

IGBT

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

IKB20N60TA

600V low loss switching series third generation

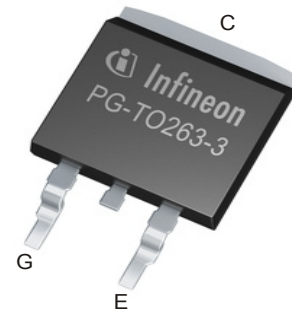
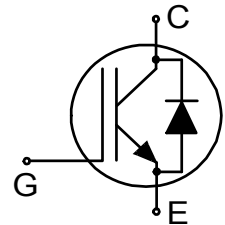
Data sheet

Industrial Power Control

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

Features:

- Automotive AEC Q101 qualified
- Designed for DC/AC converters for Automotive Application
- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum Junction Temperature 150 °C
- Short circuit withstand time 5µs
- TRENCHSTOP™ and Fieldstop technology for 600 V applications offers:
 - very tight parameter distribution
 - high ruggedness, temperature stable behavior
 - very high switching speed
- Positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Green Package



Key Performance and Package Parameters

| Type | V_{CE} | I_C | $V_{CEsat}, T_{vj}=25^{\circ}C$ | T_{vjmax} | Marking | Package |
|------------|----------|-------|---------------------------------|-------------|---------|------------|
| IKB20N60TA | 600V | 20A | 1.5V | 150°C | K20T60A | PG-TO263-3 |



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Maximum ratings

| Parameter | Symbol | Value | Unit |
|---|-------------|--------------|--------------------|
| Collector-emitter voltage, $T_{vj} \geq 25^{\circ}\text{C}$ | V_{CE} | 600 | V |
| DC collector current, limited by T_{vjmax} $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$ | I_C | 40.0 20.0 | A |
| Pulsed collector current, t_p limited by T_{vjmax} | I_{Cpuls} | 60.0 | A |
| Turn off safe operating area $V_{CE} \leq 600\text{V}$, $T_{vj} \leq 150^{\circ}\text{C}^{1)}$ | - | 60.0 | A |
| Diode forward current, limited by T_{vjmax} $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$ | I_F | 40.0 20.0 | A |
| Diode pulsed current, t_p limited by T_{vjmax} | I_{Fpuls} | 60.0 | A |
| Gate-emitter voltage | V_{GE} | ± 20 | V |
| Short circuit withstand time $V_{GE} = 15.0\text{V}$, $V_{CC} \leq 400\text{V}$ Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0\text{s}$ $T_{vj} = 150^{\circ}\text{C}$ | t_{SC} | 5 | μs |
| Power dissipation $T_C = 25^{\circ}\text{C}$ | P_{tot} | 156.0 | W |
| Operating junction temperature | T_{vj} | -40...+150 | $^{\circ}\text{C}$ |
| Storage temperature | T_{stg} | -40...+150 | $^{\circ}\text{C}$ |
| Soldering temperature, reflow soldering (MSL1 according to JEDEC J-STA-020) | | 260 | $^{\circ}\text{C}$ |

Thermal Resistance

| Parameter | Symbol | Conditions | Max. Value | Unit |
|---|---------------|------------|------------|------|
| Characteristic | | | | |
| IGBT thermal resistance, junction - case | $R_{th(j-c)}$ | | 0.90 | K/W |
| Diode thermal resistance, junction - case | $R_{th(j-c)}$ | | 1.50 | K/W |
| Thermal resistance, min. footprint junction - ambient | $R_{th(j-a)}$ | | 65 | K/W |
| Thermal resistance, 6cm ² Cu on PCB junction - ambient | $R_{th(j-a)}$ | | 40 | K/W |

¹⁾ $t_p \leq 1\mu\text{s}$

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 | $V_{(BR)CES}$ | $V_{GE} = 0\text{V}, I_C = 0.20\text{mA}$ | 600 | - | - | V |
| Collector-emitter saturation voltage | V_{CESat} | $V_{GE} = 15.0\text{V}, I_C = 20.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ | - - | 1.50 1.85 | 2.05 - | V |
| Diode forward voltage | V_F | $V_{GE} = 0\text{V}, I_F = 20.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ | - - | 1.65 1.65 | 2.05 - | V |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C = 0.29\text{mA}, V_{CE} = V_{GE}$ | 4.1 | 4.9 | 5.7 | V |
| Zero gate voltage collector current | I_{CES} | $V_{CE} = 600\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$ | - - | - - | 40.0 1500.0 | μA |
| Gate-emitter leakage current | I_{GES} | $V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$ | - | - | 100 | nA |
| Transconductance | g_{fs} | $V_{CE} = 20\text{V}, I_C = 20.0\text{A}$ | - | 11.0 | - | S |
| Integrated gate resistor | r_G | | | none | | Ω |

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} | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$ | - | 1100 | - | pF |
| Output capacitance | C_{oes} | | - | 71 | - | |
| Reverse transfer capacitance | C_{res} | | - | 32 | - | |
| Gate charge | Q_G | $V_{CC} = 480\text{V}, I_C = 20.0\text{A},$ $V_{GE} = 15\text{V}$ | - | 120.0 | - | nC |
| Internal emitter inductance measured 5mm (0.197 in.) from case | L_E | | - | 7.0 | - | nH |
| Short circuit collector current Max. 1000 short circuits Time between short circuits: $\geq 1.0\text{s}$ | $I_{C(SC)}$ | $V_{GE} = 15.0\text{V}, V_{CC} \leq 400\text{V},$ $t_{SC} \leq 5\mu\text{s}$ $T_{vj} = 150^{\circ}\text{C}$ | - | 183 | - | A |

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 | $t_{d(on)}$ | $T_{vj} = 25^{\circ}\text{C}$, $V_{CC} = 600\text{V}$, $I_C = 20.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $r_G = 12.0\Omega$, $L\sigma = 131\text{nH}$, $C\sigma = 31\text{pF}$ $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery. | - | 18 | - | ns |
| Rise time | t_r | | - | 14 | - | ns |
| Turn-off delay time | $t_{d(off)}$ | | - | 199 | - | ns |
| Fall time | t_f | | - | 42 | - | ns |
| Turn-on energy | E_{on} | | - | 0.31 | - | mJ |
| Turn-off energy | E_{off} | | - | 0.46 | - | mJ |
| Total switching energy | E_{ts} | | - | 0.77 | - | mJ |

Diode Characteristic, at $T_{vj} = 25^{\circ}\text{C}$

| | | | | | | |
|--|--------------|---|---|------|---|------------------|
| Diode reverse recovery time | t_{rr} | $T_{vj} = 25^{\circ}\text{C}$, $V_R = 600\text{V}$, $I_F = 20.0\text{A}$, $di_F/dt = 880\text{A}/\mu\text{s}$ | - | 41 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 0.31 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 13.3 | - | A |
| Diode peak rate of fall of reverse recovery current during t_b | di_{rr}/dt | | - | 711 | - | A/ μs |

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 | $t_{d(on)}$ | $T_{vj} = 150^{\circ}\text{C}$, $V_{CC} = 600\text{V}$, $I_C = 20.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $r_G = 12.0\Omega$, $L\sigma = 131\text{nH}$, $C\sigma = 31\text{pF}$ $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery. | - | 18 | - | ns |
| Rise time | t_r | | - | 17 | - | ns |
| Turn-off delay time | $t_{d(off)}$ | | - | 217 | - | ns |
| Fall time | t_f | | - | 70 | - | ns |
| Turn-on energy | E_{on} | | - | 0.47 | - | mJ |
| Turn-off energy | E_{off} | | - | 0.60 | - | mJ |
| Total switching energy | E_{ts} | | - | 1.07 | - | mJ |

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

| | | | | | | |
|--|--------------|--|---|------|---|------------------|
| Diode reverse recovery time | t_{rr} | $T_{vj} = 150^{\circ}\text{C}$, $V_R = 600\text{V}$, $I_F = 20.0\text{A}$, $di_F/dt = 800\text{A}/\mu\text{s}$ | - | 201 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 1.28 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 16.6 | - | A |
| Diode peak rate of fall of reverse recovery current during t_b | di_{rr}/dt | | - | 481 | - | A/ μs |

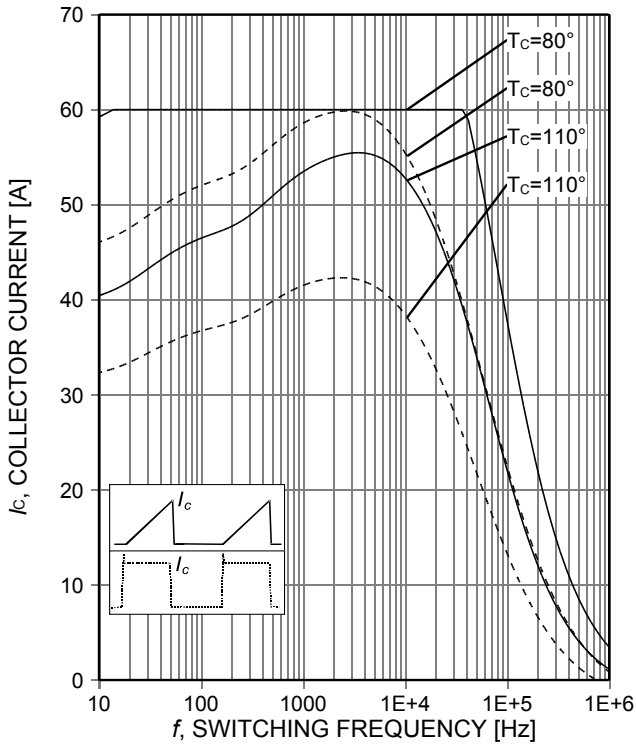


Figure 1. **Collector current as a function of switching frequency**
 ($T_j \leq 150^\circ\text{C}$, $D=0.5$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $R_G=12\Omega$)

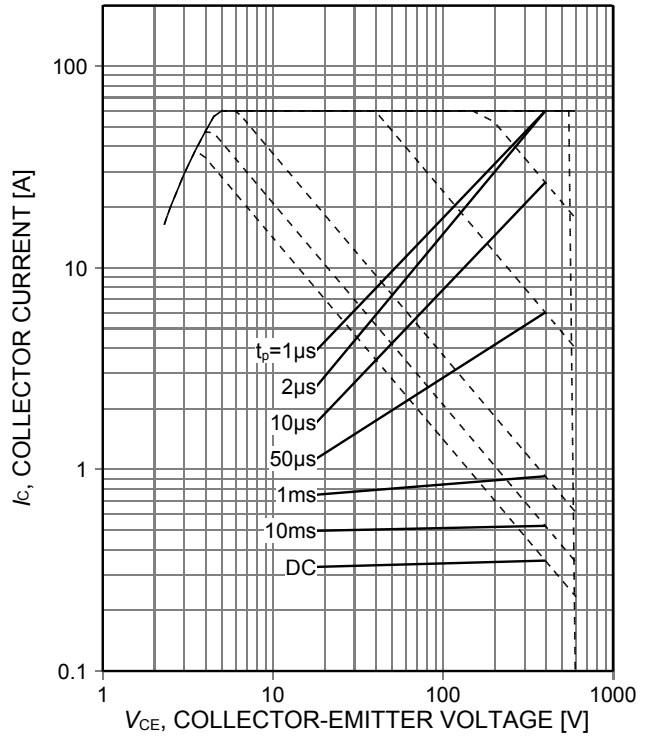


Figure 2. **Safe operating area**
 ($D=0$, $T_C=25^\circ\text{C}$, $T_j \leq 150^\circ\text{C}$; $V_{GE}=15\text{V}$)

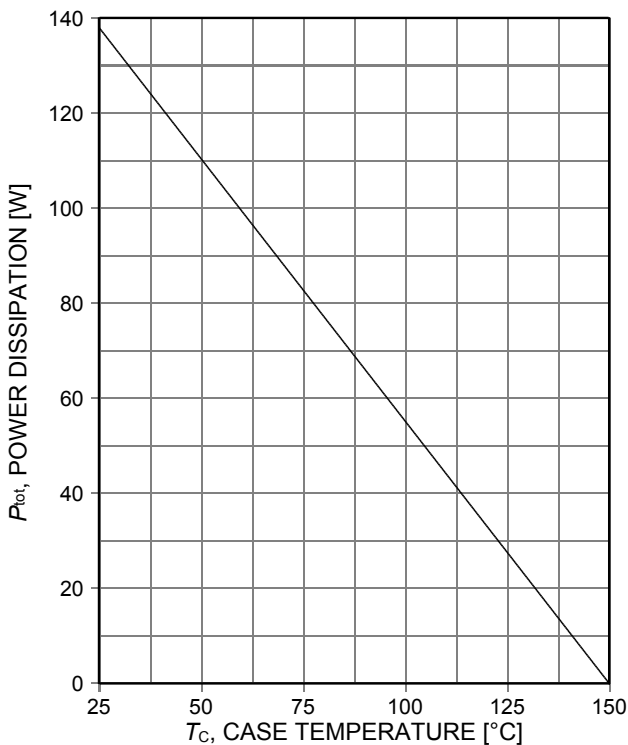


Figure 3. **Power dissipation as a function of case temperature**
 ($T_j \leq 150^\circ\text{C}$)

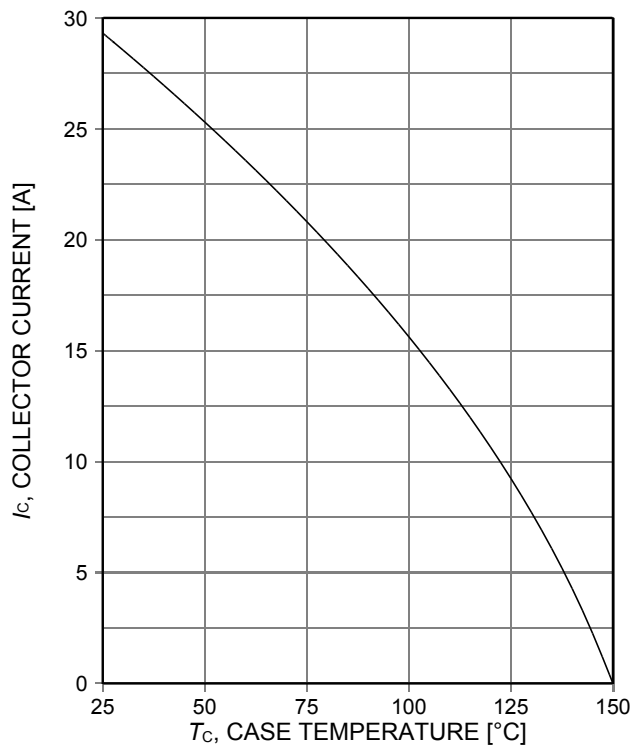


Figure 4. **Collector current as a function of case temperature**
 ($V_{GE} \geq 15\text{V}$, $T_j \leq 150^\circ\text{C}$)

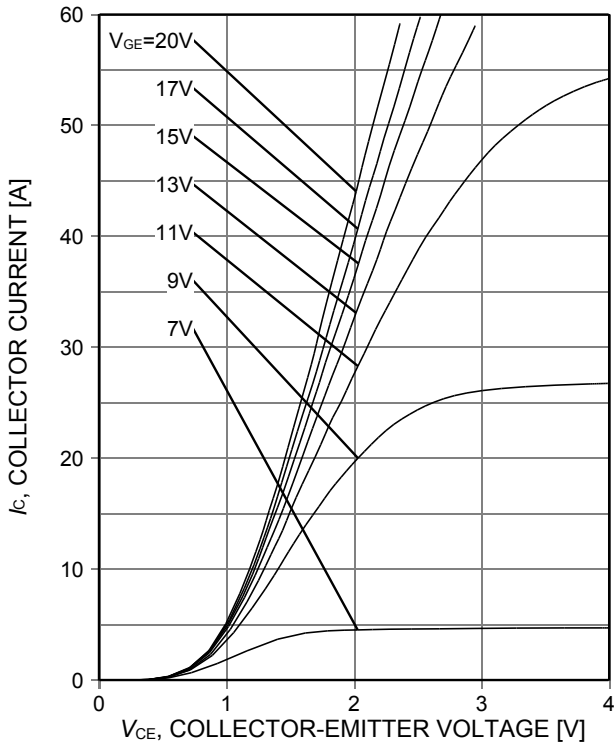


Figure 5. **Typical output characteristic**
($T_j=25^\circ\text{C}$)

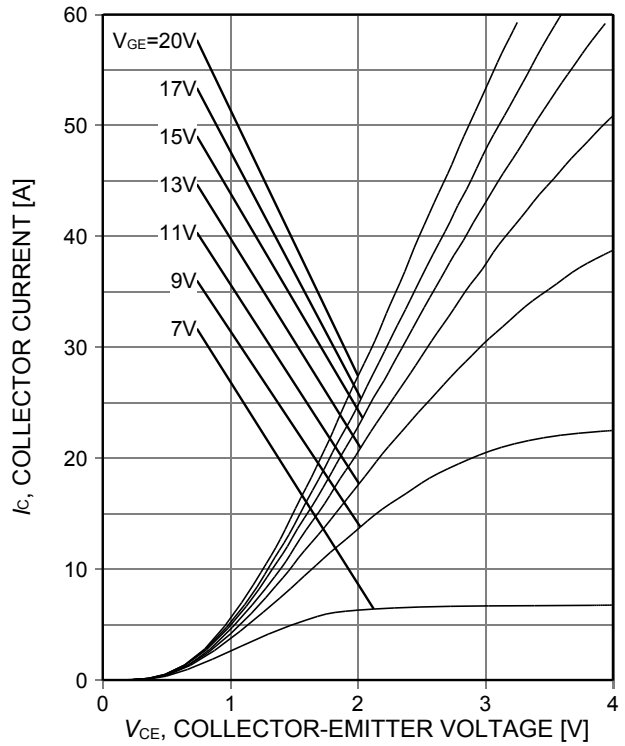


Figure 6. **Typical output characteristic**
($T_j=150^\circ\text{C}$)

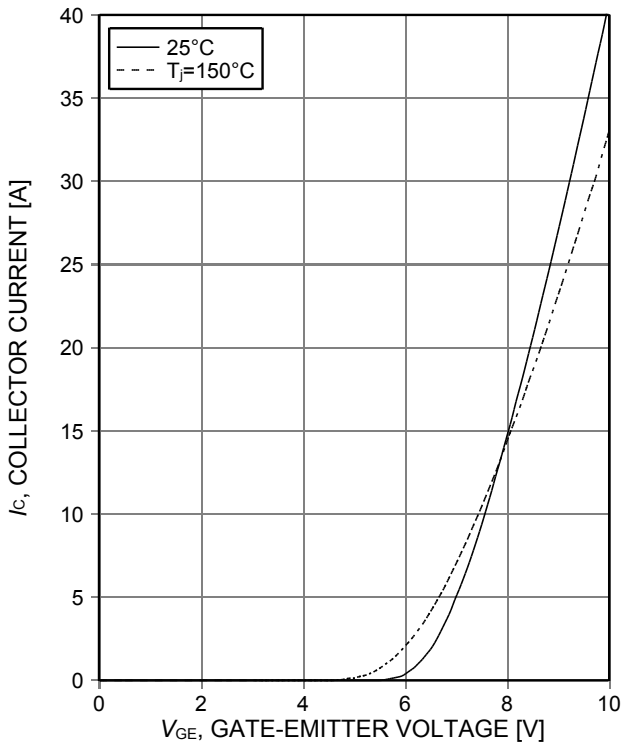


Figure 7. **Typical transfer characteristic**
($V_{CE}=10\text{V}$)

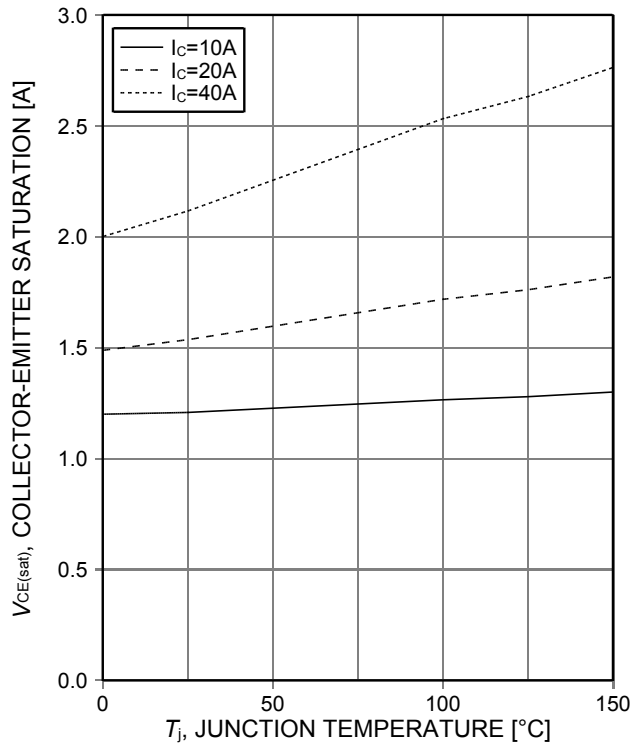


Figure 8. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}=15\text{V}$)

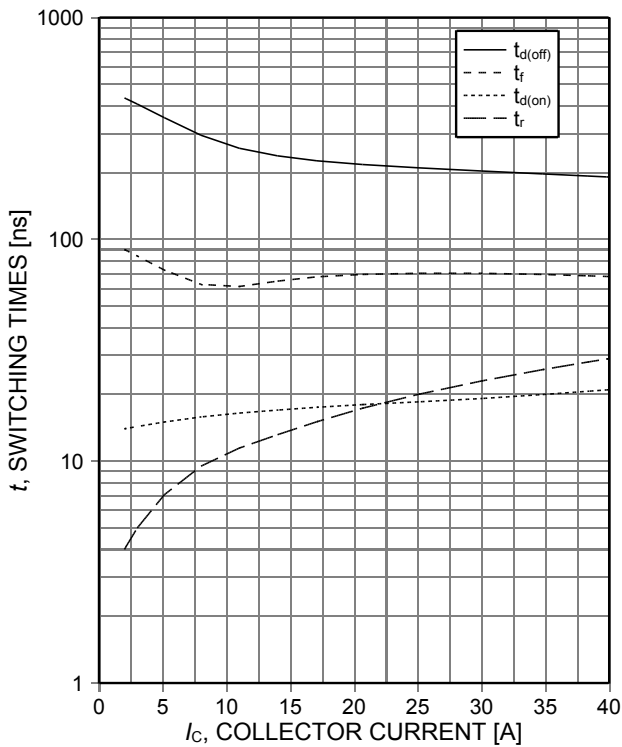


Figure 9. **Typical switching times as a function of collector current**
(inductive load, $T_j=150^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $R_G=12\Omega$, Dynamic test circuit in Figure E)

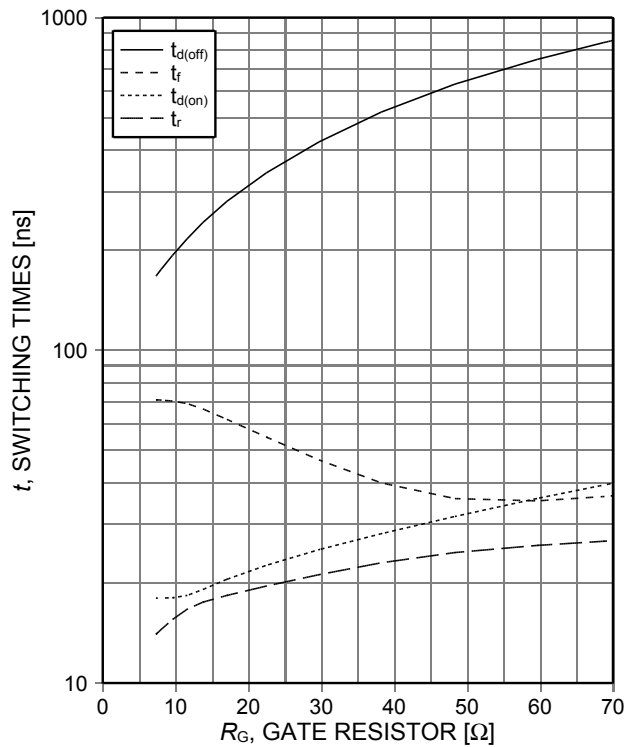


Figure 10. **Typical switching times as a function of gate resistor**
(inductive load, $T_j=150^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=20\text{A}$, Dynamic test circuit in Figure E)

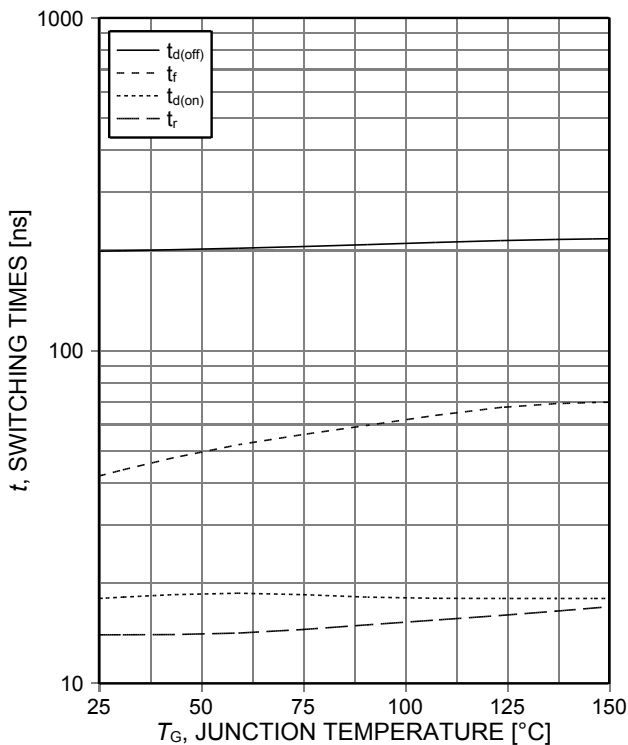


Figure 11. **Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=20\text{A}$, $R_G=12\Omega$, Dynamic test circuit in Figure E)

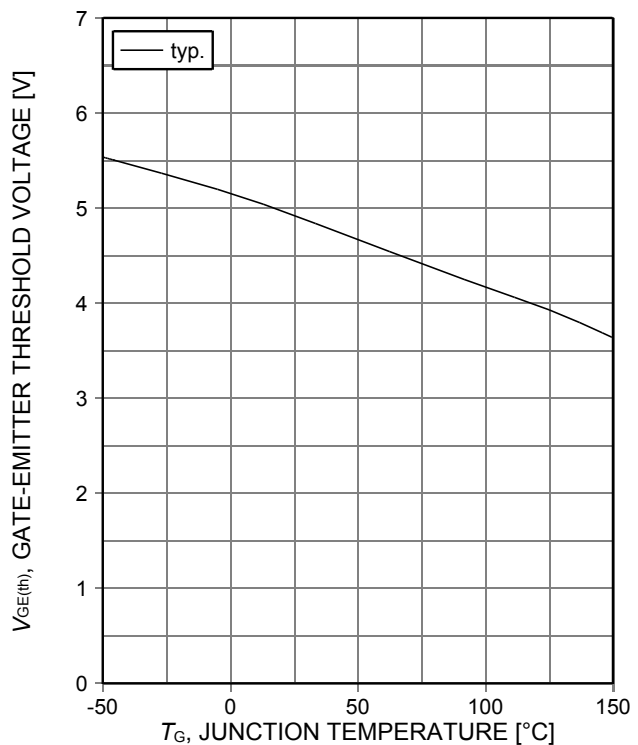


Figure 12. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C=0.29\text{mA}$)

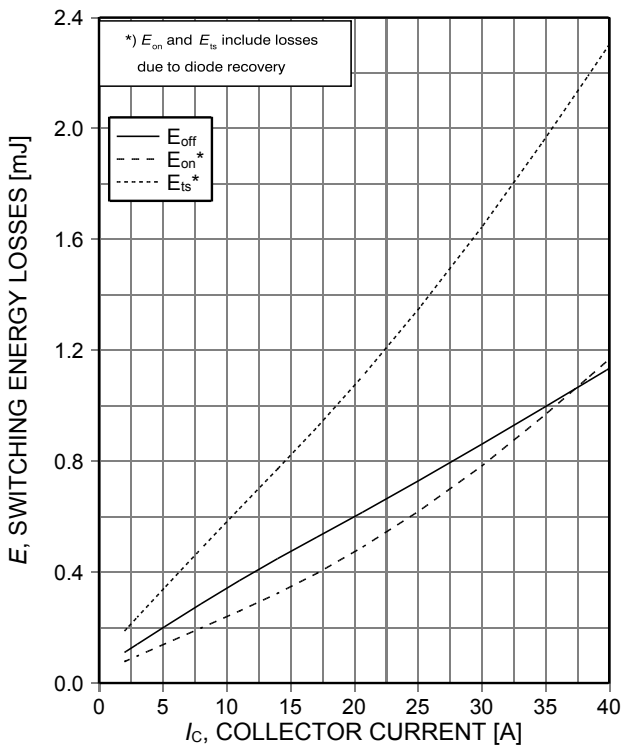


Figure 13. **Typical switching energy losses as a function of collector current**
 (inductive load, $T_j=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $R_G=12\Omega$, Dynamic test circuit in Figure E)

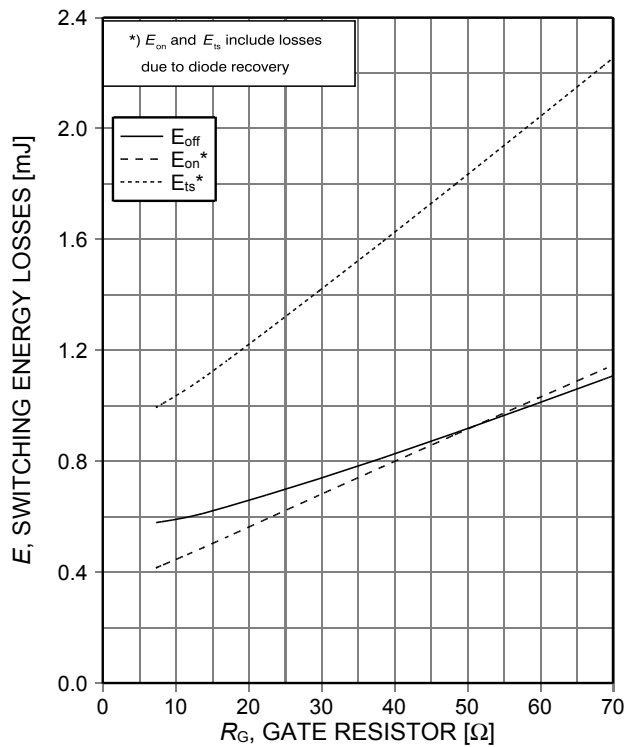


Figure 14. **Typical switching energy losses as a function of gate resistor**
 (inductive load, $T_j=150^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=20\text{A}$, Dynamic test circuit in Figure E)

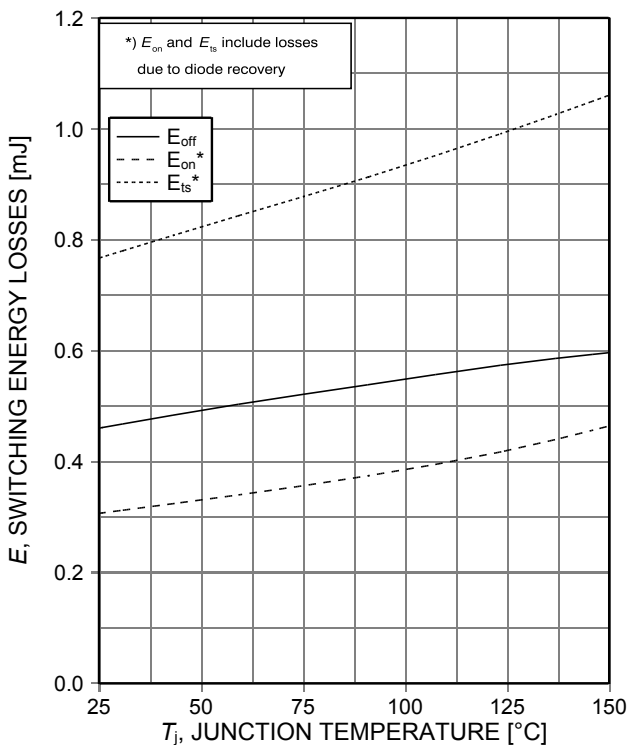


Figure 15. **Typical switching energy losses as a function of junction temperature**
 (inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=20\text{A}$, $R_G=12\Omega$, Dynamic test circuit in Figure E)

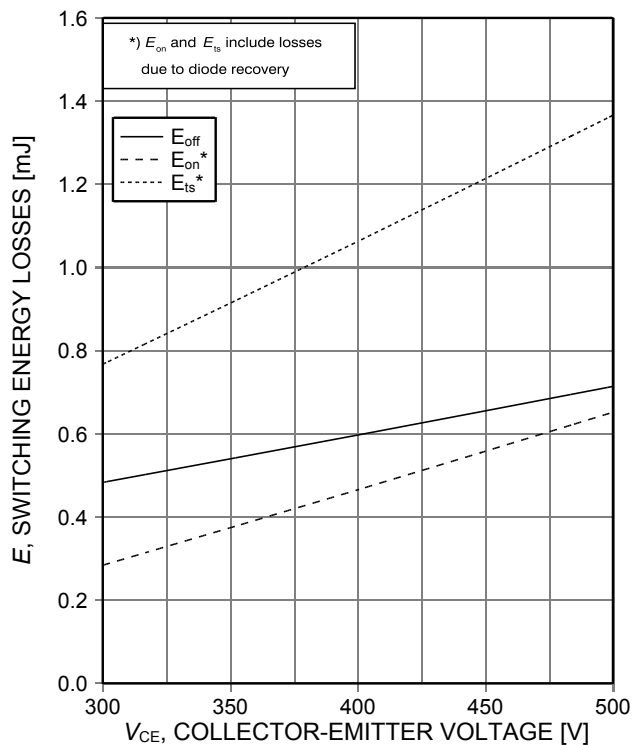


Figure 16. **Typical switching energy losses as a function of collector emitter voltage**
 (inductive load, $T_j=150^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=20\text{A}$, $R_G=12\Omega$, Dynamic test circuit in Figure E)

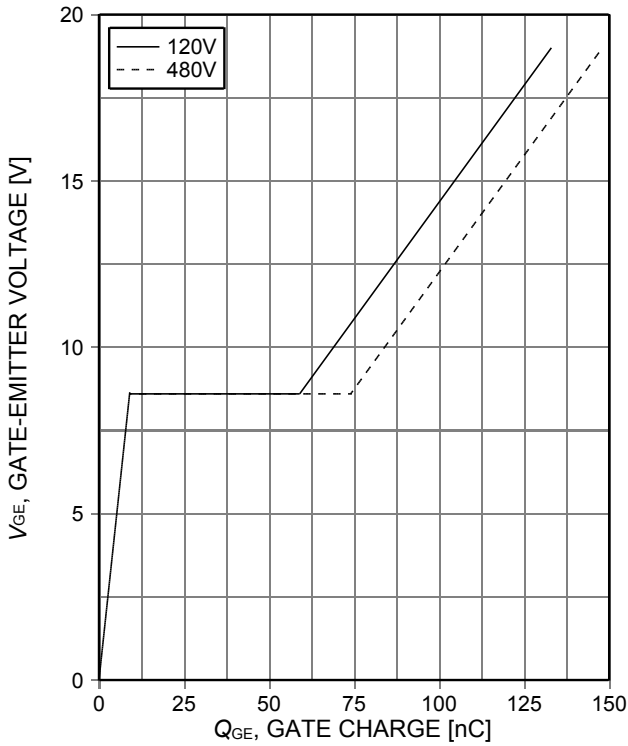


Figure 17. **Typical gate charge**
($I_C=20A$)

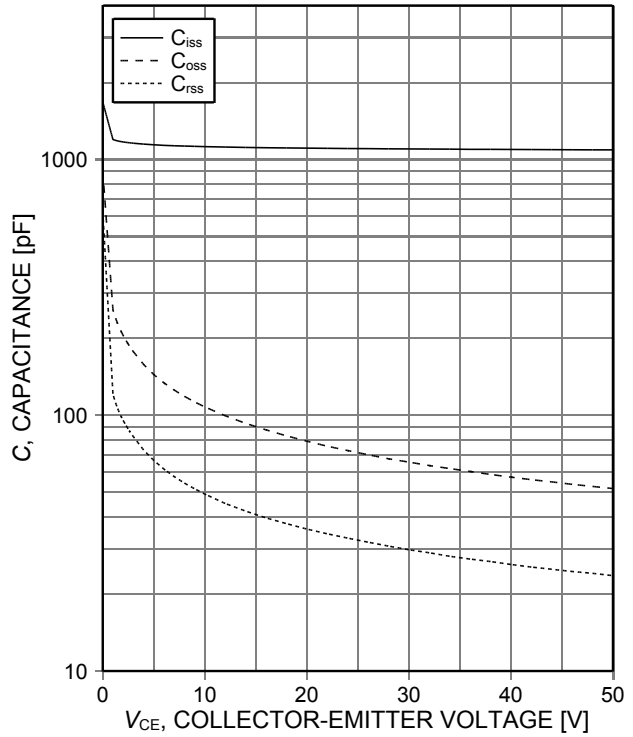


Figure 18. **Typical capacitance as a function of collector-emitter voltage**
($V_{GE}=0V, f=1MHz$)

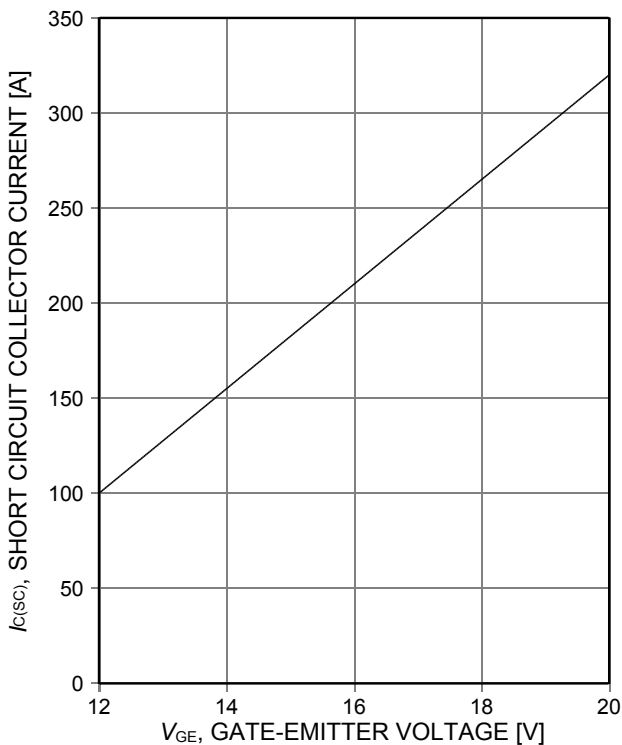


Figure 19. **Typical short circuit collector current as a function of gate-emitter voltage**
($V_{CE}\leq 400V, T_j\leq 150^\circ C$)

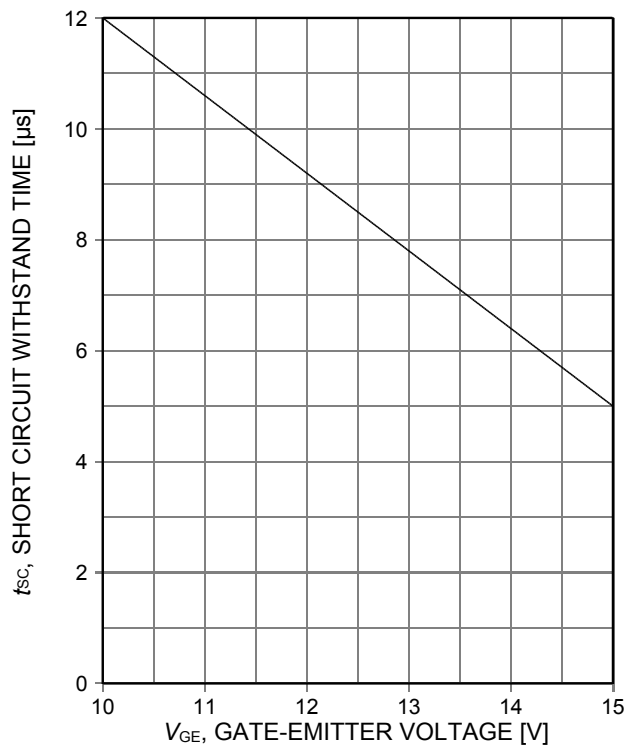


Figure 20. **Short circuit withstand time as a function of gate-emitter voltage**
($V_{CE}=400V, \text{start at } T_j=25^\circ C, T_{jmax}\leq 150^\circ C$)

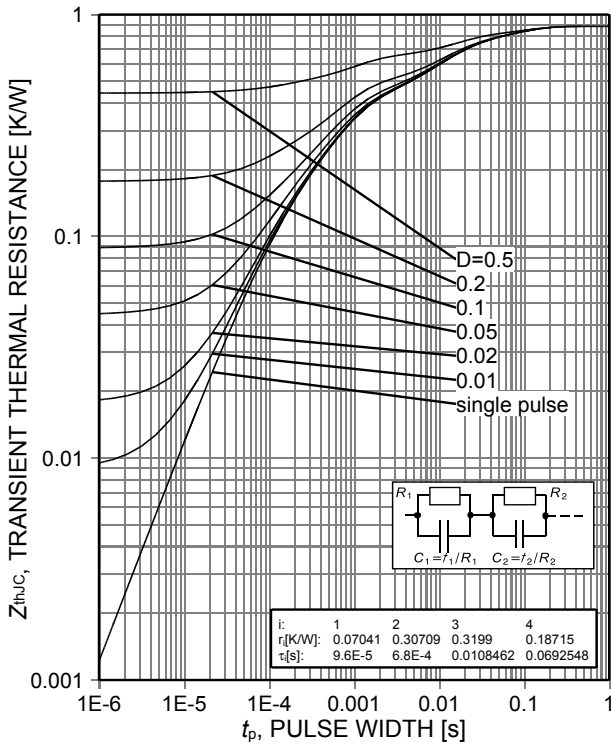


Figure 21. IGBT transient thermal resistance as a function of pulse width for different duty cycles D ($D=t_p/T$)

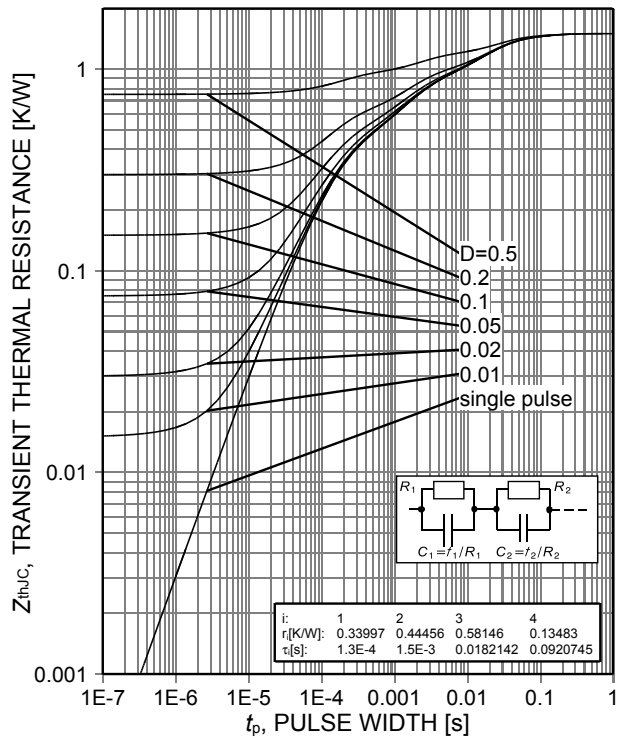


Figure 22. Diode transient thermal impedance as a function of pulse width for different duty cycles D ($D=t_p/T$)

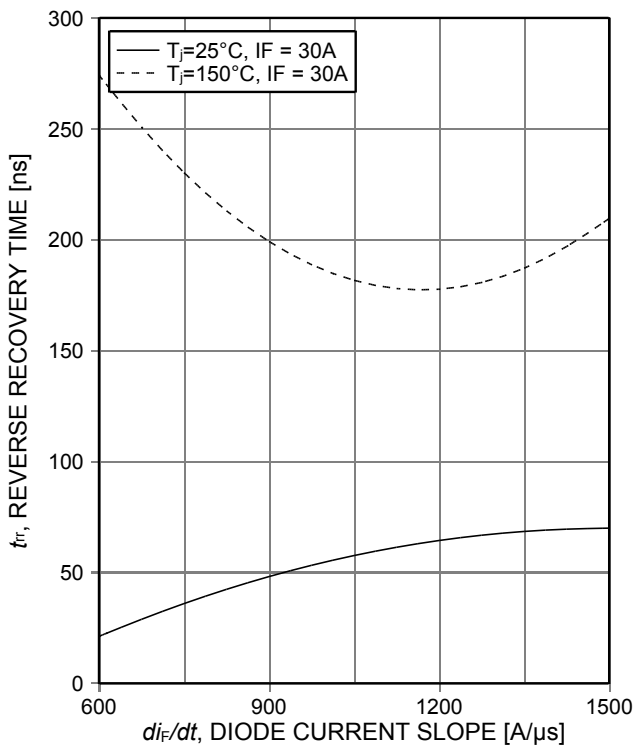


Figure 23. Typical reverse recovery time as a function of diode current slope ($V_R=400V$, Dynamic test circuit in Figure E)

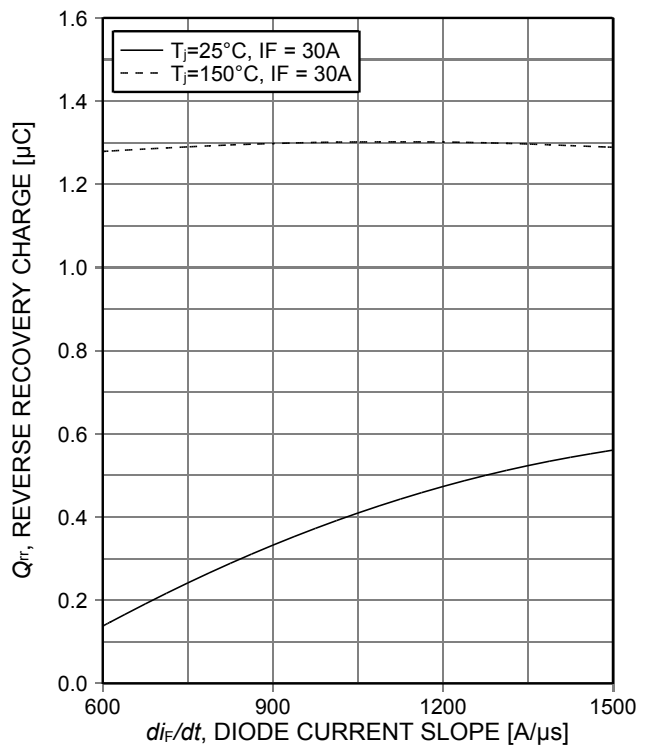


Figure 24. Typical reverse recovery charge as a function of diode current slope ($V_R=400V$, Dynamic test circuit in Figure E)

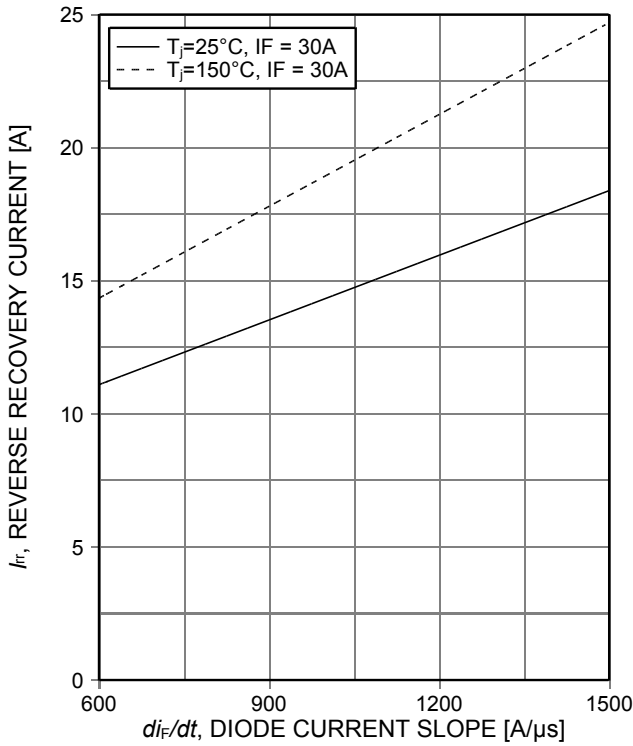


Figure 25. **Typical reverse recovery current as a function of diode current slope**
($V_R=400V$, Dynamic test circuit in Figure E)

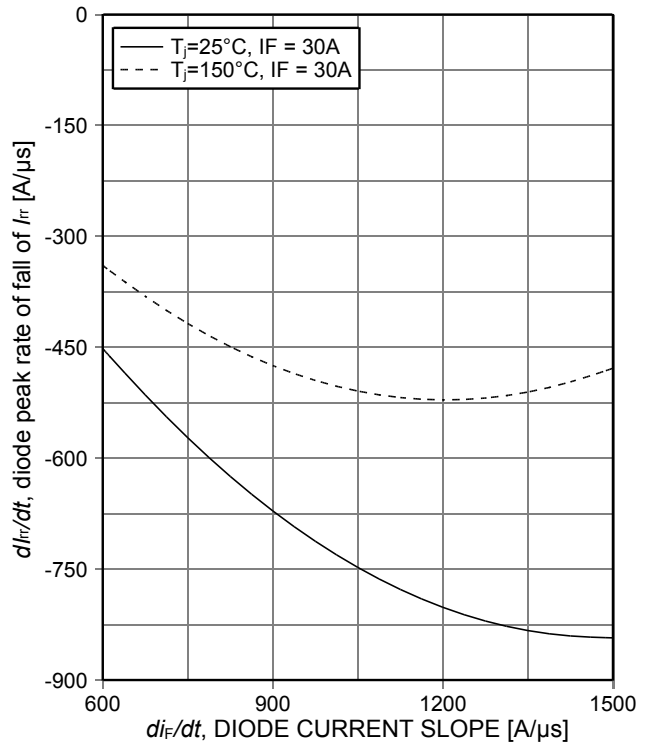


Figure 26. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R=400V$, Dynamic test circuit in Figure E)

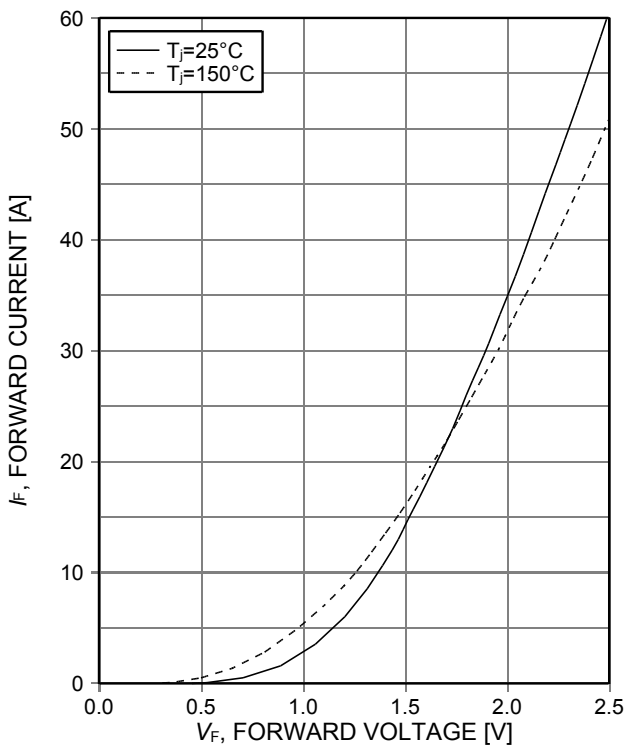


Figure 27. **Typical diode forward current as a function of forward voltage**

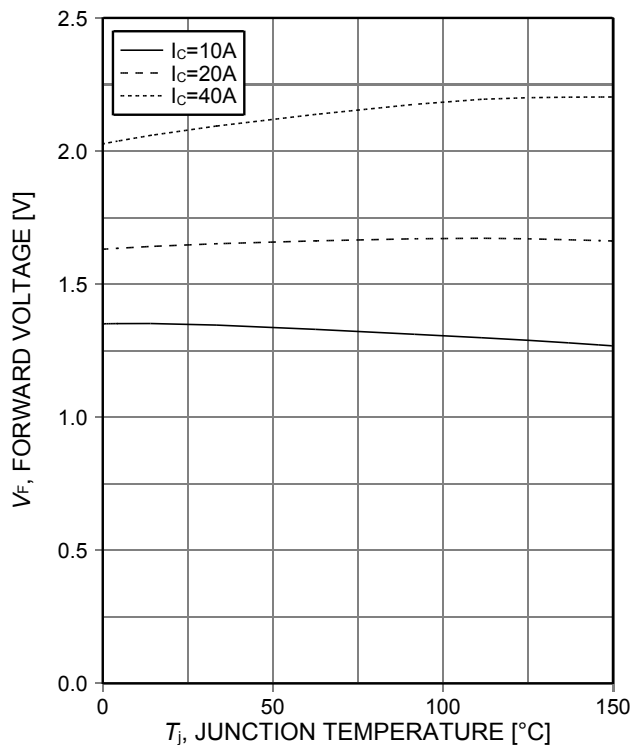
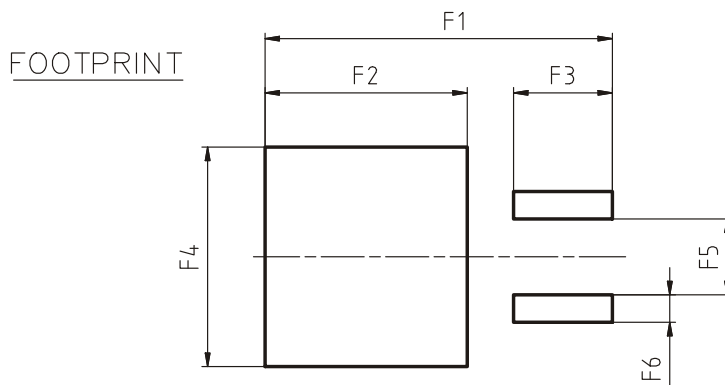
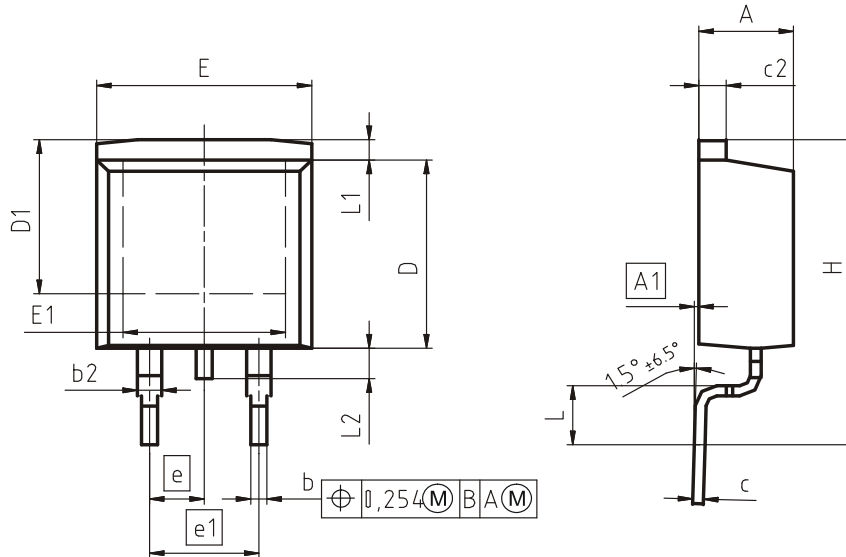


Figure 28. **Typical diode forward voltage as a function of junction temperature**

PG-TO263-3



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.30 | 4.57 | 0.169 | 0.180 |
| A1 | 0.00 | 0.25 | 0.000 | 0.010 |
| b | 0.65 | 0.85 | 0.026 | 0.033 |
| b2 | 0.95 | 1.15 | 0.037 | 0.045 |
| c | 0.33 | 0.65 | 0.013 | 0.026 |
| c2 | 1.17 | 1.40 | 0.046 | 0.055 |
| D | 8.51 | 9.45 | 0.335 | 0.372 |
| D1 | 7.10 | 7.90 | 0.280 | 0.311 |
| E | 9.80 | 10.31 | 0.386 | 0.406 |
| E1 | 6.50 | 8.60 | 0.256 | 0.339 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 2 | | 2 | |
| H | 14.61 | 15.88 | 0.575 | 0.625 |
| L | 2.29 | 3.00 | 0.090 | 0.118 |
| L1 | 0.70 | 1.60 | 0.028 | 0.063 |
| L2 | 1.00 | 1.78 | 0.039 | 0.070 |
| F1 | 16.05 | 16.25 | 0.632 | 0.640 |
| F2 | 9.30 | 9.50 | 0.366 | 0.374 |
| F3 | 4.50 | 4.70 | 0.177 | 0.185 |
| F4 | 10.70 | 10.90 | 0.421 | 0.429 |
| F5 | 3.65 | 3.85 | 0.144 | 0.152 |
| F6 | 1.25 | 1.45 | 0.049 | 0.057 |

DOCUMENT NO.
Z8B00003324

SCALE

7.5mm

EUROPEAN PROJECTION

ISSUE DATE
30-08-2007

REVISION
01

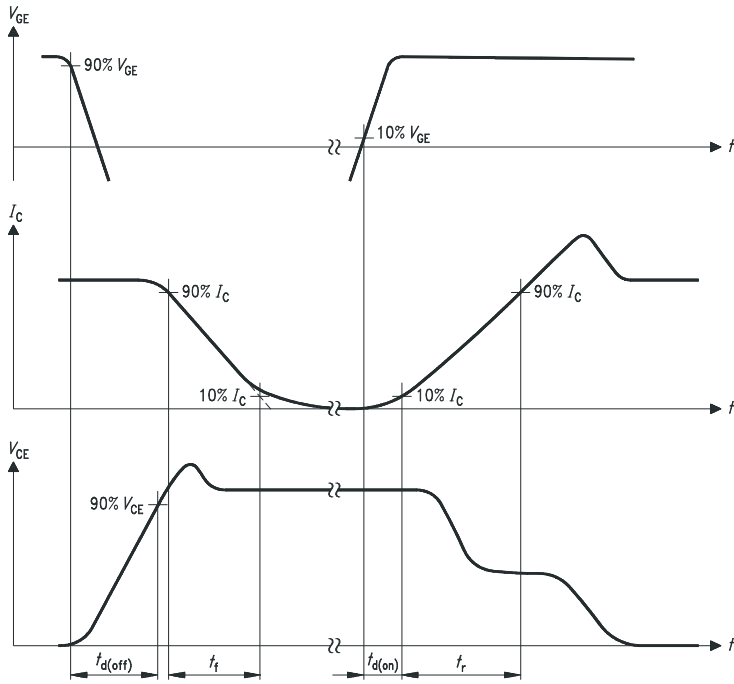


Figure A. Definition of switching times

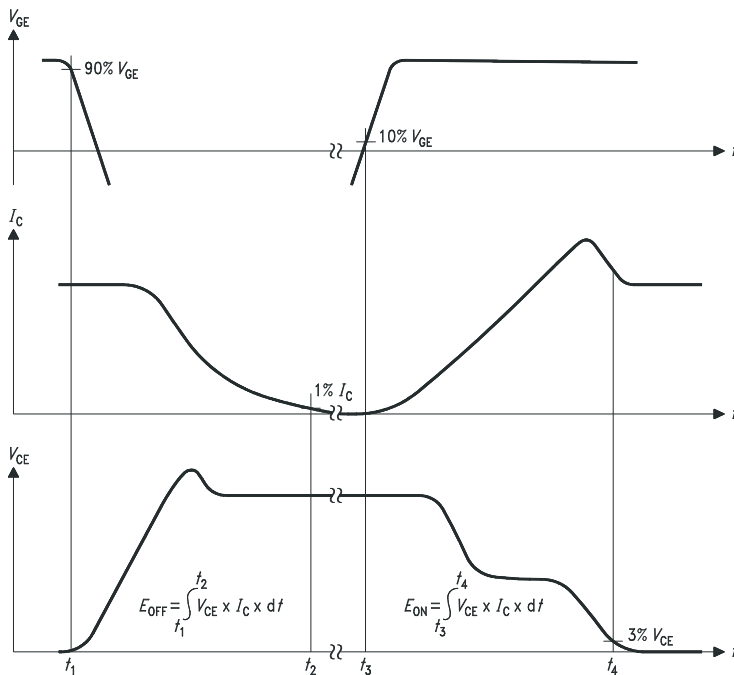


Figure B. Definition of switching losses

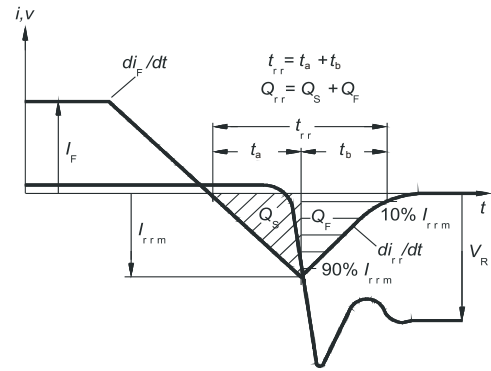


Figure C. Definition of diodes switching characteristics

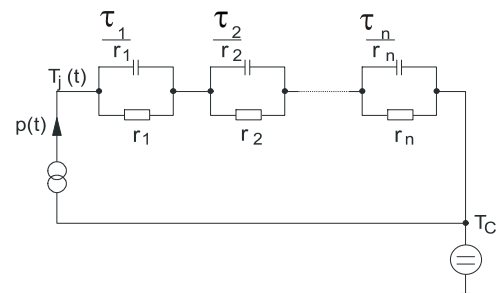


Figure D. Thermal equivalent circuit

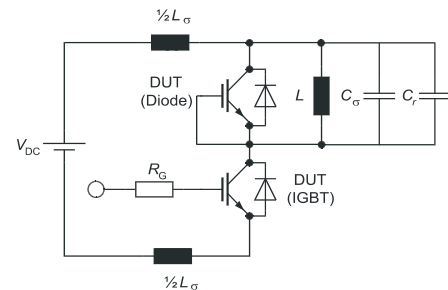


Figure E. Dynamic test circuit
Parasitic inductance L_{σ} ,
Parasitic capacitor C_{σ} ,
Relief capacitor C_r
(only for ZVT switching)

Revision History

IKB20N60TA

Revision: 2013-08-21, Rev. 2.2

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 0.1 | 2009-06-03 | - |
| 1.0 | 2009-07-23 | - |
| 2.0 | 2010-03-22 | - |
| 2.1 | 2010-03-22 | - |
| 2.2 | 2013-08-21 | Minor changes |

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