V_{GE}$=0/15V, $I_C$=40A, Dynamic test circuit in Figure E)
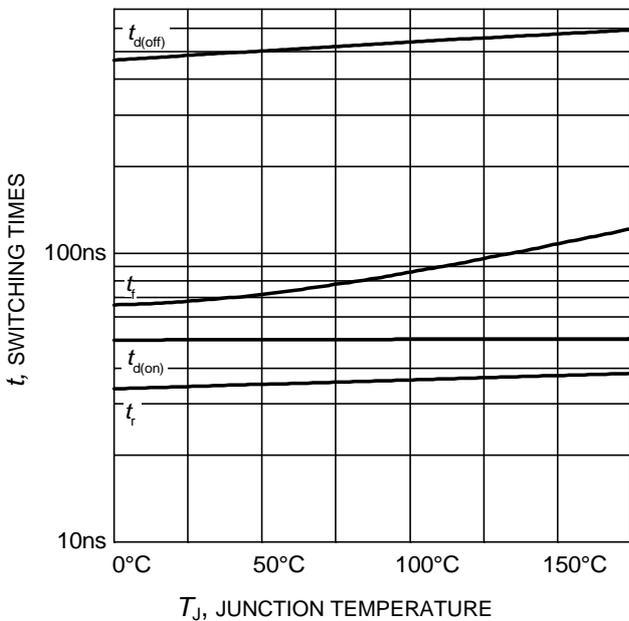


**Figure 11. Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}$=600V, $V_{GE}$=0/15V, $I_C$=40A, $R_G$=15Ω, Dynamic test circuit in Figure E)
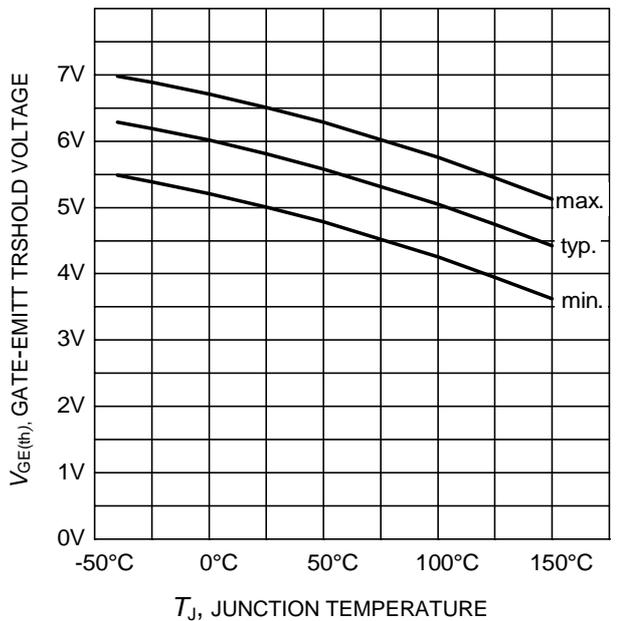


**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**
($I_C$ = 1.5mA)
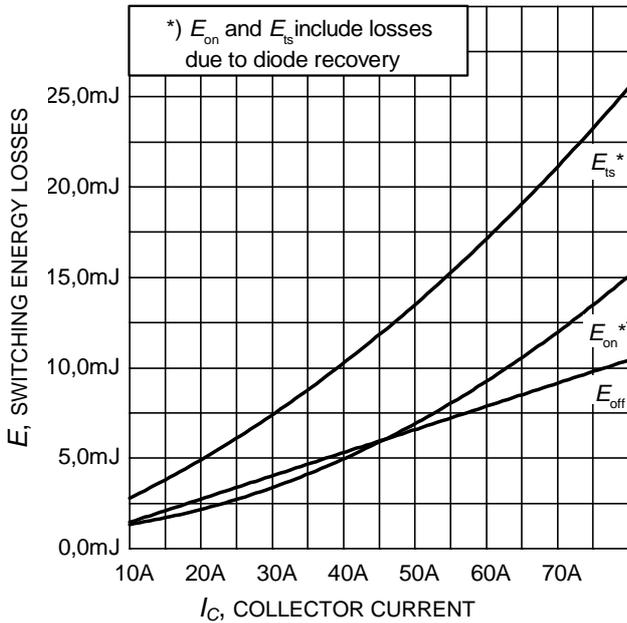
**Figure 13. Typical switching energy losses as a function of collector current**
(inductive load, $T_J$=150°C, $V_{CE}$=600V, $V_{GE}$=0/15V, $R_G$=15Ω, Dynamic test circuit in Figure E)
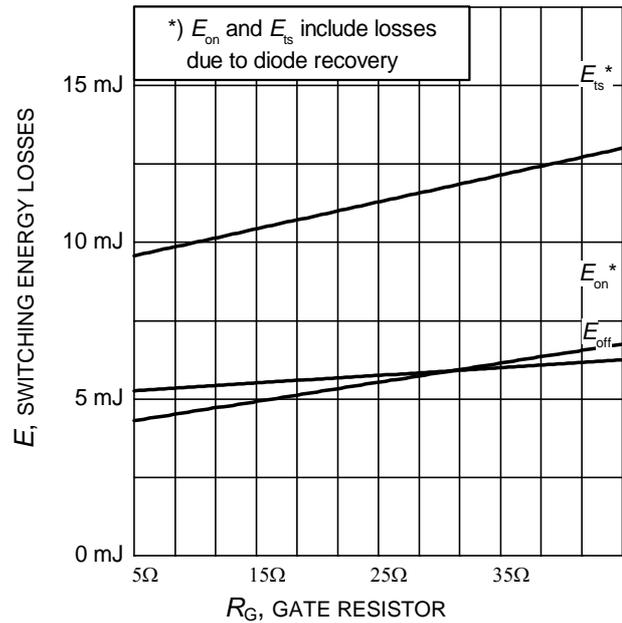


**Figure 14. Typical switching energy losses as a function of gate resistor**
(inductive load, $T_J$=150°C, $V_{CE}$=600V, $V_{GE}$=0/15V, $I_C$=40A, Dynamic test circuit in Figure E)
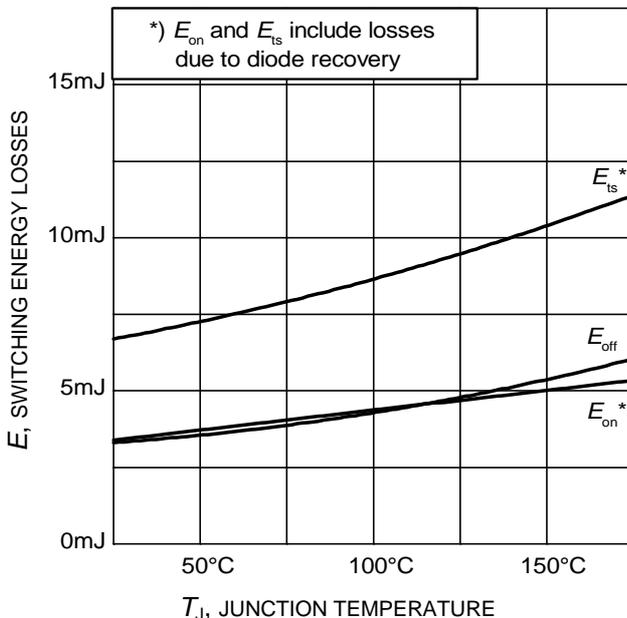


**Figure 15. Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}$=600V, $V_{GE}$=0/15V, $I_C$=40A, $R_G$=15Ω, Dynamic test circuit in Figure E)
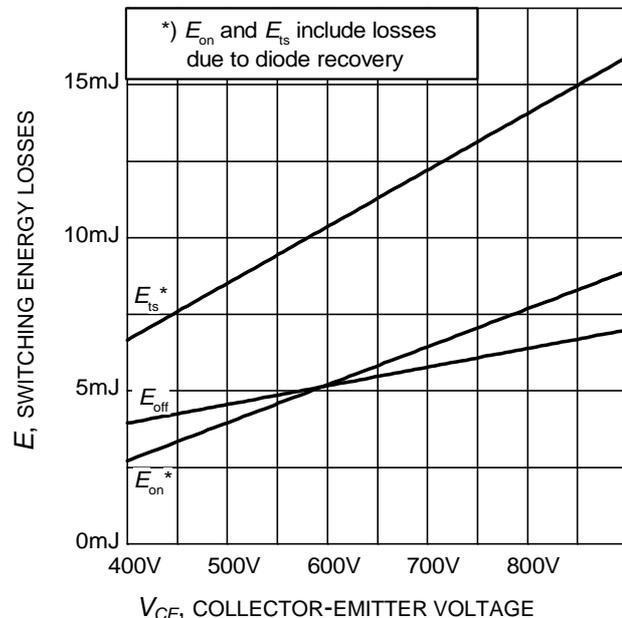


**Figure 16. Typical switching energy losses as a function of collector emitter voltage**
(inductive load, $T_J$=150°C, $V_{GE}$=0/15V, $I_C$=40A, $R_G$=15Ω, Dynamic test circuit in Figure E)
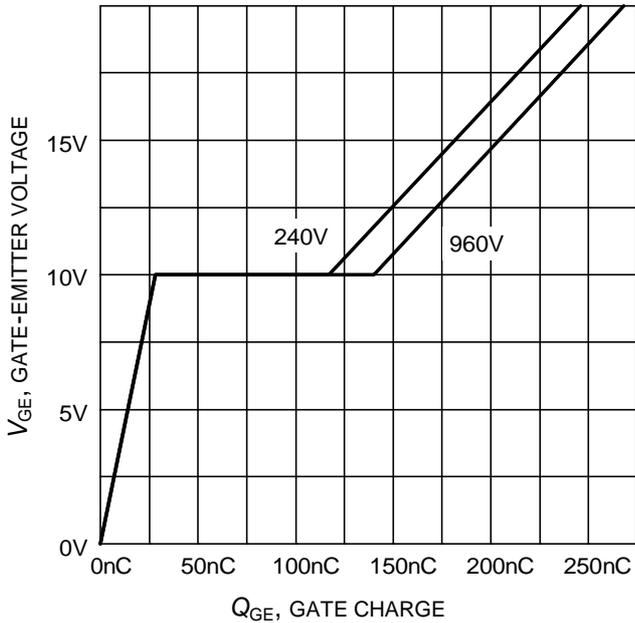
**Figure 17. Typical gate charge**
($I_C$=40 A)
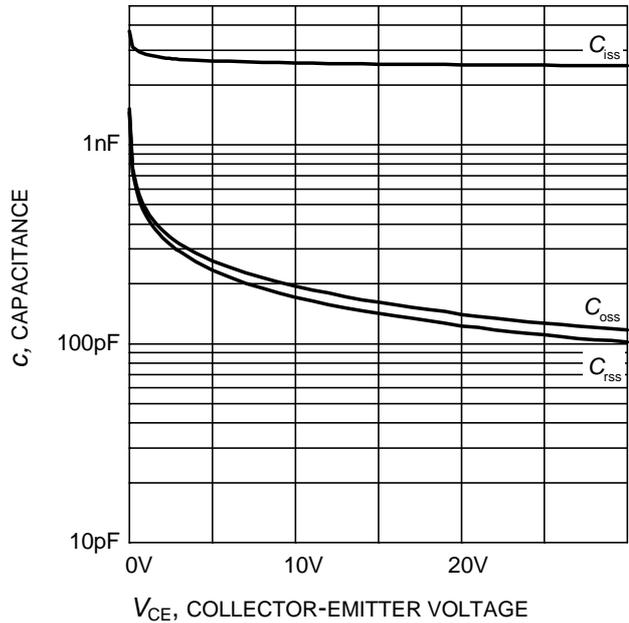


**Figure 18. Typical capacitance as a function of collector-emitter voltage**
($V_{GE}$=0V, $f$ = 1 MHz)
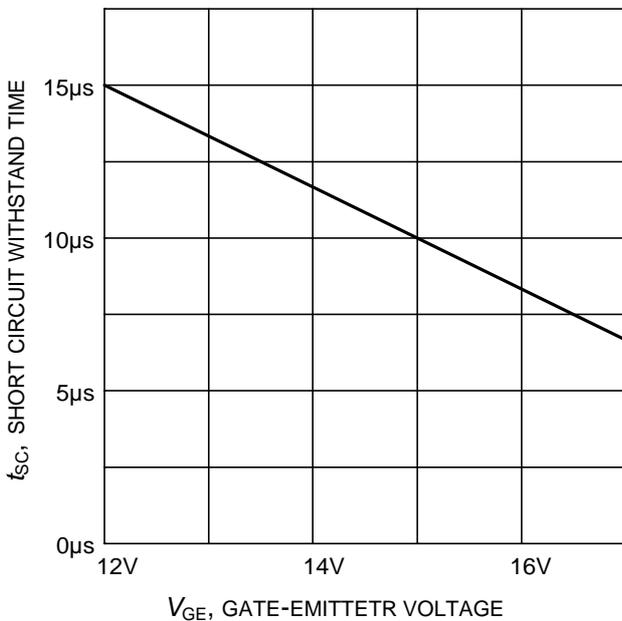


**Figure 19. Short circuit withstand time as a function of gate-emitter voltage**
($V_{CE}$=600V, start at $T_J$=25°C)
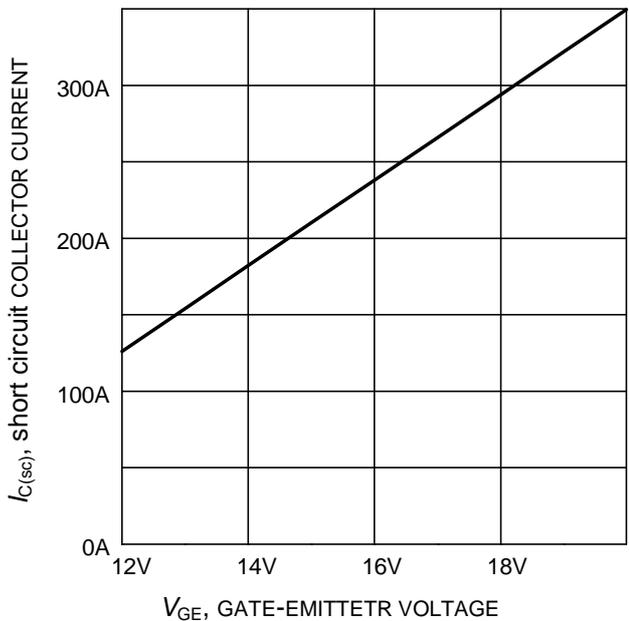


**Figure 20. Typical short circuit collector current as a function of gate-emitter voltage**
($V_{CE} \leq 600V$, $T_j \leq 150°C$)
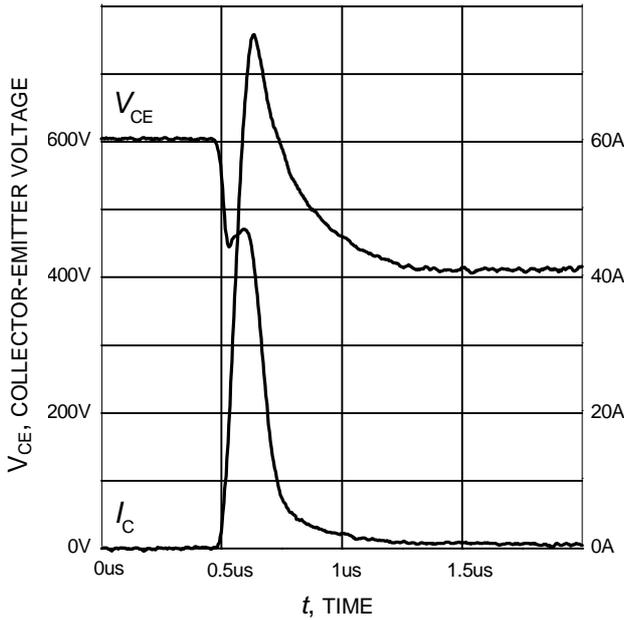
**Figure 21. Typical turn on behavior**
($V_{GE}$=0/15V, $R_G$=15Ω, $T_j$ = 150°C,
Dynamic test circuit in Figure E)
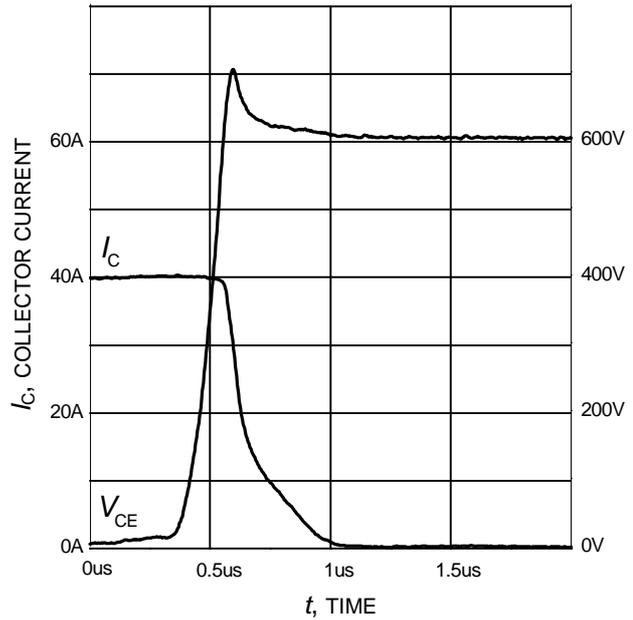


**Figure 22. Typical turn off behavior**
($V_{GE}$=15/0V, $R_G$=15Ω, $T_j$ = 150°C,
Dynamic test circuit in Figure E)



| $R$, ( K / W ) | $\tau$, ( s ) |
|---|---|
| 0.159 | $1.10*10^{-1}$ |
| 0.133 | $1.56*10^{-2}$ |
| 0.120 | $1.35*10^{-3}$ |
| 0.038 | $1.51*10^{-4}$ |
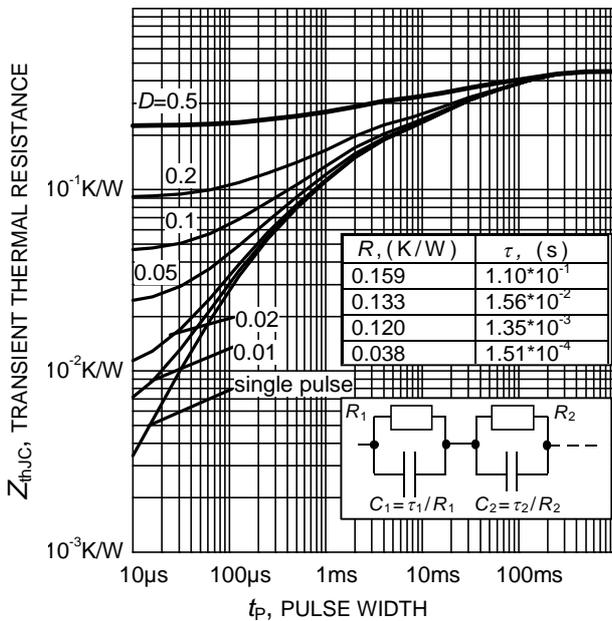
**Figure 23. IGBT transient thermal resistance**
($D = t_p / T$)



| $R$, ( K / W ) | $\tau$, ( s ) |
|---|---|
| 0.228 | $1.01*10^{-1}$ |
| 0.257 | $1.15*10^{-2}$ |
| 0.238 | $1.30*10^{-3}$ |
| 0.087 | $1.53*10^{-4}$ |
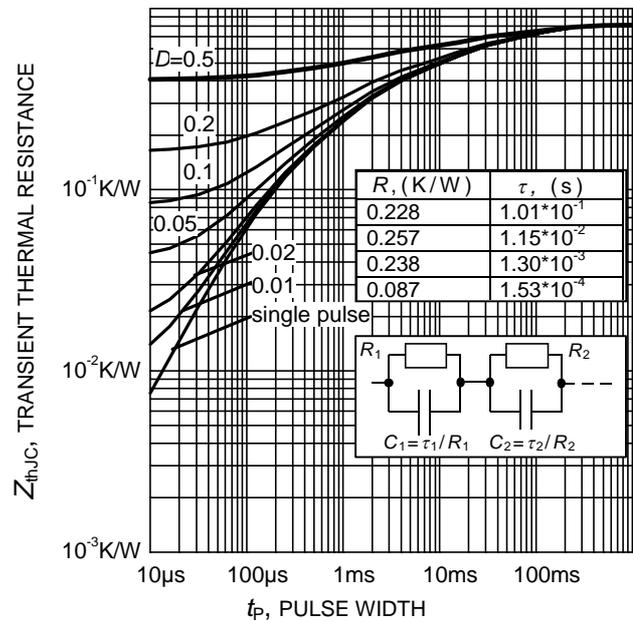
**Figure 24. Diode transient thermal
impedance as a function of pulse
width**
($D=t_P/T$)
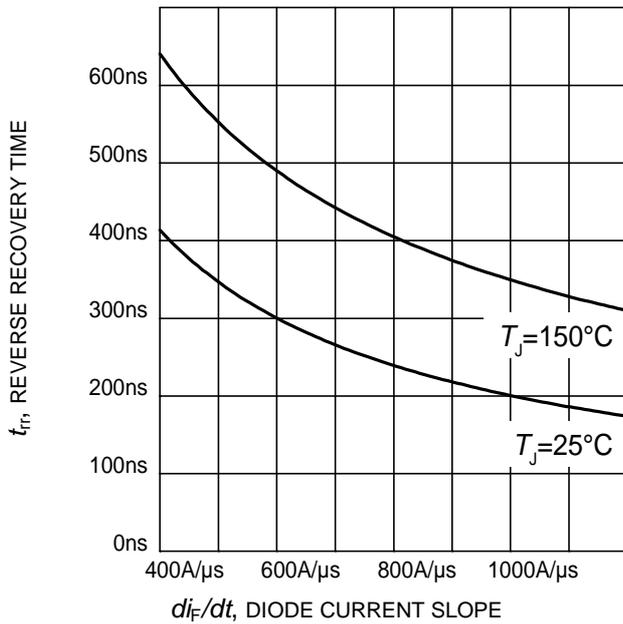
**Figure 23. Typical reverse recovery time as a function of diode current slope**
($V_R$=600V, $I_F$=40A,
Dynamic test circuit in Figure E)
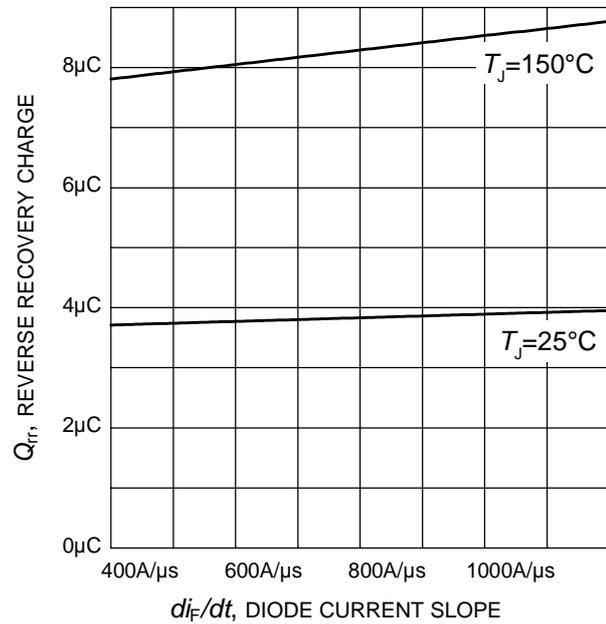


**Figure 24. Typical reverse recovery charge as a function of diode current slope**
($V_R$=600V, $I_F$=40A,
Dynamic test circuit in Figure E)
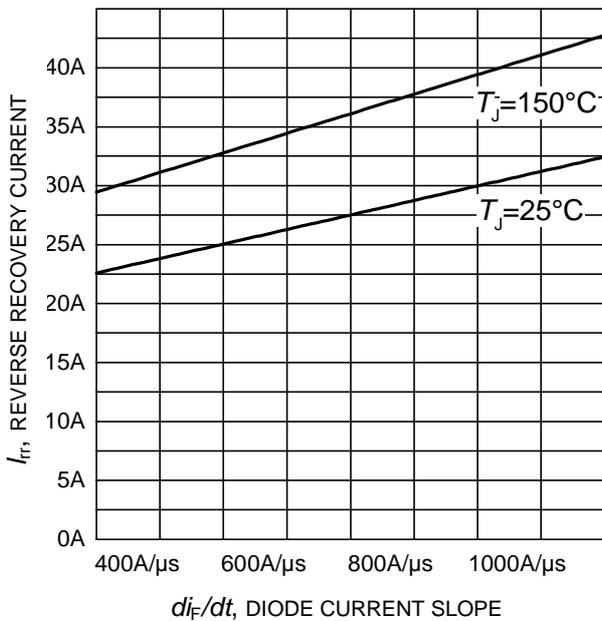


**Figure 25. Typical reverse recovery current as a function of diode current slope**
($V_R$=600V, $I_F$=40A,
Dynamic test circuit in Figure E)
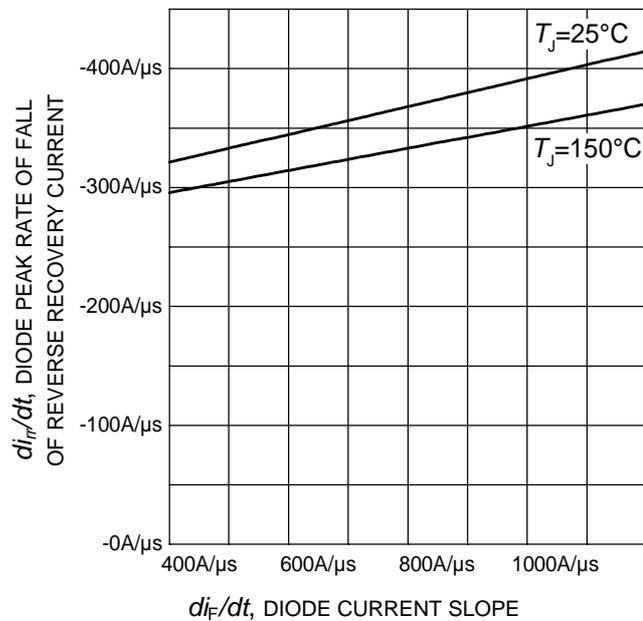


**Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R$=600V, $I_F$=40A,
Dynamic test circuit in Figure E)
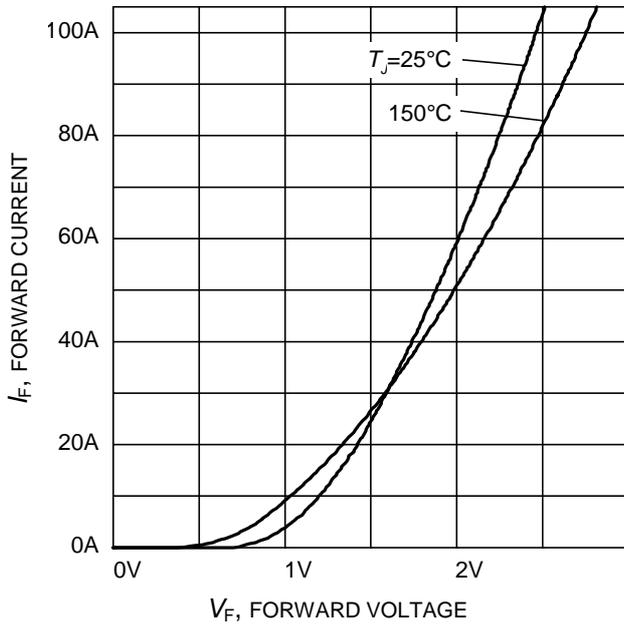
**Figure 27. Typical diode forward current as a function of forward voltage**
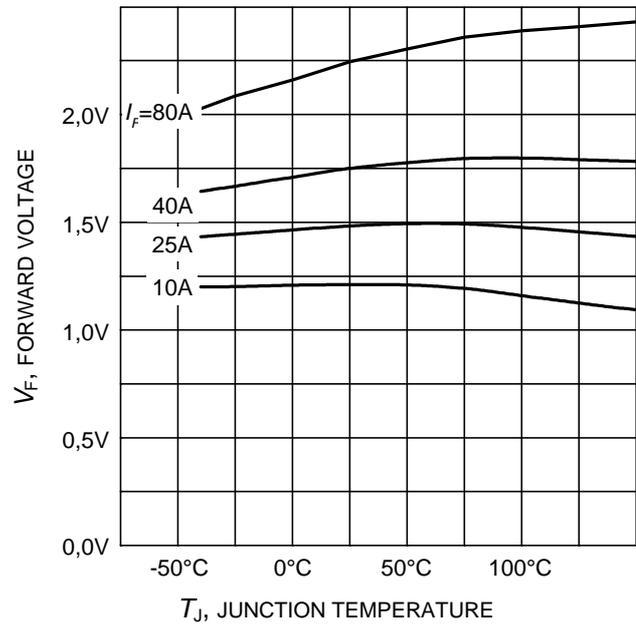


**Figure 28. Typical diode forward voltage as a function of junction temperature**

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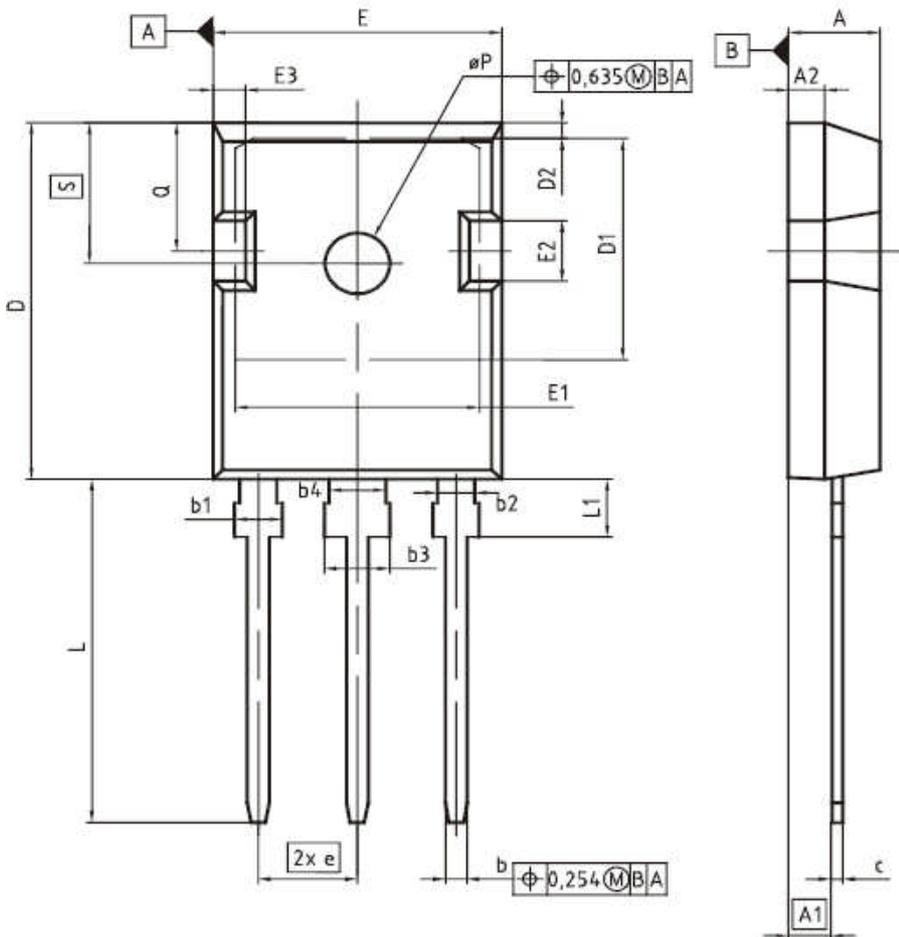


| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.83 | 5.21 | 0.190 | 0.205 |
| A1 | 2.27 | 2.54 | 0.089 | 0.100 |
| A2 | 1.85 | 2.16 | 0.073 | 0.085 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.90 | 2.41 | 0.075 | 0.095 |
| b2 | 1.90 | 2.16 | 0.075 | 0.085 |
| 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**

7.5mm

**EUROPEAN PROJECTION**

**ISSUE DATE**
09-07-2010

**REVISION**
05
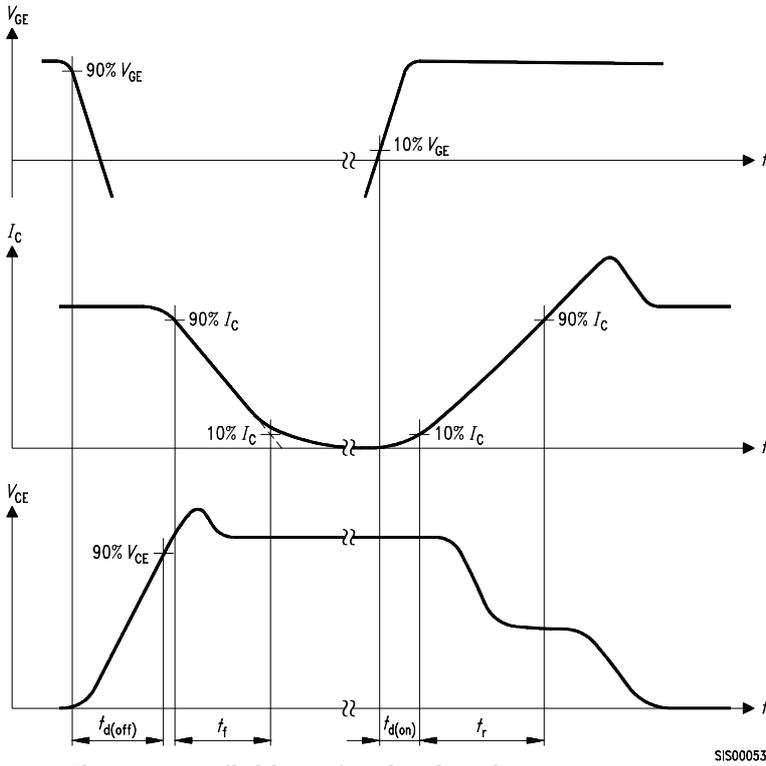
**Figure A. Definition of switching times**
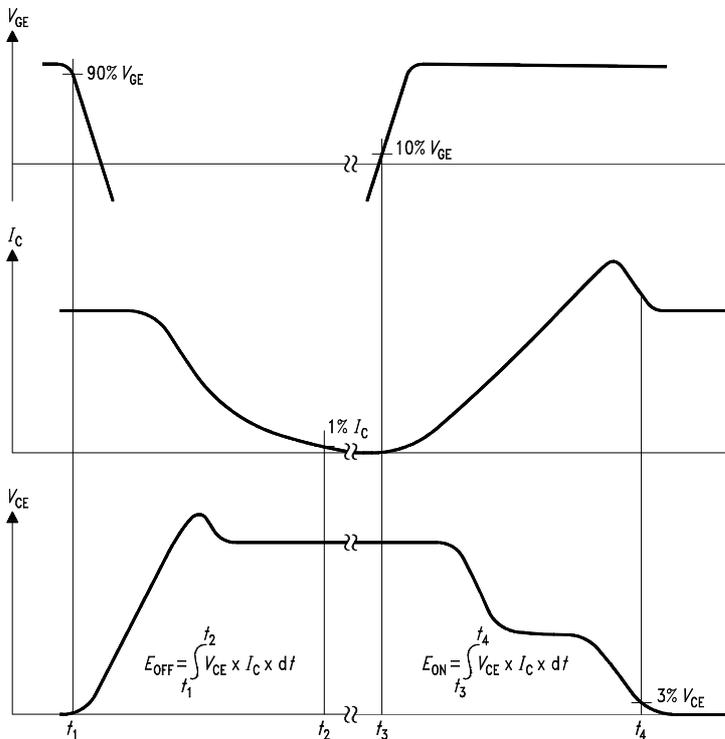


**Figure B. Definition of switching losses**

$$E_{OFF} = \int_{t_1}^{t_2} V_{CE} \times I_C \times dt$$

$$E_{ON} = \int_{t_3}^{t_4} V_{CE} \times I_C \times dt$$
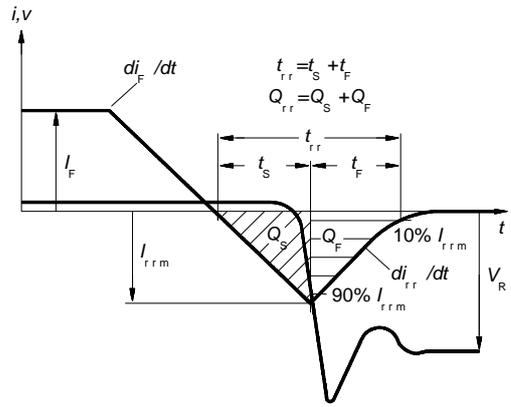


**Figure C. Definition of diodes switching characteristics**

$$t_{rr} = t_S + t_F$$
$$Q_{rr} = Q_S + Q_F$$
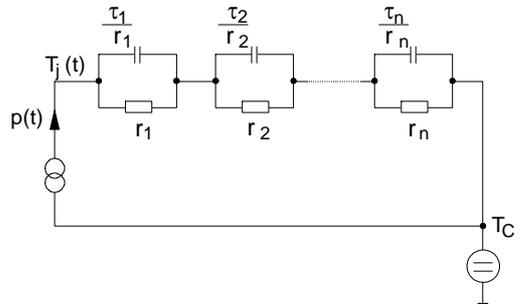


**Figure D. Thermal equivalent circuit**
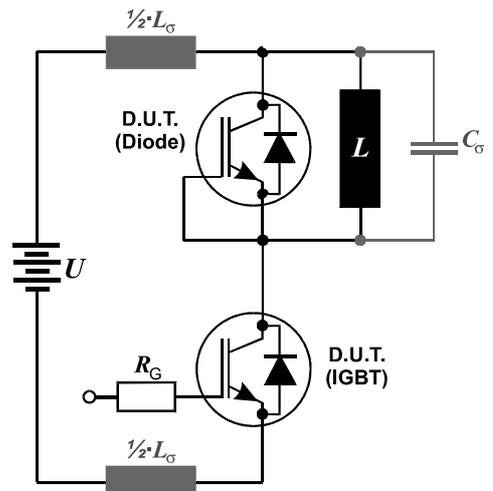


**Figure E. Dynamic test circuit**
Leakage inductance $L_\sigma$ =180nH
and Stray capacity $C_\sigma$ =39pF.