

IGBT

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

IKQ120N60T

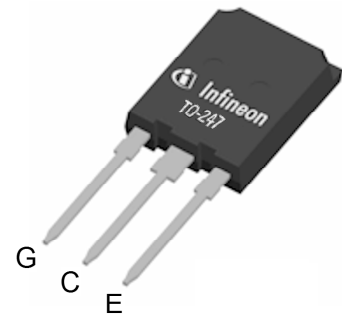
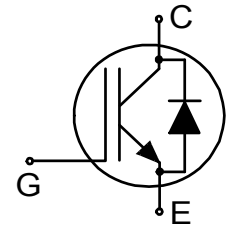
600V low loss switching series third generation

Data sheet

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

Features:

- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum junction temperature 175°C
- Short circuit withstand time 5µs
- TRENCHSTOP™ and Fieldstop technology for 600V applications offers:
 - very tight parameter distribution
 - high ruggedness, temperature stable behavior
 - high switching speed
- Positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low gate charge Q_G
- Increased current capability
- Green package
- Very soft, fast recovery anti-parallel Emitter Controlled HE diode



Applications:

- General purpose inverters
- Uninterruptible power supplies
- Motor drives
- Medium to low switching frequency power converters



Key Performance and Package Parameters

| Type | V_{CE} | I_C | $V_{CEsat}, T_{vj}=25^{\circ}C$ | T_{vjmax} | Marking | Package |
|------------|----------|-------|---------------------------------|-------------|---------|------------|
| IKQ120N60T | 600V | 120A | 1.5V | 175°C | K120T60 | 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, $T_{vj} \geq 25^{\circ}\text{C}$ | V_{CE} | 600 | V |
| DC collector current, limited by T_{vjmax} $T_C = 25^{\circ}\text{C}$ value limited by bondwire $T_C = 135^{\circ}\text{C}$ | I_C | 160.0 120.0 | A |
| Pulsed collector current, t_p limited by T_{vjmax} | I_{Cpuls} | 480.0 | A |
| Turn off safe operating area $V_{CE} \leq 600\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}$ | - | 480.0 | A |
| Diode forward current, limited by T_{vjmax} $T_C = 25^{\circ}\text{C}$ $T_C = 124^{\circ}\text{C}$ | I_F | 160.0 120.0 | A |
| Diode pulsed current, t_p limited by T_{vjmax} | I_{Fpuls} | 480.0 | 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} | 833.0 | W |
| Operating junction temperature | T_{vj} | -40...+175 | $^{\circ}\text{C}$ |
| Storage temperature | T_{stg} | -55...+150 | $^{\circ}\text{C}$ |
| Soldering temperature, ¹⁾ 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, ²⁾ junction - case | $R_{th(j-c)}$ | | 0.18 | K/W |
| Diode thermal resistance, ²⁾ junction - case | $R_{th(j-c)}$ | | 0.30 | K/W |
| Thermal resistance junction - ambient | $R_{th(j-a)}$ | | 40 | K/W |

¹⁾ Package not recommended for surface mount application

²⁾ Thermal resistance of thermal grease $R_{th(c-s)}$ (case to heat sink) of more than 0.1K/W not included.

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} | $V_{GE} = 15.0\text{V}, I_C = 120.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$ | - - | 1.50 1.90 | 2.00 - | V |
| Diode forward voltage | V_F | $V_{GE} = 0\text{V}, I_F = 120.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$ | - - | 1.65 1.60 | 2.05 - | V |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C = 1.92\text{mA}, V_{CE} = V_{GE}$ | 4.1 | 4.9 | 5.7 | V |
| Zero gate voltage collector current | I_{CES} | $V_{CE} = 600\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$ | - - | - 3000.0 | 40.0 - | μA |
| Gate-emitter leakage current | I_{GES} | $V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$ | - | - | 100 | nA |
| Transconductance | g_{fs} | $V_{CE} = 20\text{V}, I_C = 120.0\text{A}$ | - | 75.0 | - | 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} | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$ | - | 7530 | - | pF |
| Output capacitance | C_{oes} | | - | 446 | - | |
| Reverse transfer capacitance | C_{res} | | - | 206 | - | |
| Gate charge | Q_G | $V_{CC} = 480\text{V}, I_C = 120.0\text{A},$ $V_{GE} = 15\text{V}$ | - | 703.0 | - | nC |

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 | $t_{d(on)}$ | $T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 120.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 3.0\Omega, R_{G(off)} = 3.0\Omega,$ $L_{\sigma} = 63\text{nH}, C_{\sigma} = 31\text{pF}$ L_{σ}, C_{σ} from Fig. E | - | 50 | - | ns | |
| Rise time | t_r | | - | 75 | - | ns | |
| Turn-off delay time | $t_{d(off)}$ | | - | 565 | - | ns | |
| Fall time | t_f | | - | 68 | - | ns | |
| Turn-on energy | E_{on} | | Energy losses include "tail" and diode reverse recovery. | - | 6.20 | - | mJ |
| Turn-off energy | E_{off} | | | - | 5.90 | - | mJ |
| Total switching energy | E_{ts} | | | - | 12.10 | - | mJ |

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

| | | | | | | |
|--|--------------|---|---|------|---|------------------------|
| Diode reverse recovery time | t_{rr} | $T_{vj} = 25^{\circ}\text{C}$, $V_R = 400\text{V}$, $I_F = 120.0\text{A}$, $di_F/dt = 1000\text{A}/\mu\text{s}$ | - | 241 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 3.40 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 26.5 | - | A |
| Diode peak rate of fall of reverse recovery current during t_b | di_{rr}/dt | | - | -120 | - | $\text{A}/\mu\text{s}$ |

Switching Characteristic, Inductive Load

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

IGBT Characteristic, at $T_{vj} = 175^{\circ}\text{C}$

| | | | | | | |
|------------------------|---------------------|---|---|-------|---|----|
| Turn-on delay time | $t_{d(\text{on})}$ | $T_{vj} = 175^{\circ}\text{C}$, $V_{CC} = 400\text{V}$, $I_C = 120.0\text{A}$, $V_{GE} = 0.0/15.0\text{V}$, $R_{G(\text{on})} = 3.0\Omega$, $R_{G(\text{off})} = 3.0\Omega$, $L\sigma = 63\text{nH}$, $C\sigma = 31\text{pF}$ $L\sigma$, $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery. | - | 52 | - | ns |
| Rise time | t_r | | - | 104 | - | ns |
| Turn-off delay time | $t_{d(\text{off})}$ | | - | 623 | - | ns |
| Fall time | t_f | | - | 75 | - | ns |
| Turn-on energy | E_{on} | | - | 11.40 | - | mJ |
| Turn-off energy | E_{off} | | - | 7.10 | - | mJ |
| Total switching energy | E_{ts} | | - | 18.50 | - | mJ |

Diode Characteristic, at $T_{vj} = 175^{\circ}\text{C}$

| | | | | | | |
|--|--------------|---|---|-------|---|------------------------|
| Diode reverse recovery time | t_{rr} | $T_{vj} = 175^{\circ}\text{C}$, $V_R = 400\text{V}$, $I_F = 120.0\text{A}$, $di_F/dt = 650\text{A}/\mu\text{s}$ | - | 368 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 10.30 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 45.0 | - | A |
| Diode peak rate of fall of reverse recovery current during t_b | di_{rr}/dt | | - | -243 | - | $\text{A}/\mu\text{s}$ |

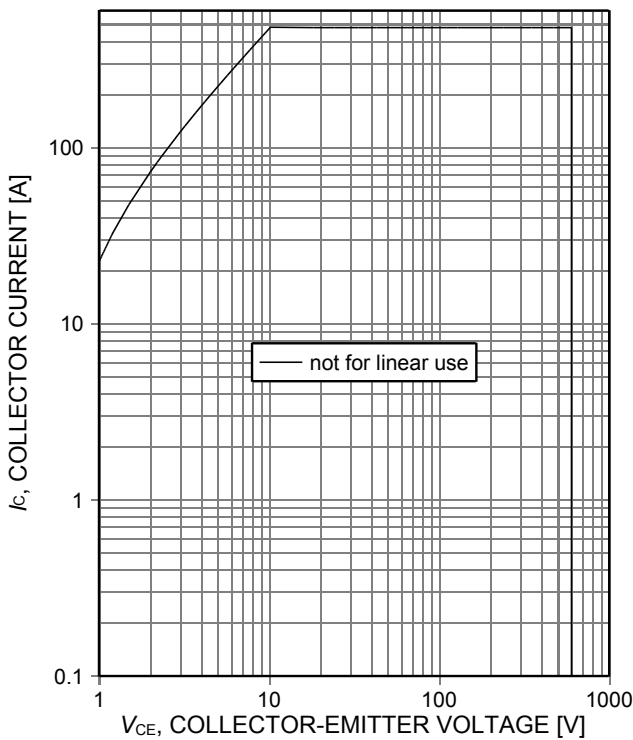


Figure 1. **Safe operating area**
 ($D=0$, $T_C=25^\circ\text{C}$, $T_J \leq 175^\circ\text{C}$, $V_{GE}=0/15\text{V}$, $t_p=1\mu\text{s}$)

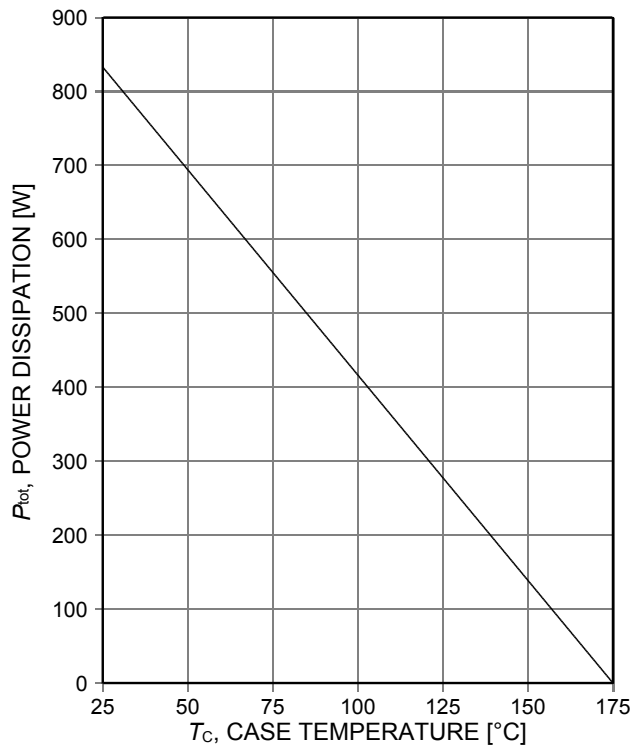


Figure 2. **Power dissipation as a function of case temperature**
 ($T_J \leq 175^\circ\text{C}$)

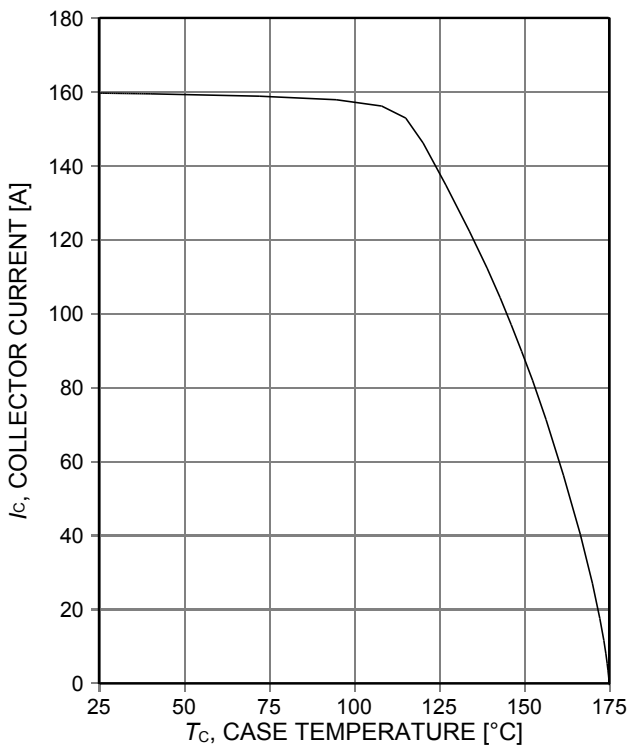


Figure 3. **Collector current as a function of case temperature**
 ($V_{GE} \geq 15\text{V}$, $T_J \leq 175^\circ\text{C}$)

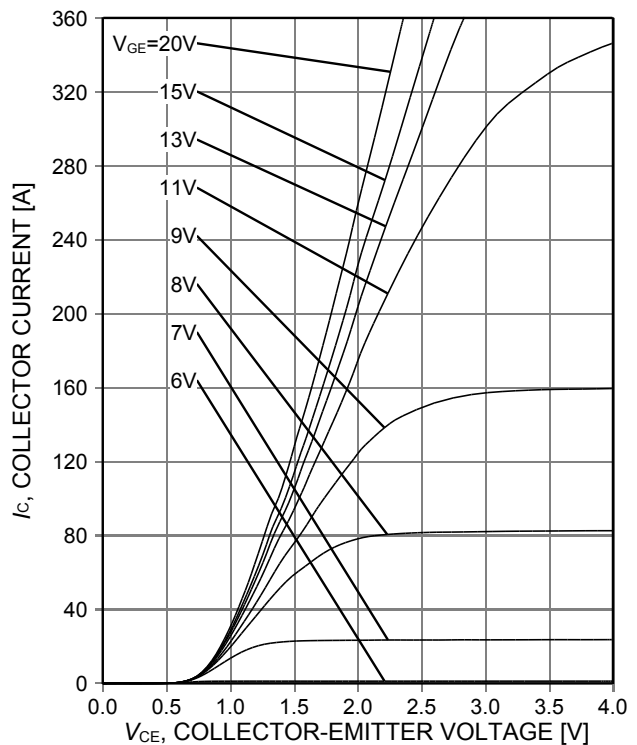


Figure 4. **Typical output characteristic**
 ($T_J=25^\circ\text{C}$)

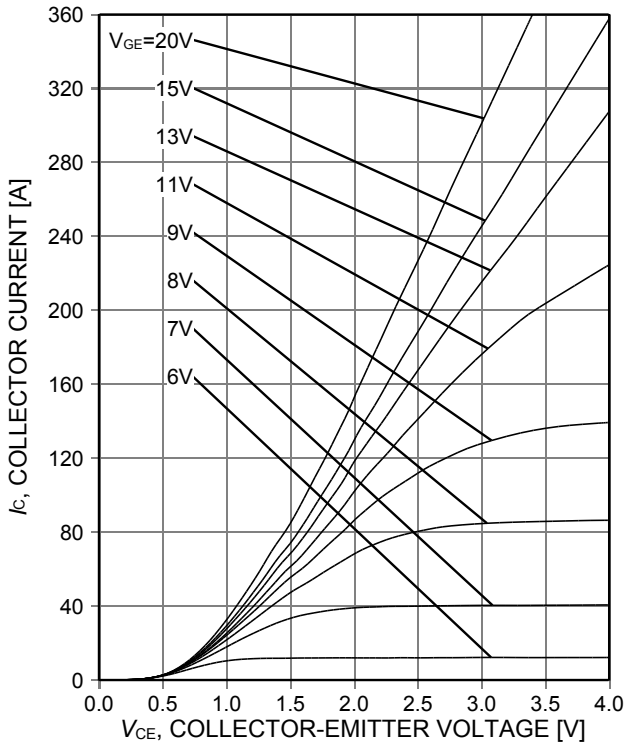


Figure 5. **Typical output characteristic**
($T_j=175^\circ\text{C}$)

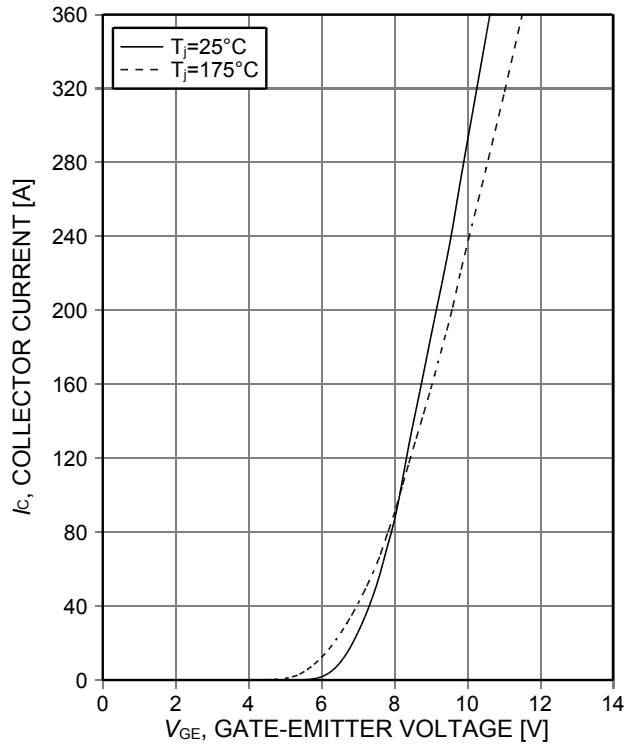


Figure 6. **Typical transfer characteristic**
($V_{CE}=20\text{V}$)

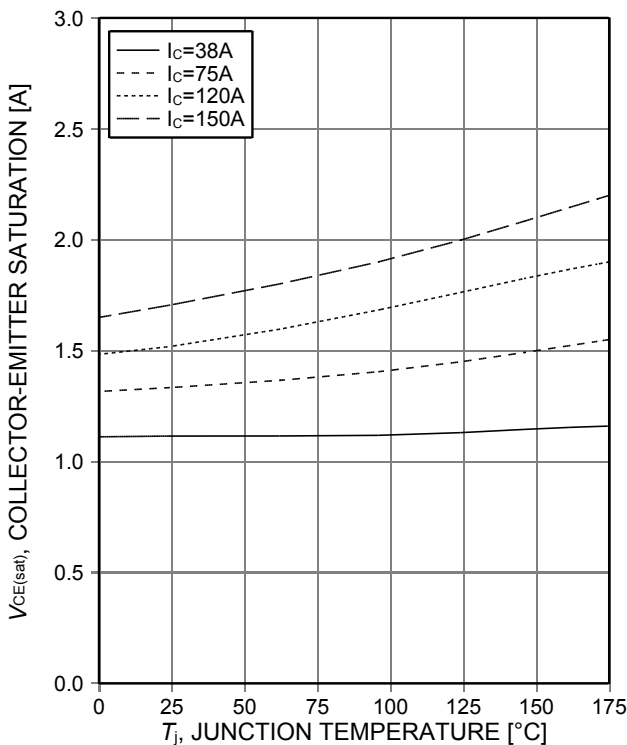


Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}=15\text{V}$)

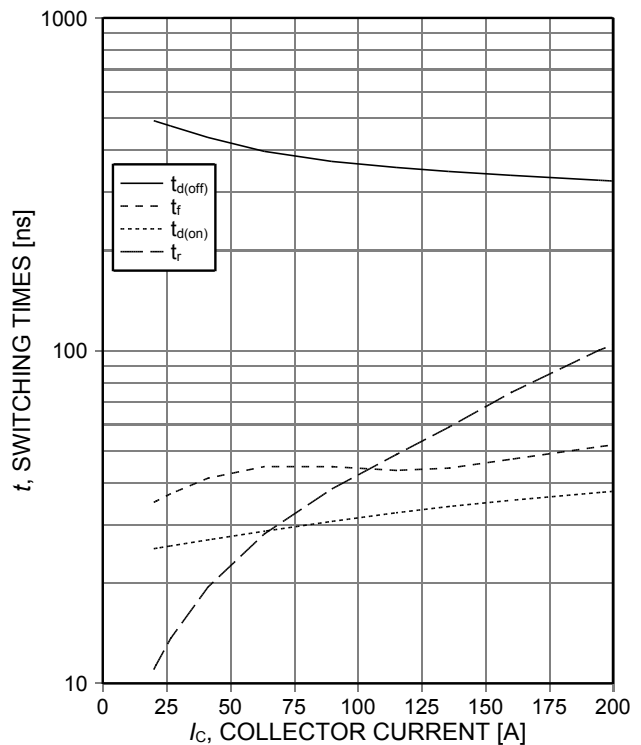


Figure 8. **Typical switching times as a function of collector current**
(inductive load, $T_j=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=3\Omega$, Dynamic test circuit in Figure E)

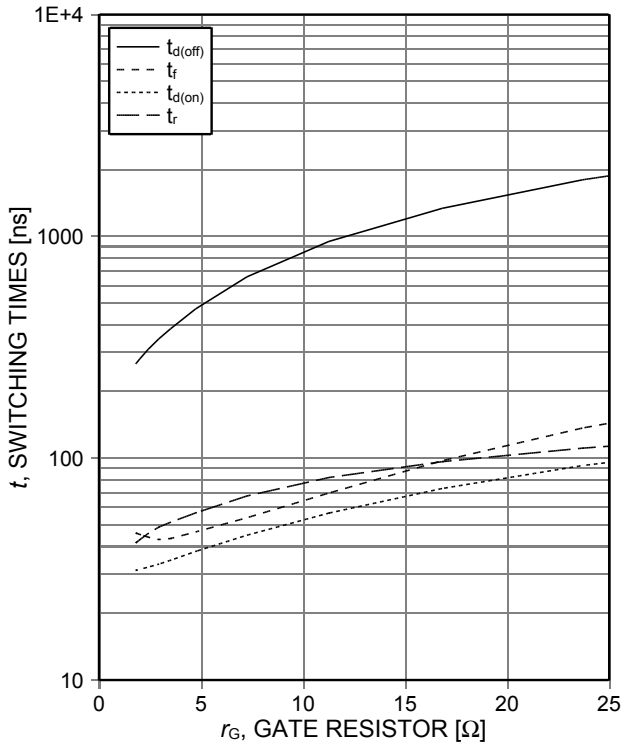


Figure 9. **Typical switching times as a function of gate resistor**
 (inductive load, $T_j=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=120\text{A}$, Dynamic test circuit in Figure E)

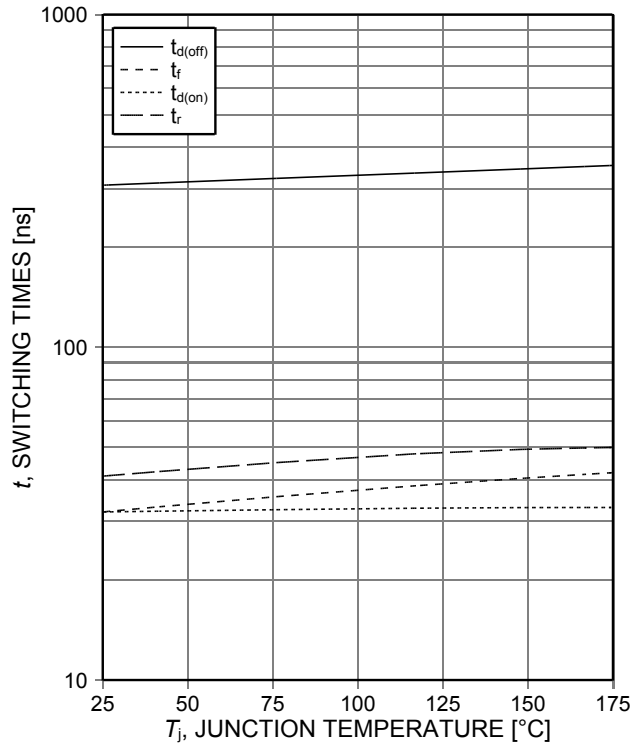


Figure 10. **Typical switching times as a function of junction temperature**
 (inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=120\text{A}$, $r_G=3\Omega$, Dynamic test circuit in Figure E)

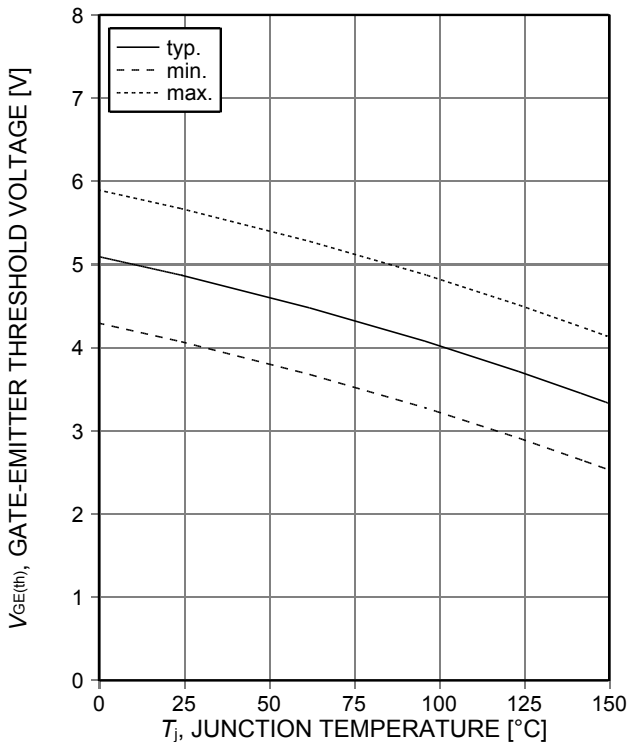


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**
 ($I_C=1,92\text{mA}$)

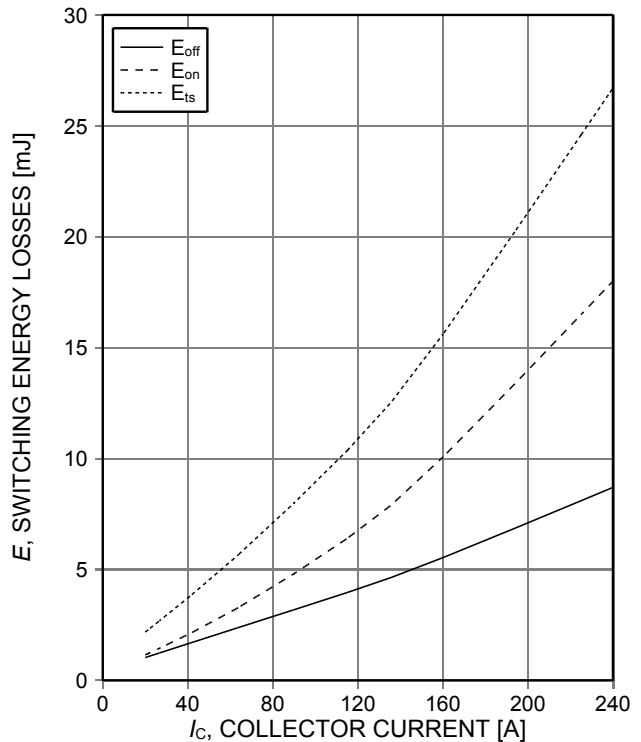


Figure 12. **Typical switching energy losses as a function of collector current**
 (inductive load, $T_j=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $r_G=3\Omega$, Dynamic test circuit in Figure E)

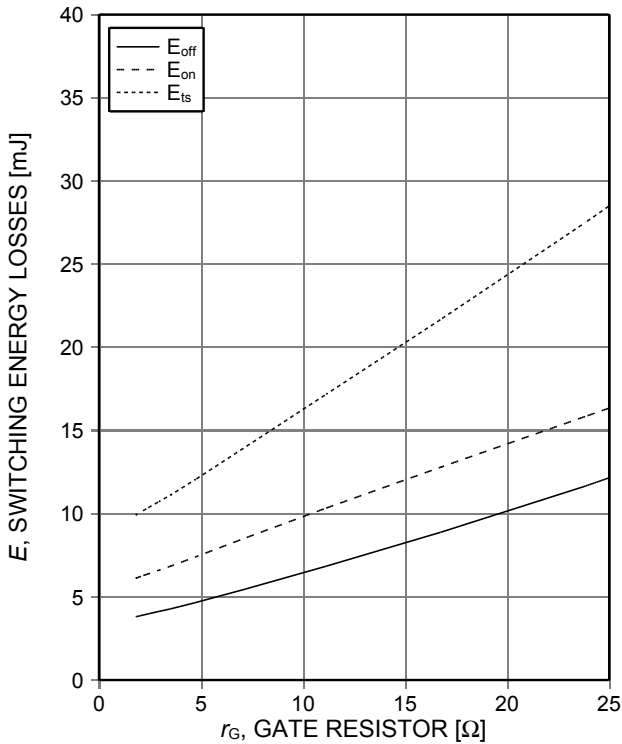


Figure 13. **Typical switching energy losses as a function of gate resistor**
 (inductive load, $T_j=175^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=120\text{A}$, Dynamic test circuit in Figure E)

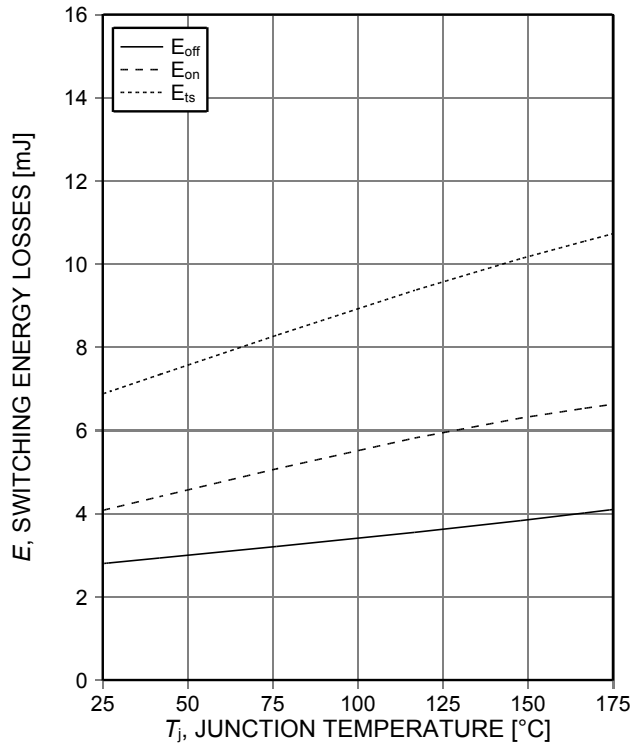


Figure 14. **Typical switching energy losses as a function of junction temperature**
 (inductive load, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=120\text{A}$, $r_G=3\Omega$, Dynamic test circuit in Figure E)

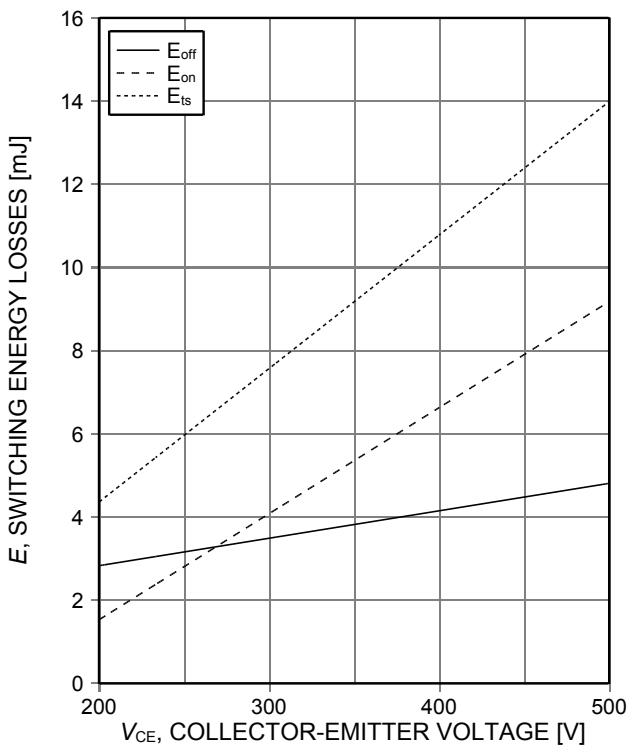


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**
 (inductive load, $T_j=175^\circ\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=120\text{A}$, $R_G=3\Omega$, Dynamic test circuit in Figure E)

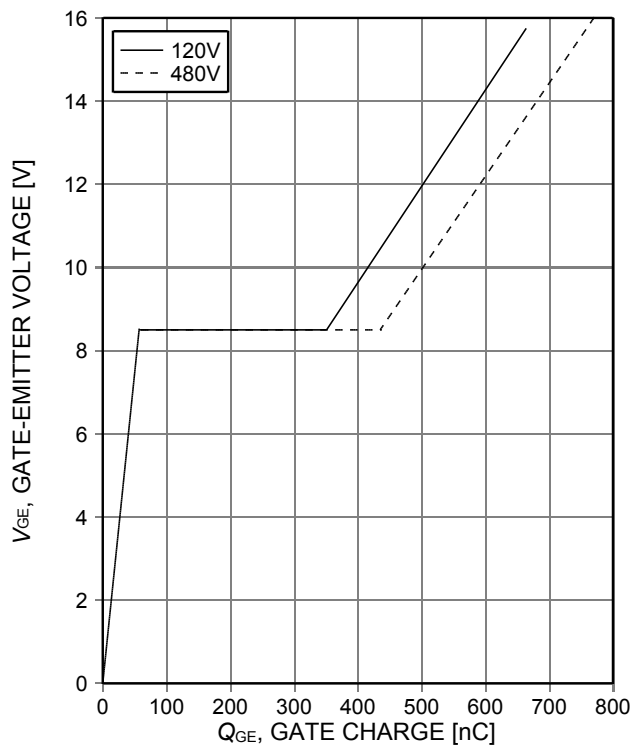


Figure 16. **Typical gate charge**
 ($I_C=120\text{A}$)

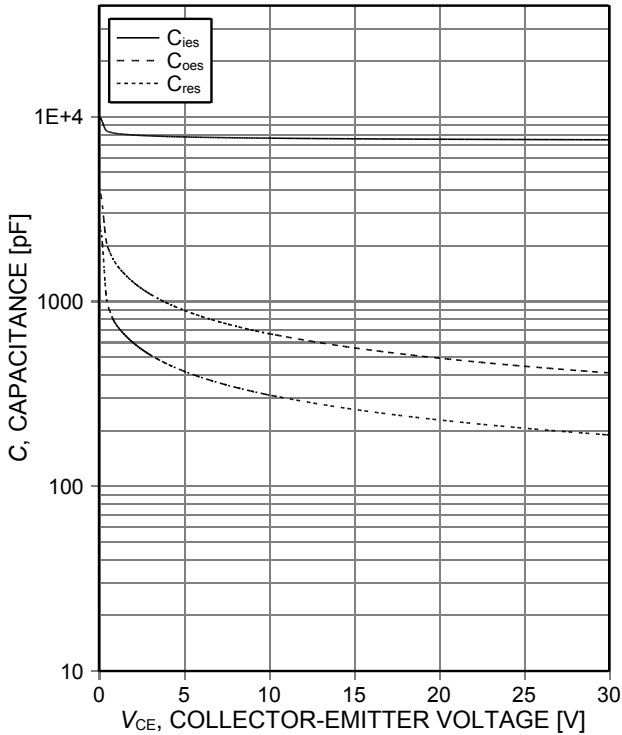


Figure 17. Typical capacitance as a function of collector-emitter voltage ($V_{GE}=0V$, $f=1MHz$)

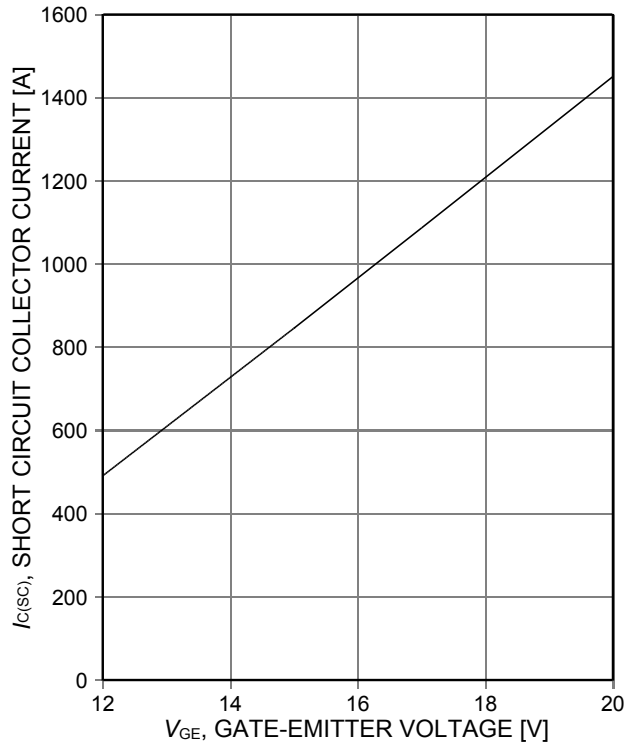


Figure 18. Typical short circuit collector current as a function of gate-emitter voltage ($V_{CE}\leq 400V$, $T_j\leq 150^\circ C$)

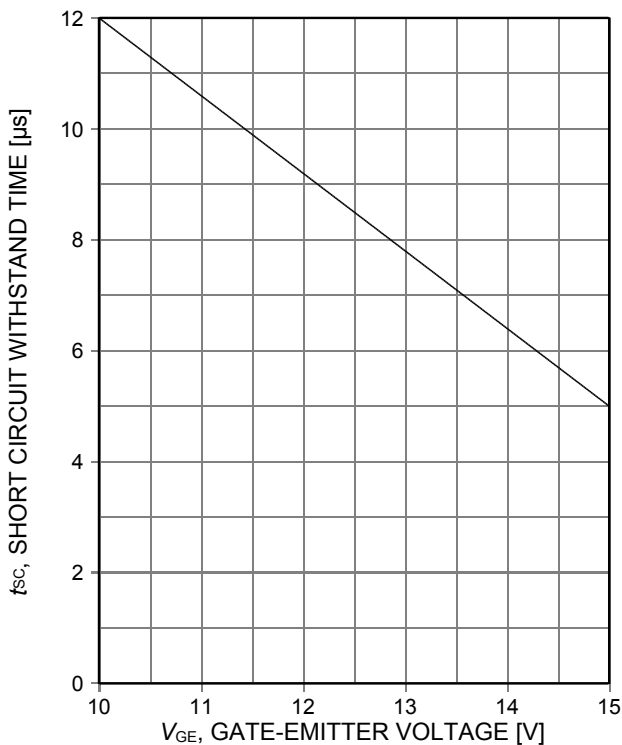


Figure 19. Short circuit withstand time as a function of gate-emitter voltage ($V_{CE}=400V$, start at $T_j=25^\circ C$, $T_{jmax}\leq 150^\circ C$)

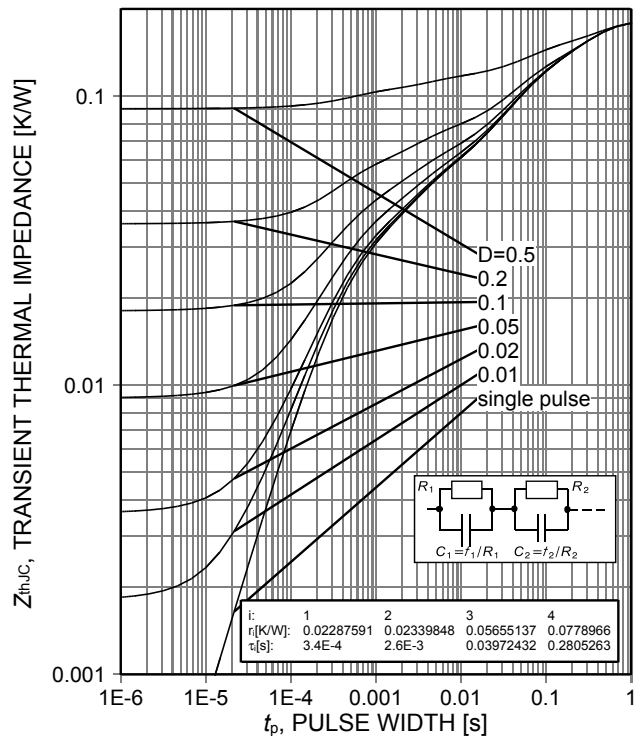


Figure 20. IGBT transient thermal impedance as a function of pulse width for different duty cycles D ($D=t_p/T$)

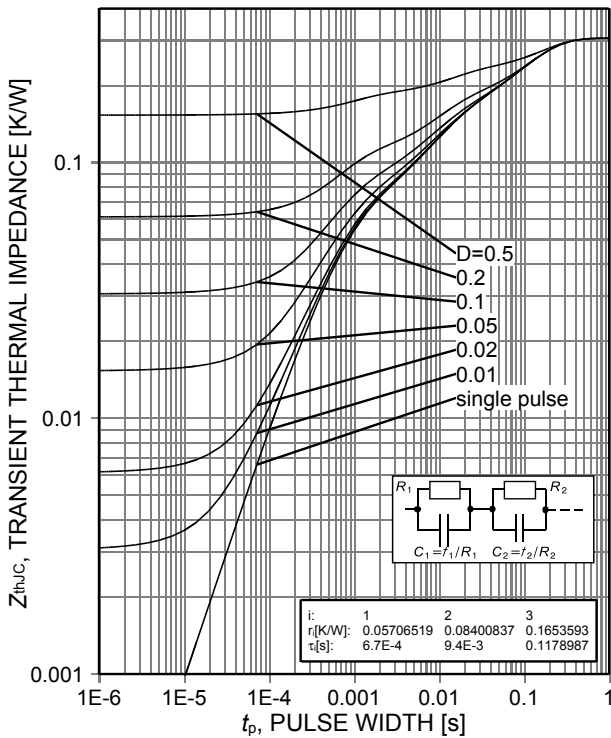


Figure 21. Diode transient thermal impedance as a function of pulse width for different duty cycles D ($D=t_p/T$)

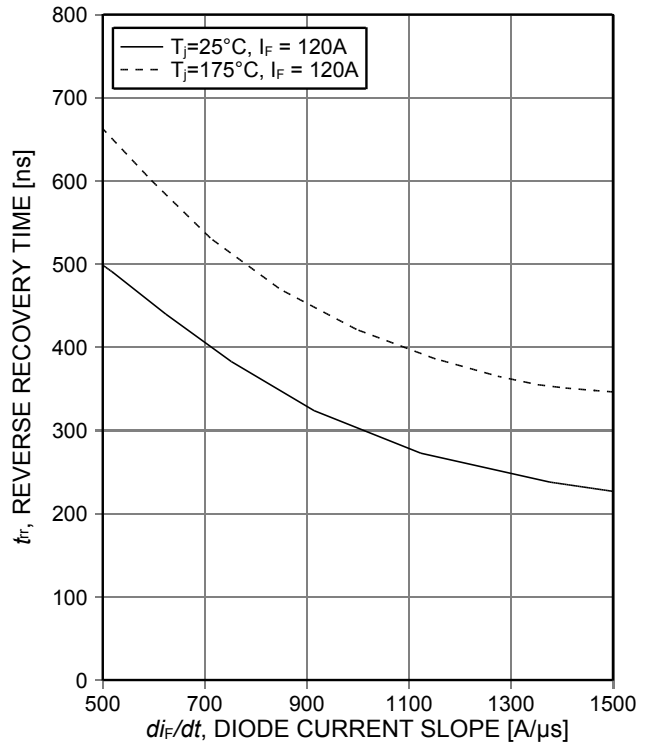


Figure 22. Typical reverse recovery time as a function of diode current slope ($V_R=400V$, Dynamic test circuit in Figure E)

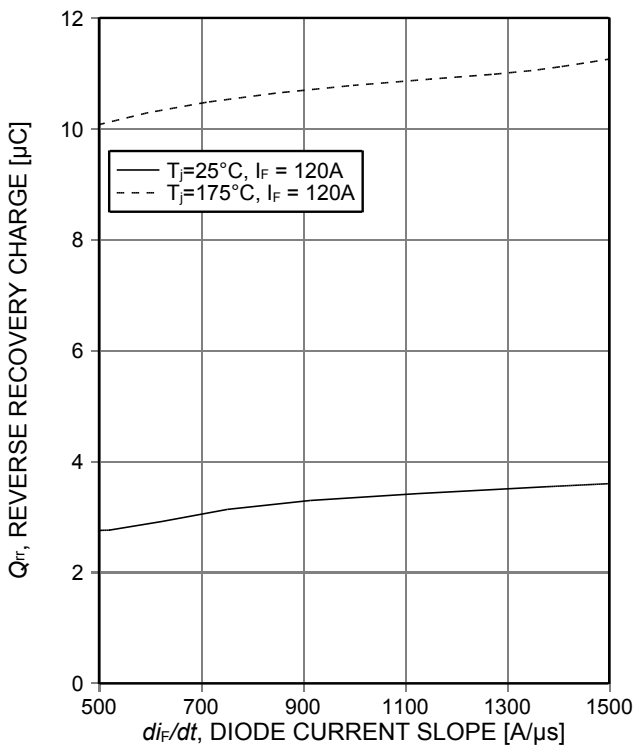


Figure 23. Typical reverse recovery charge as a function of diode current slope ($V_R=400V$, Dynamic test circuit in Figure E)

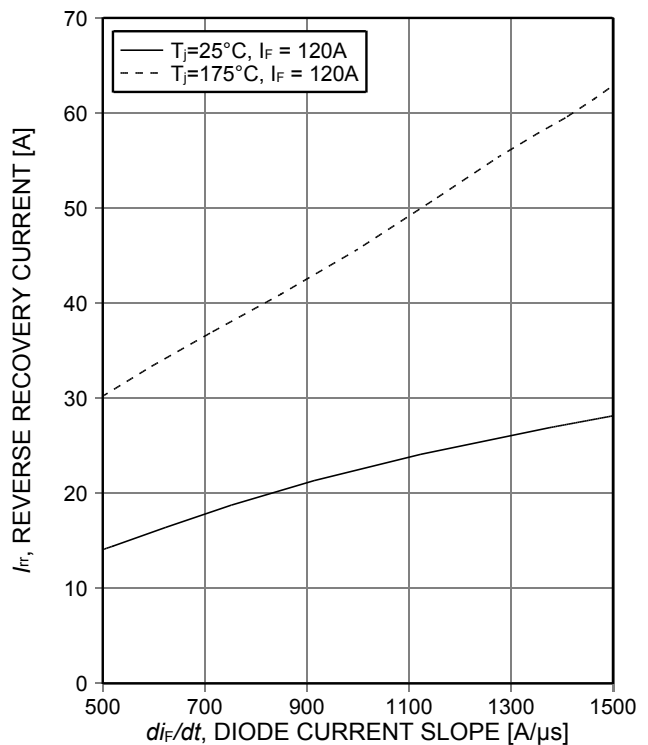


Figure 24. Typical reverse recovery current as a function of diode current slope ($V_R=400V$, Dynamic test circuit in Figure E)

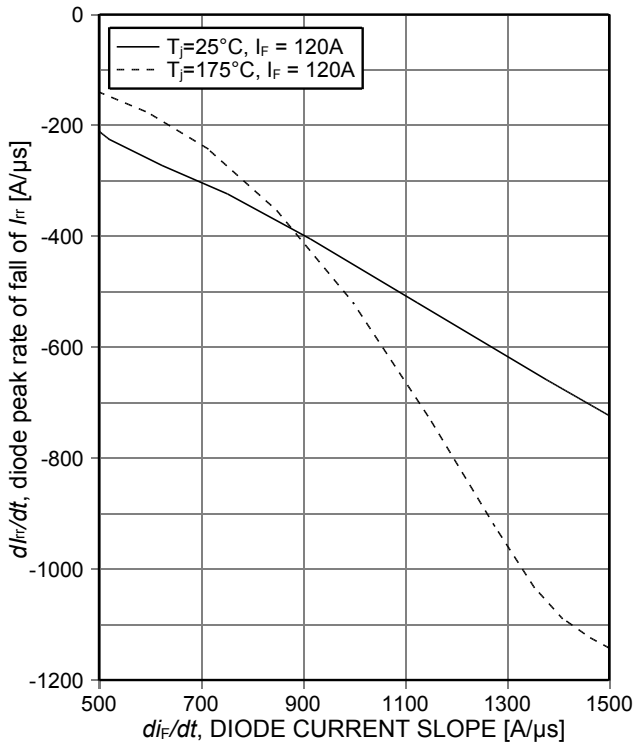


Figure 25. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R=400V$, Dynamic test circuit in Figure E)

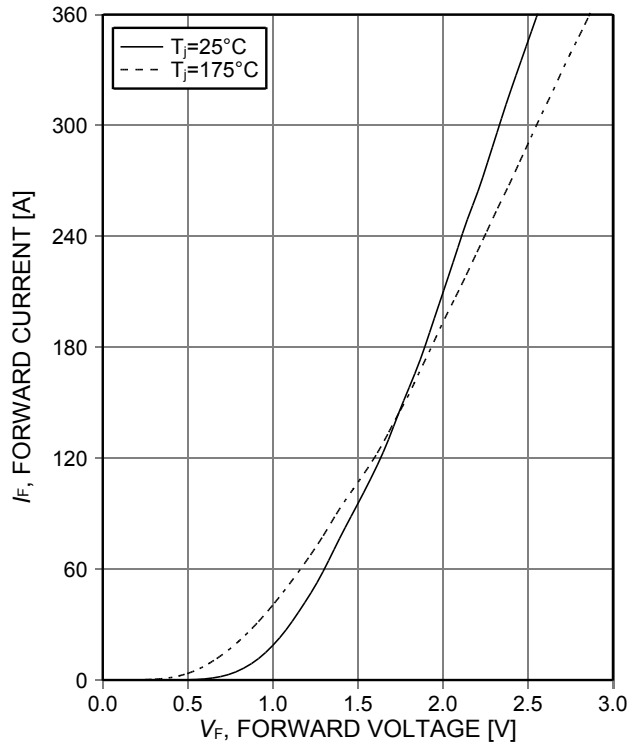


Figure 26. **Typical diode forward current as a function of forward voltage**

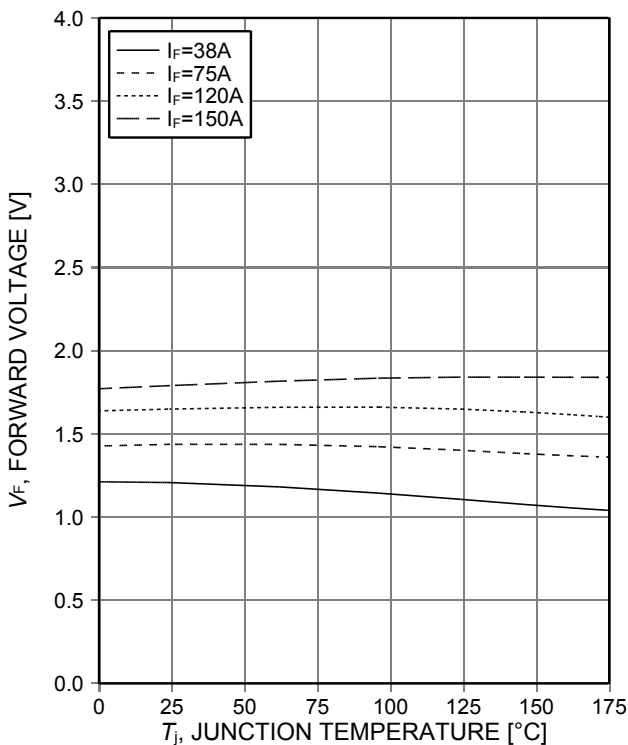
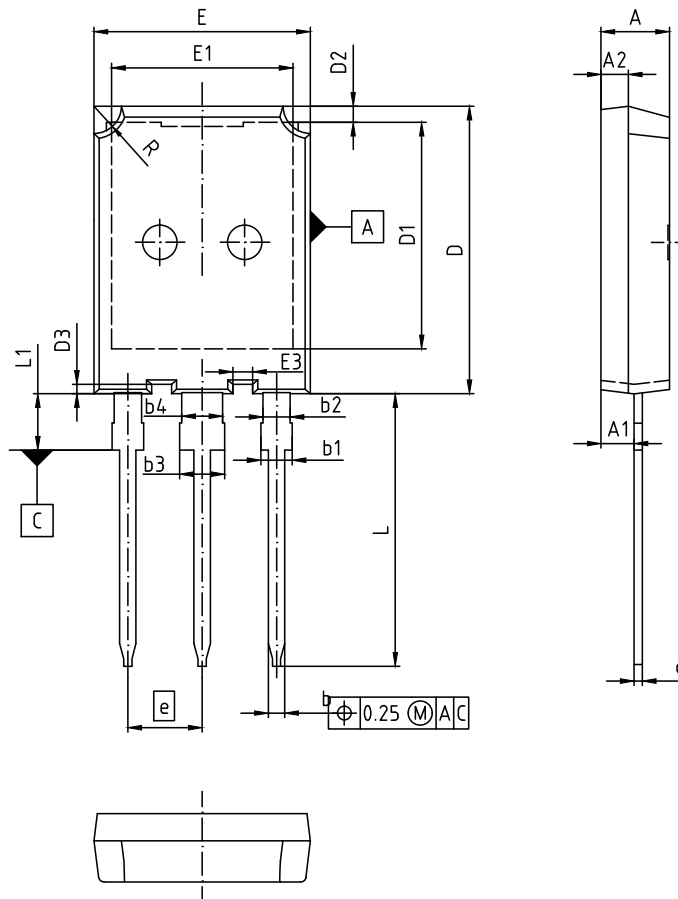


Figure 27. **Typical diode forward voltage as a function of junction temperature**

PG-TO247-3-46



Mold Flash or Protrusions not included

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.10 | 0.193 | 0.201 |
| A1 | 2.31 | 2.51 | 0.091 | 0.099 |
| A2 | 1.90 | 2.10 | 0.075 | 0.083 |
| b | 1.16 | 1.26 | 0.046 | 0.050 |
| b1 | 1.96 | 2.25 | 0.077 | 0.089 |
| b2 | 1.96 | 2.06 | 0.077 | 0.081 |
| b3 | 2.96 | 3.25 | 0.117 | 0.128 |
| b4 | 2.96 | 3.06 | 0.117 | 0.120 |
| c | 0.59 | 0.66 | 0.023 | 0.026 |
| D | 20.90 | 21.10 | 0.823 | 0.831 |
| D1 | 16.25 | 16.85 | 0.640 | 0.663 |
| D2 | 1.05 | 1.35 | 0.041 | 0.053 |
| D3 | 0.58 | 0.78 | 0.023 | 0.031 |
| E | 15.70 | 15.90 | 0.618 | 0.626 |
| E1 | 13.10 | 13.50 | 0.516 | 0.531 |
| E3 | 1.35 | 1.55 | 0.053 | 0.061 |
| e | 5.44 (BSC) | | 0.214 (BSC) | |
| N | 3 | | 3 | |
| L | 19.80 | 20.10 | 0.780 | 0.791 |
| L1 | - | 4.30 | - | 0.169 |
| R | 1.90 | 2.10 | 0.075 | 0.083 |

DOCUMENT NO.
Z8B00174295

SCALE

EUROPEAN PROJECTION

ISSUE DATE
13-08-2014

REVISION
01

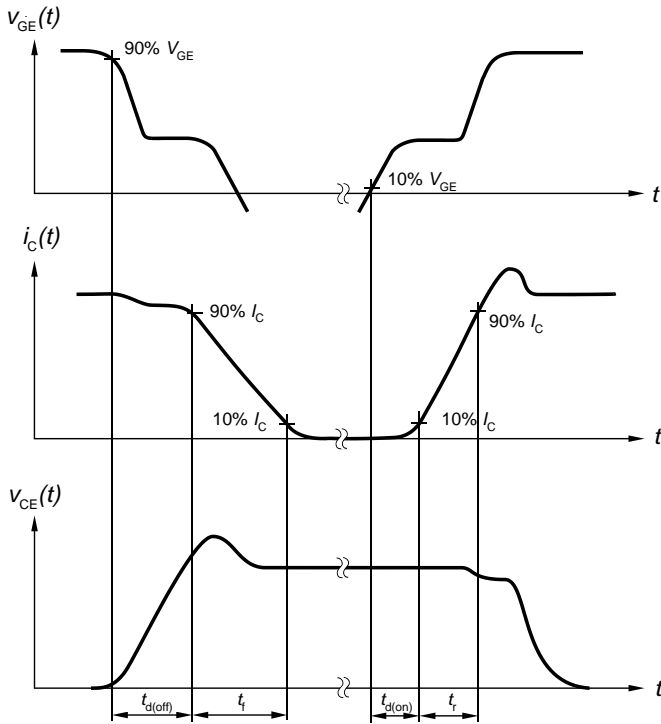


Figure A. Definition of switching times

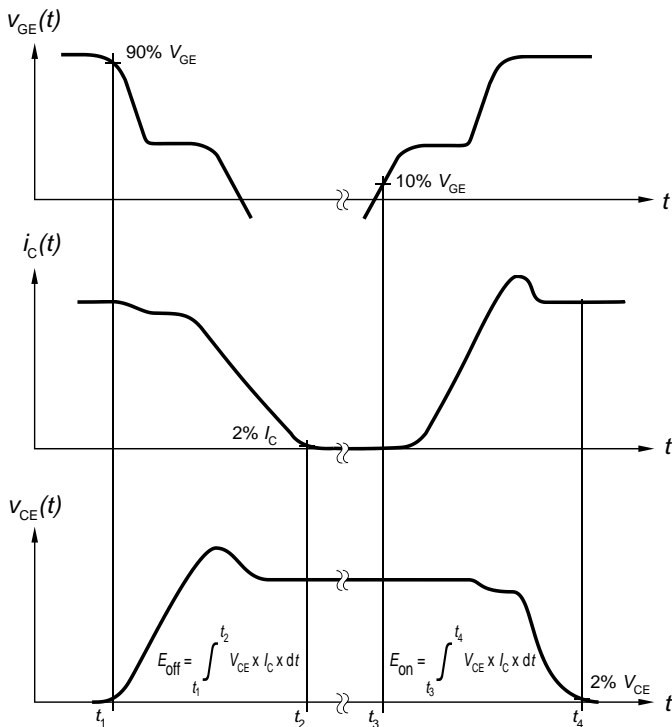


Figure B. Definition of switching losses

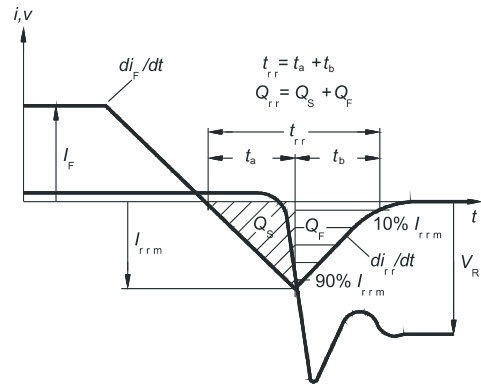


Figure C. Definition of diodes switching characteristics

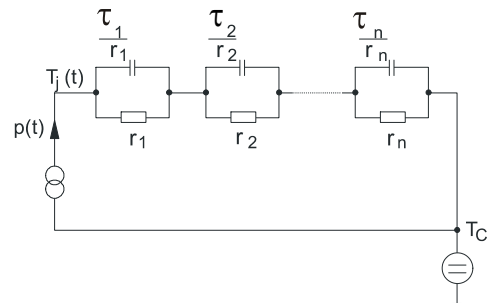


Figure D. Thermal equivalent circuit

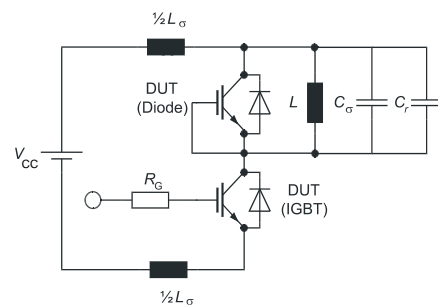


Figure E. Dynamic test circuit
Parasitic inductance L_σ ,
parasitic capacitor C_σ ,
relief capacitor C_r
(only for ZVT switching)

Revision History

IKQ120N60T

Revision: 2014-11-18, Rev. 2.2

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.1 | 2014-11-18 | Final data sheet |
| 2.2 | 2014-11-18 | Update of Transconductance gfs |

We Listen to Your Comments

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