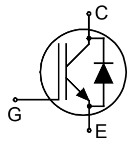
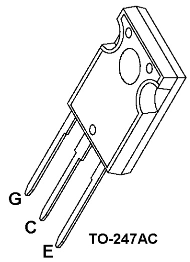
Preliminary Datasheet

# SKW30N60HS

## High Speed IGBT in NPT-technology




- 30% lower $E_{off}$ compared to previous generation
  16 µJ/A
- Short circuit withstand time – 10 µs
- NPT-Technology for 600V applications offers:
  - parallel switching capability
  - very tight parameter distribution
  - high ruggedness, temperature stable behaviour




| **Type** | $V_{CE}$ | $I_C$ | $V_{CE(sat)}$ | $T_j$ | **Package** | **Ordering Code** |
|---|---|---|---|---|---|---|
| SKW30N60HS | 600V | 30 | 3.5V | 150°C | TO-247AC | Q67040-S4244-A001 |

**Maximum Ratings**

| **Parameter** | **Symbol** | **Value** | **Unit** |
|---|---|---|---|
| Collector-emitter voltage | $V_{CE}$ | 600 | V |
| DC collector current<br>$T_C$ = 25°C<br>$T_C$ = 100°C | $I_C$ | <br>41<br>30 | A |
| Pulsed collector current, $t_p$ limited by $T_{jmax}$ | $I_{Cpuls}$ | 112 | |
| Turn off safe operating area<br>$V_{CE} \leq$ 600V, $T_j \leq$ 150°C | - | 112 | |
| Diode forward current<br>$T_C$ = 25°C<br>$T_C$ = 100°C | $I_F$ | <br>41<br>28 | |
| Diode pulsed current, $t_p$ limited by $T_{jmax}$ | $I_{Fpuls}$ | 112 | |
| Gate-emitter voltage | $V_{GE}$ | ±20 | V |
| Short circuit withstand time[1)]<br>$V_{GE}$ = 15V, $V_{CC} \leq$ 600V, $T_j \leq$ 150°C | $t_{SC}$ | 10 | µs |
| Power dissipation<br>$T_C$ = 25°C | $P_{tot}$ | 250 | W |
| Operating junction and storage temperature | $T_j$ ,<br>$T_{stg}$ | -55...+150 | °C |
| Soldering temperature, 1.6mm (0.063 in.) from case for 10s | - | 260 | |

[1)] Allowed number of short circuits: <1000; time between short circuits: >1s.

**Thermal Resistance**

| Parameter | Symbol | Conditions | Max. Value | Unit |
|---|---|---|---|---|
| **Characteristic** | | | | |
| IGBT thermal resistance, junction – case | $R_{thJC}$ | | 0.5 | K/W |
| Diode thermal resistance, junction – case | $R_{thJCD}$ | | tbd | |
| Thermal resistance, junction – ambient | $R_{thJA}$ | TO-247AC | 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, $I_C$=500µA | 600 | - | - | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $V_{GE}$ = 15V, $I_C$=30A<br>$T_j$=25°C<br>$T_j$=150°C | | <br>2.9<br>3.5 | | |
| Diode forward voltage | $V_F$ | $V_{GE}$=0V, $I_F$=28A<br>$T_j$=25°C<br>$T_j$=150°C | <br><br>- | | <br>1.95<br>1.8 | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C$=300µA,$V_{CE}$=$V_{GE}$ | 3 | 4 | 5 | |
| Zero gate voltage collector current | $I_{CES}$ | $V_{CE}$=600V,$V_{GE}$=0V<br>$T_j$=25°C<br>$T_j$=150°C | <br>-<br>- | <br>-<br>- | <br>40<br>3000 | µA |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$=0V,$V_{GE}$=20V | - | - | 100 | nA |
| Transconductance | $g_{fs}$ | $V_{CE}$=20V, $I_C$=30A | - | - | 20 | S |

**Dynamic Characteristic**

| | | | | | | |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{iss}$ | $V_{CE}$=25V, | - | 1500 | | pF |
| Output capacitance | $C_{oss}$ | $V_{GE}$=0V, | - | 200 | | |
| Reverse transfer capacitance | $C_{rss}$ | $f$=1MHz | - | 92 | | |
| Gate charge | $Q_{Gate}$ | $V_{CC}$=480V, $I_C$=30A<br>$V_{GE}$=15V | - | 140 | | nC |
| Internal emitter inductance measured 5mm (0.197 in.) from case | $L_E$ | TO-247AC | - | 13 | | nH |
| Short circuit collector current[1)] | $I_{C(SC)}$ | $V_{GE}$=15V,$t_{SC}$≤10µs<br>$V_{CC}$ ≤ 600V,<br>$T_j$ ≤ 150°C | - | 220 | | A |

[1)] Allowed number of short circuits: <1000; time between short circuits: >1s.

**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, | - | 16 | | ns |
| Rise time | $t_r$ | $V_{CC}$=400V, $I_C$=30A, | - | 21 | | |
| Turn-off delay time | $t_{d(off)}$ | $V_{GE}$=0/15V, | - | 106 | | |
| Fall time | $t_f$ | $R_G$=1.8 | - | 21 | | |
| Turn-on energy | $E_{on}$ | Energy losses include “tail” and diode reverse recovery. | - | 0.67 | | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.34 | | |
| Total switching energy | $E_{ts}$ | | - | 1.01 | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j$=25°C, | - | 22 | | ns |
| Rise time | $t_r$ | $V_{CC}$=400V, $I_C$=30A, | - | 30 | | |
| Turn-off delay time | $t_{d(off)}$ | $V_{GE}$=0/15V, | - | 250 | | |
| Fall time | $t_f$ | $R_G$=11 | - | 26 | | |
| Turn-on energy | $E_{on}$ | Energy losses include “tail” and diode reverse recovery. | - | 0.78 | | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.55 | | |
| Total switching energy | $E_{ts}$ | | - | 1.33 | | |

**Anti-Parallel Diode Characteristic**

| Parameter | Symbol | Conditions | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| Diode reverse recovery time | $t_{rr}$<br>$t_S$<br>$t_F$ | $T_j$=25°C,<br>$V_R$=200V, $I_F$=28A,<br>$di_F/dt$=200A/µs | -<br>-<br>- | TBD<br>TBD<br>TBD | | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | TBD | | nC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | TBD | | A |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | TBD | | A/µs |

**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 | - | 17 | | ns |
| Rise time | $t_r$ | $V_{CC}$=400V, | - | 19 | | |
| Turn-off delay time | $t_{d(off)}$ | $I_C$=30A, | - | 122 | | |
| Fall time | $t_f$ | $V_{GE}$=0/15V, | - | 29 | | |
| Turn-on energy | $E_{on}$ | $R_G$= 1.8 | - | 0.90 | | mJ |
| Turn-off energy | $E_{off}$ | Energy losses include | - | 0.48 | | |
| Total switching energy | $E_{ts}$ | “tail” and diode reverse recovery. | - | 1.38 | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j$=150°C | - | 22 | | ns |
| Rise time | $t_r$ | $V_{CC}$=400V, | - | 28 | | |
| Turn-off delay time | $t_{d(off)}$ | $I_C$=30A, | - | 274 | | |
| Fall time | $t_f$ | $V_{GE}$=0/15V, | - | 28 | | |
| Turn-on energy | $E_{on}$ | $R_G$= 11 | - | 1.06 | | mJ |
| Turn-off energy | $E_{off}$ | Energy losses include | - | 0.70 | | |
| Total switching energy | $E_{ts}$ | “tail” and diode reverse recovery. | - | 1.76 | | |

**Anti-Parallel Diode Characteristic**

| Parameter | Symbol | Conditions | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| Diode reverse recovery time | $t_{rr}$<br>$t_S$<br>$t_F$ | $T_j$=150°C<br>$V_R$=200V, $I_F$=28A,<br>$di_F/dt$=200A/µs | -<br>-<br>- | TBD<br>TBD<br>TBD | | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | | | nC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | TBD | | A |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | TBD | | A/µs |

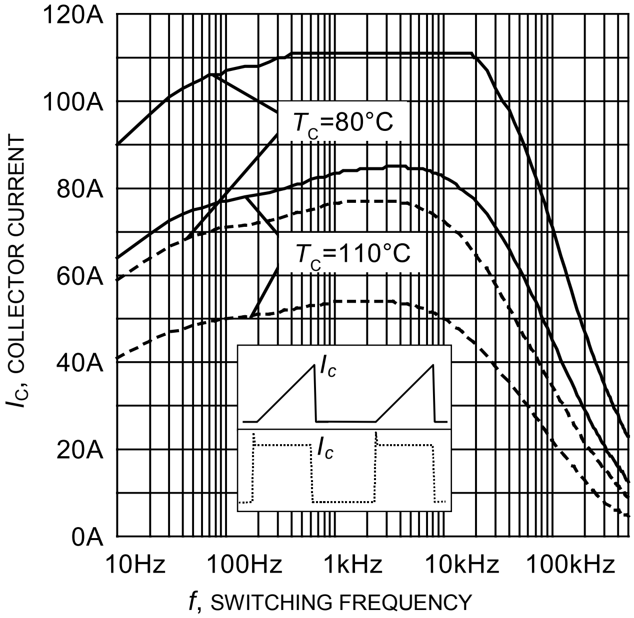



**Figure 1. Collector current as a function of switching frequency**
($T_j \leq 150°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/+15V$, $R_G = 11\Omega$)

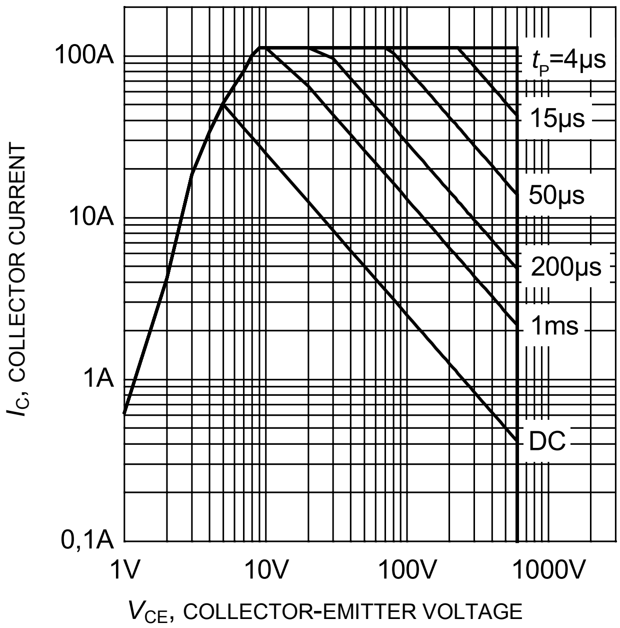



**Figure 2. Safe operating area**
($D = 0$, $T_C = 25°C$, $T_j \leq 150°C$; $V_{GE}$=15V)

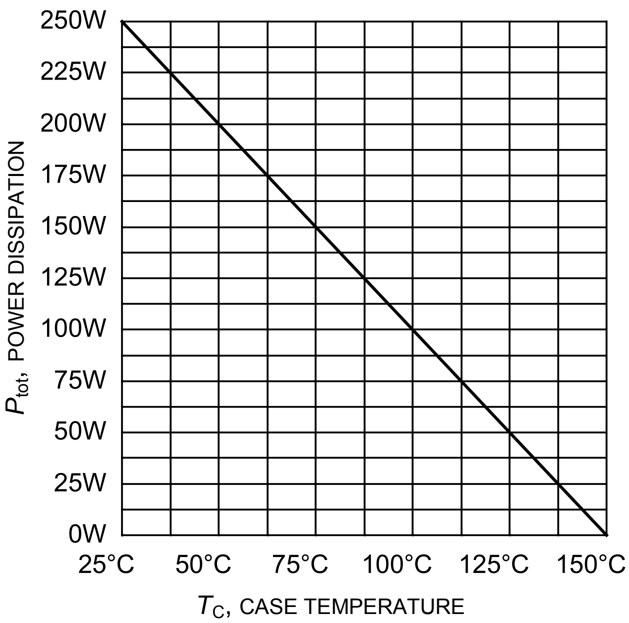



**Figure 3. Power dissipation as a function of case temperature**
($T_j \leq 150°C$)

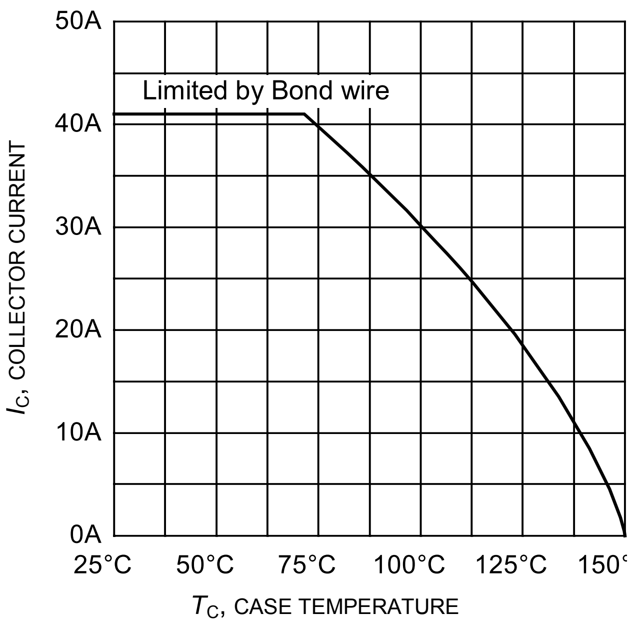



**Figure 4. Collector current as a function of case temperature**
($V_{GE} \leq 15V$, $T_j \leq 150°C$)

$I_C$, COLLECTOR CURRENT

$V_{CE}$, COLLECTOR-EMITTER VOLTAGE

**Figure 5. Typical output characteristic**
($T_j$ = 25°C)

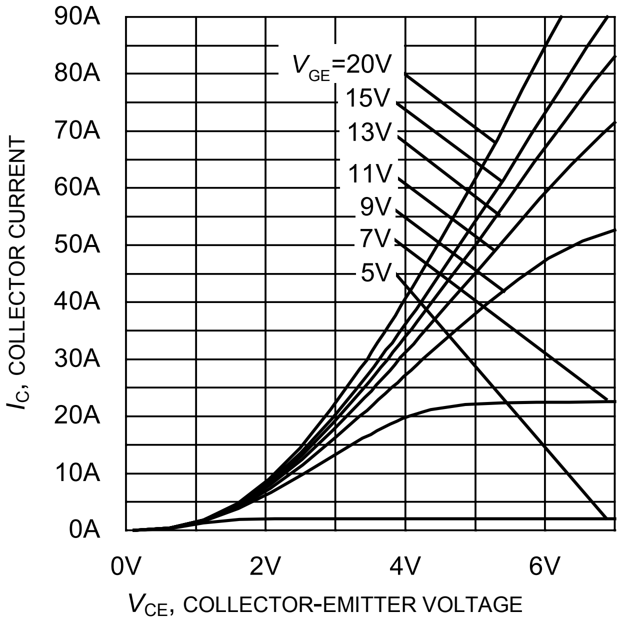



**Figure 6. Typical output characteristic**
($T_j$ = 150°C)

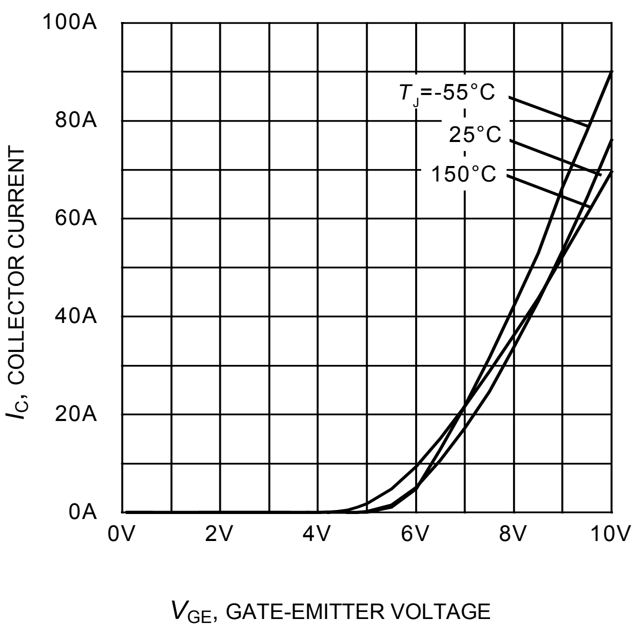



**Figure 7. Typical transfer characteristic**
($V_{GE}$=10V)

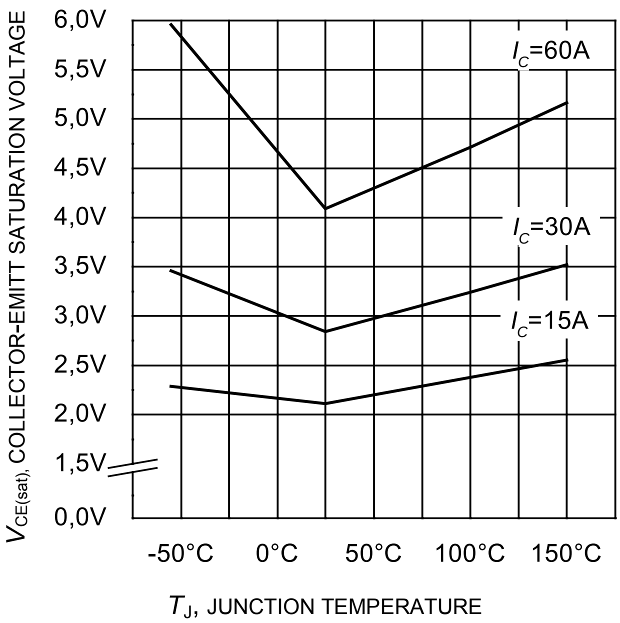



**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}$ = 15V)

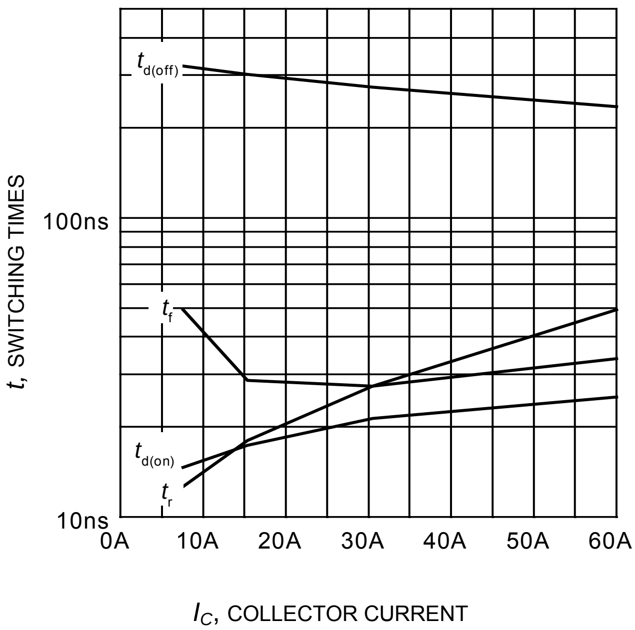



**Figure 9. Typical switching times as a function of collector current**
(inductive load, $T_J$=150°C, $V_{CE}$=400V, VGE=0/15V, $R_G$=11Ω)

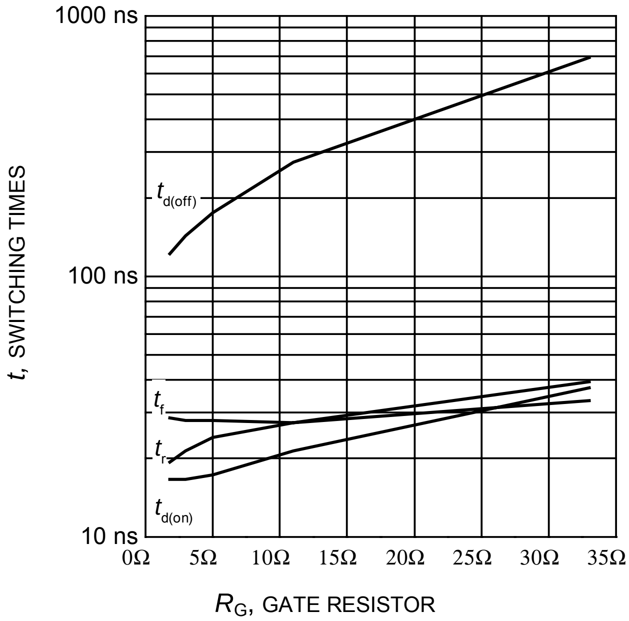



**Figure 10. Typical switching times as a function of gate resistor**
(inductive load, $T_J$=150°C, $V_{CE}$=400V, VGE=0/15V, $I_C$=30A)

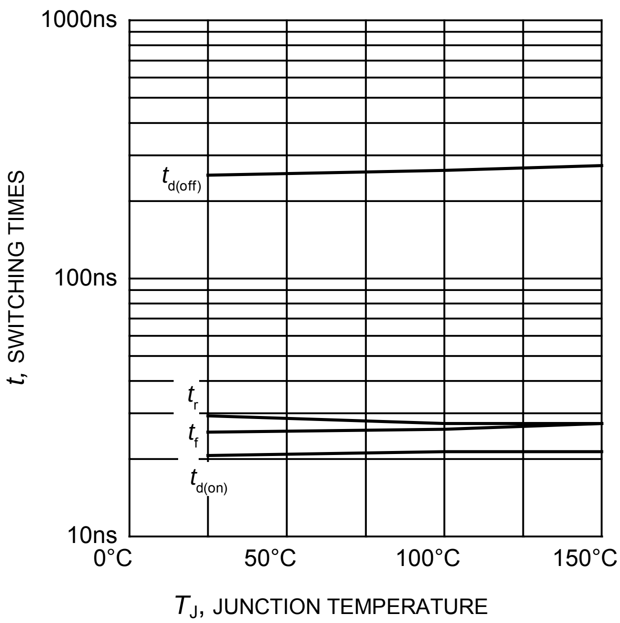



**Figure 11. Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}$=400V, VGE=0/15V, $I_C$=20A, $R_G$=11Ω)

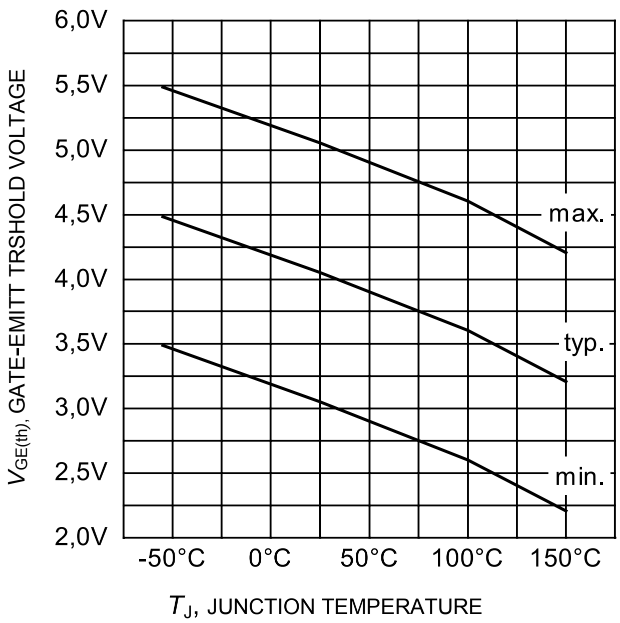



**Figure 12. Collector current as a function of case temperature**
($V_{GE} \leq$ 15V, $T_j \leq$ 150°C)

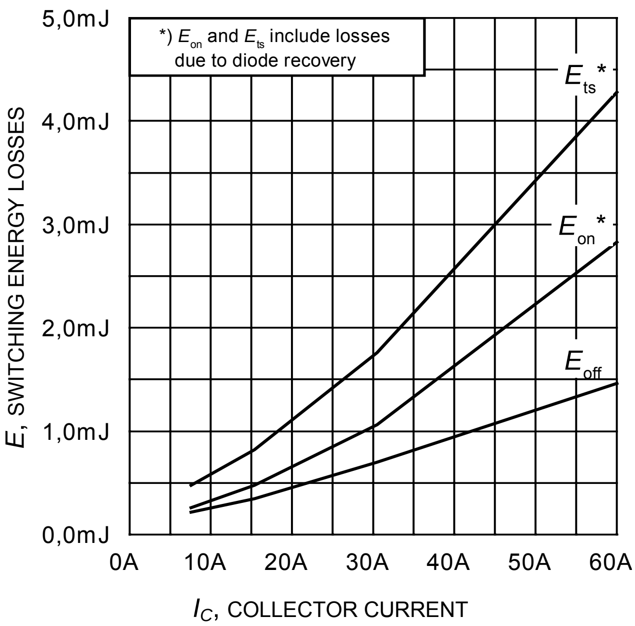



**Figure 13. Typical switching energy losses as a function of collector current**
(inductive load, $T_J$=150°C, $V_{CE}$=400V, VGE=0/15V, $R_G$=11Ω)

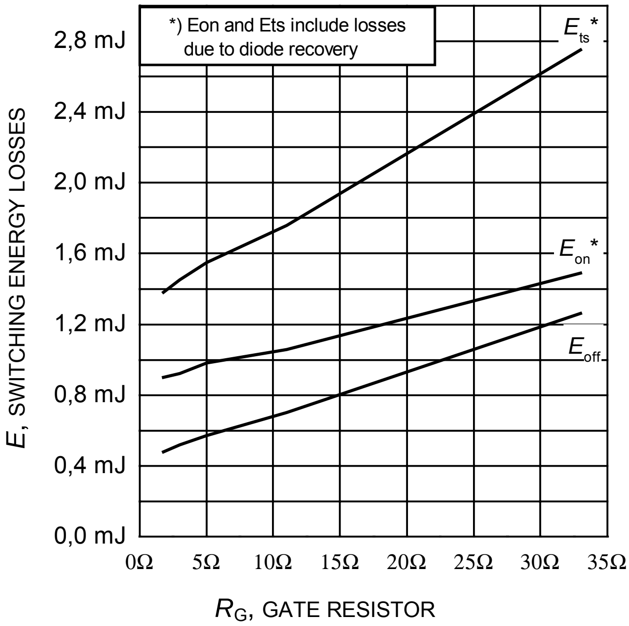



**Figure 14. Typical switching energy losses as a function of gate resistor**
(inductive load, $T_J$=150°C, $V_{CE}$=400V, VGE=0/15V, $I_C$=30A

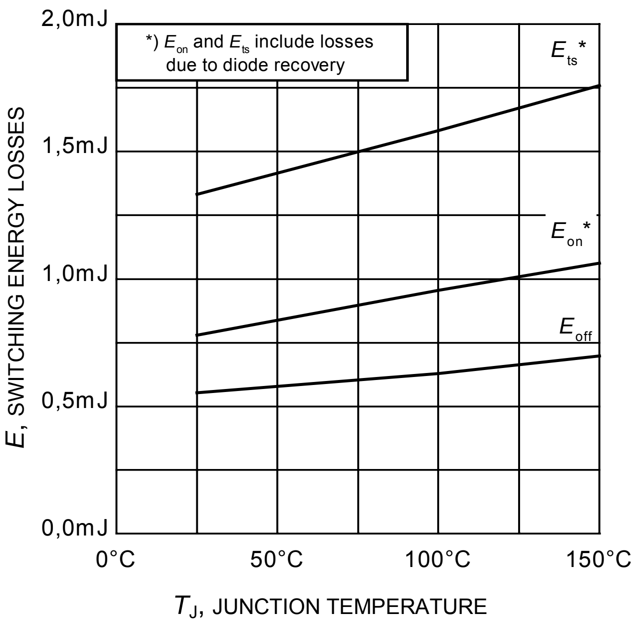



**Figure 15. Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}$=400V, VGE=0/15V, $I_C$=30A, $R_G$=11Ω)

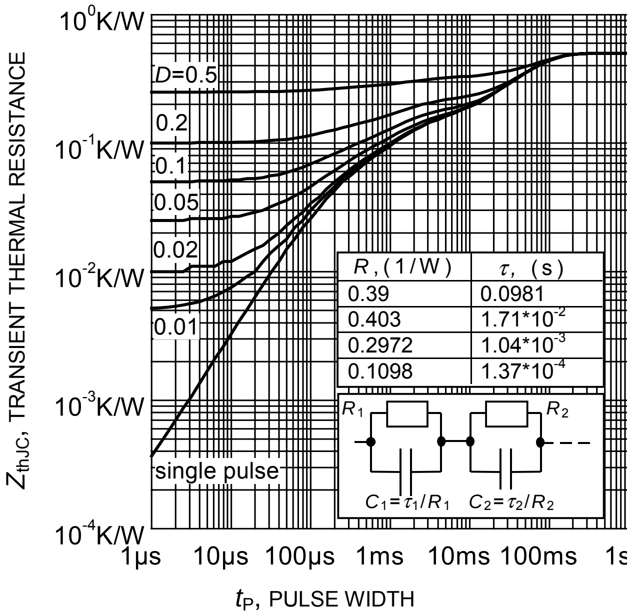



**Figure 16. IGBT transient thermal resistance**
($D = t_p / T$)

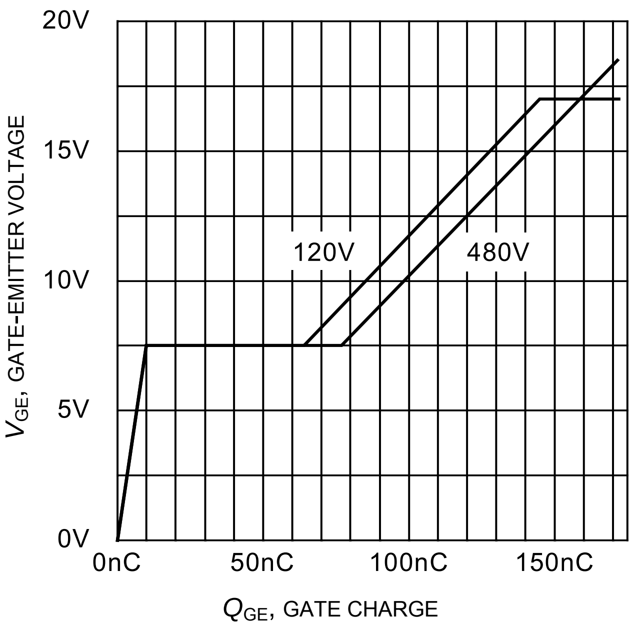



**Figure 17. Typical gate charge**
($I_C$=30 A)

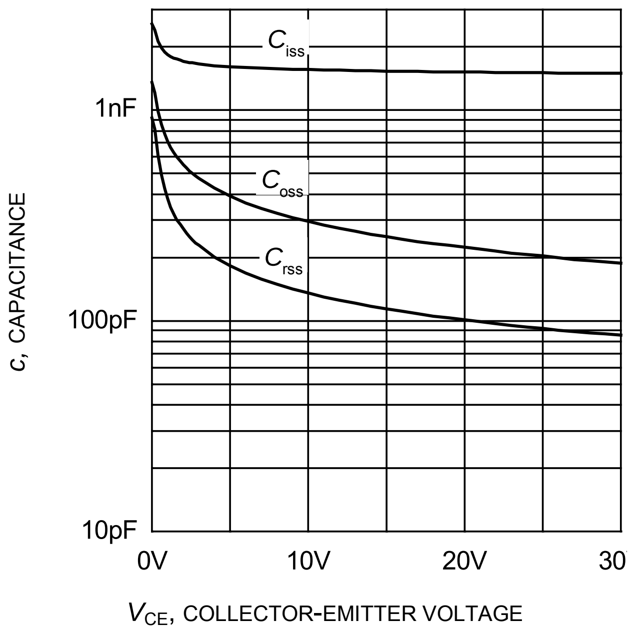



**Figure 18. Typical capacitance as a function of collector-emitter voltage**
($V_{GE}$=0V, *f* = 1 MHz)

$t_{SC}$, SHORT CIRCUIT WITHSTAND TIME

$V_{GE}$, GATE-EMITETR VOLTAGE

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

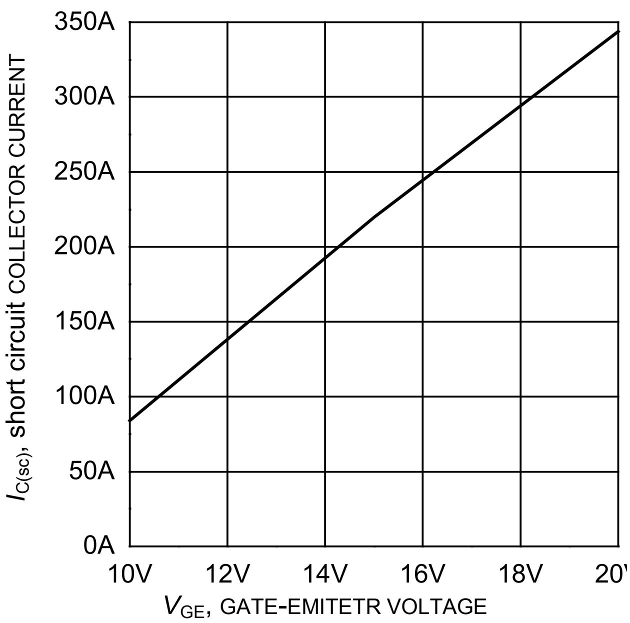
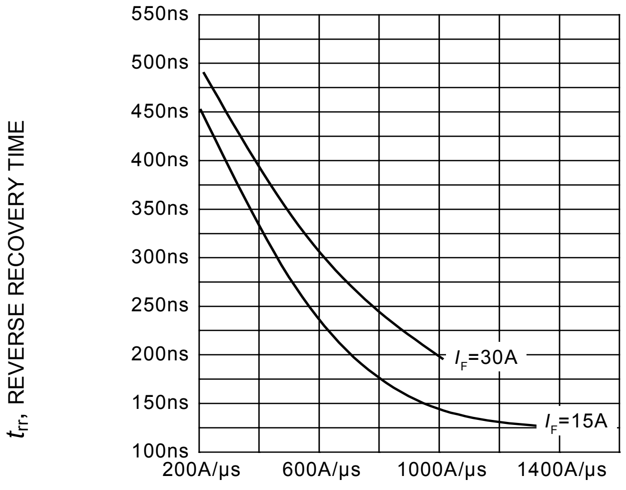
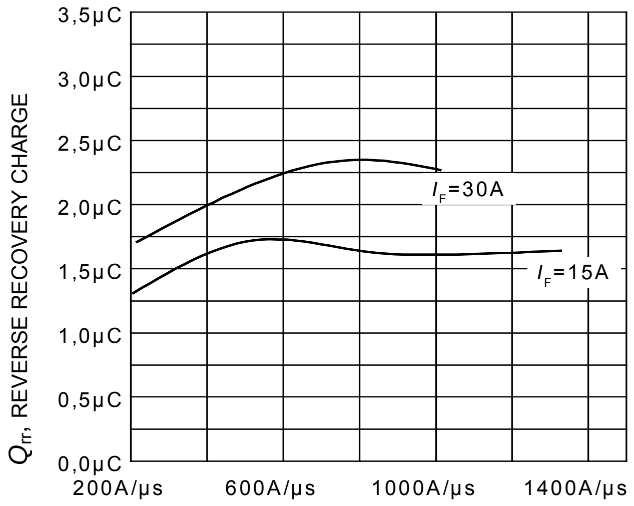



**Figure 20. Typical short circuit collector current as a function of gate-emitter voltage**
($V_{CE}$ ≤ 600V, $T_j$ ≤ 150°C)



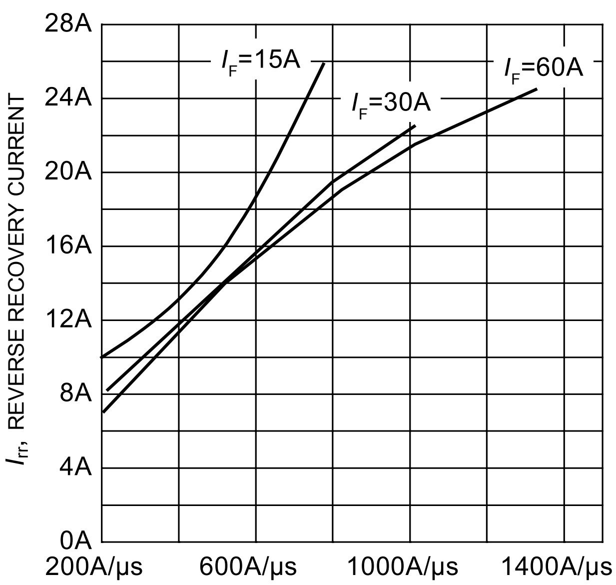




$di_F/dt$, DIODE CURRENT SLOPE

**Figure 21. Typical reverse recovery time as a function of diode current slope**
($V_R$=200V, $T_J$=125°C)

$di_F/dt$, DIODE CURRENT SLOPE

**Figure 22. Typical reverse recovery charge as a function of diode current slope**
($V_R$=200V, $T_J$=125°C)




$di_F/dt$, DIODE CURRENT SLOPE

**Figure 23. Typical reverse recovery current as a function of diode current slope**
($V_R$=200V, $T_J$=125°C)

$di_{rr}/dt$, DIODE PEAK RATE OF FALL OF REVERSE RECOVERY CURRENT

$di_F/dt$, DIODE CURRENT SLOPE

**Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R$=200V, $T_J$=125°C)

$I_F$, FORWARD CURRENT

$V_F$, FORWARD VOLTAGE

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

$V_F$, FORWARD VOLTAGE

$T_J$, JUNCTION TEMPERATURE

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

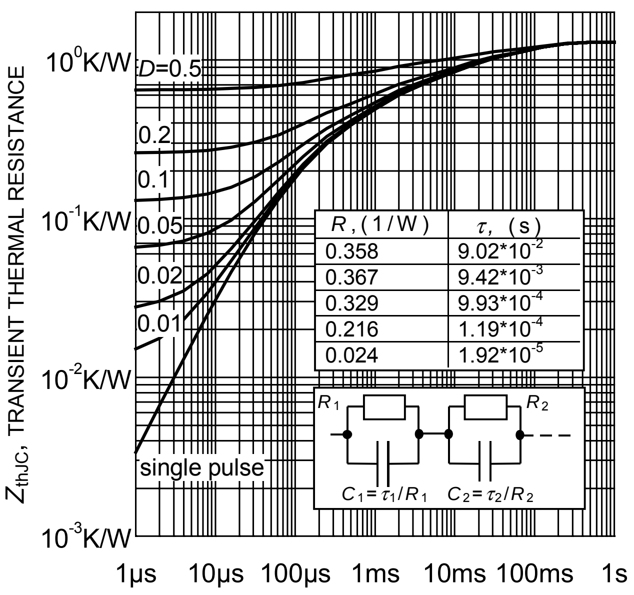
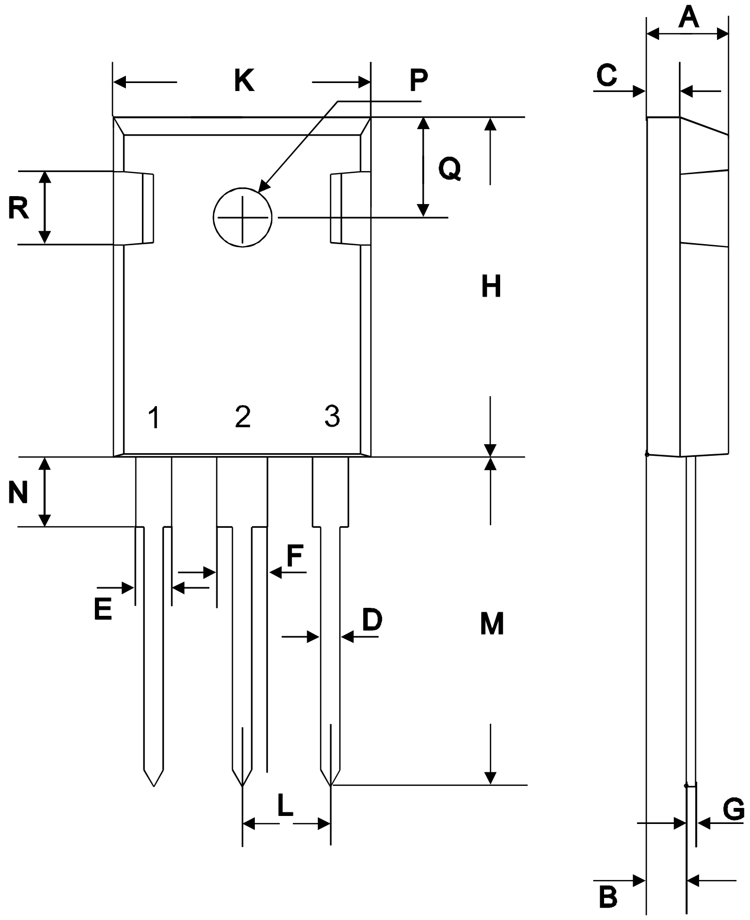



**Figure 27. Diode transient thermal impedance as a function of pulse width**
($D$=$t_P$/$T$)

TO-247AC




| symbol | dimensions | | | |
|---|---|---|---|---|
| | [mm] | | [inch] | |
| | min | max | min | max |
| A | 4.78 | 5.28 | 0.1882 | 0.2079 |
| B | 2.29 | 2.51 | 0.0902 | 0.0988 |
| C | 1.78 | 2.29 | 0.0701 | 0.0902 |
| D | 1.09 | 1.32 | 0.0429 | 0.0520 |
| E | 1.73 | 2.06 | 0.0681 | 0.0811 |
| F | 2.67 | 3.18 | 0.1051 | 0.1252 |
| G | 0.76 max | | 0.0299 max | |
| H | 20.80 | 21.16 | 0.8189 | 0.8331 |
| K | 15.65 | 16.15 | 0.6161 | 0.6358 |
| L | 5.21 | 5.72 | 0.2051 | 0.2252 |
| M | 19.81 | 20.68 | 0.7799 | 0.8142 |
| N | 3.560 | 4.930 | 0.1402 | 0.1941 |
| ∅P | 3.61 | | 0.1421 | |
| Q | 6.12 | 6.22 | 0.2409 | 0.2449 |

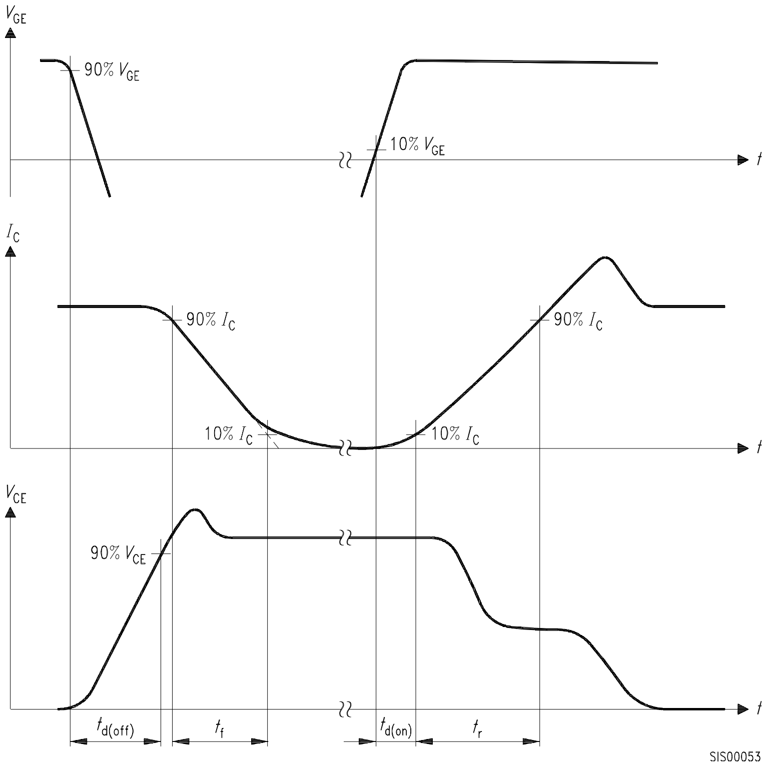



**Figure A. Definition of switching times**

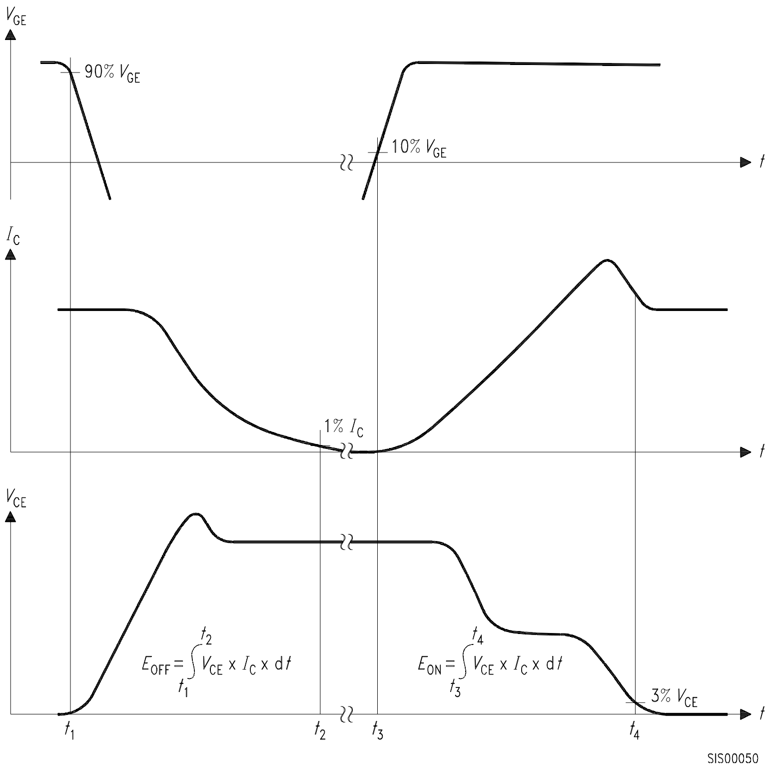



**Figure B. Definition of switching losses**

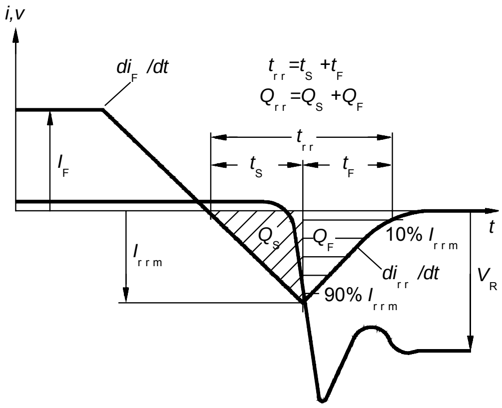



**Figure C. Definition of diodes switching characteristics**

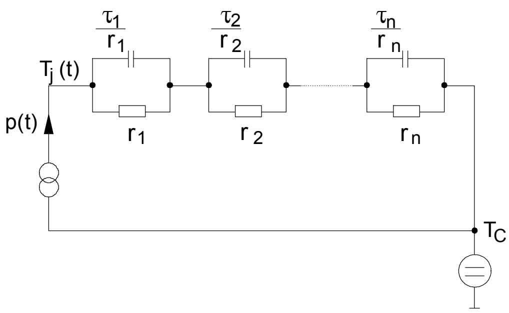



**Figure D. Thermal equivalent circuit**

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**Attention please!**

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