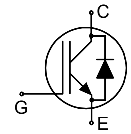
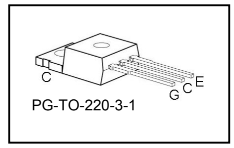
HighSpeed 2-Technology with soft, fast recovery anti-parallel EmCon HE diode




- **Designed for:**
  - SMPS
  - Lamp Ballast
  - ZVS-Converter
  - optimised for soft-switching / resonant topologies




- **2nd generation HighSpeed-Technology for 1200V applications offers:**
  - loss reduction in resonant circuits
  - temperature stable behavior
  - parallel switching capability
  - tight parameter distribution
  - $E_{off}$ optimized for $I_C$ =1A
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC[2] for target applications
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/

| **Type** | $V_{CE}$ | $I_C$ | $E_{off}$ | $T_j$ | **Marking** | **Package** |
|---|---|---|---|---|---|---|
| IKP01N120H2 | 1200V | 1A | 0.09mJ | 150°C | K01H1202 | PG-TO-220-3-1 |

**Maximum Ratings**

| **Parameter** | **Symbol** | **Value** | **Unit** |
|---|---|---|---|
| Collector-emitter voltage | $V_{CE}$ | 1200 | V |
| Triangular collector current<br>$T_C$ = 25°C, $f$ = 140kHz<br>$T_C$ = 100°C, $f$ = 140kHz | $I_C$ | <br>3.2<br>1.3 | A |
| Pulsed collector current, $t_p$ limited by $T_{jmax}$ | $I_{Cpuls}$ | 3.5 | |
| Turn off safe operating area<br>$V_{CE} \leq$ 1200V, $T_j \leq$ 150°C | - | 3.5 | |
| Diode forward current<br>$T_C$ = 25°C<br>$T_C$ = 100°C | $I_F$ | <br>3.2<br>1.3 | |
| Gate-emitter voltage | $V_{GE}$ | ±20 | V |
| Power dissipation<br>$T_C$ = 25°C | $P_{tot}$ | 28 | W |
| Operating junction and storage temperature | $T_j$ , $T_{stg}$ | -40...+150 | °C |
| Soldering temperature, 1.6mm (0.063 in.) from case for 10s | - | 260 | |

[2] J-STD-020 and JESD-022

**Thermal Resistance**

| Parameter | Symbol | Conditions | Max. Value | Unit |
|---|---|---|---|---|
| **Characteristic** | | | | |
| IGBT thermal resistance, junction – case | $R_{thJC}$ | | 4.5 | K/W |
| Diode thermal resistance, Junction - case | $R_{thJCD}$ | | 11 | |
| Thermal resistance, junction – ambient | $R_{thJA}$ | PG-TO-220-3-1 | 62 | |

**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, $I_C$=300µA | 1200 | - | - | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $V_{GE}$ = 15V, $I_C$=1A<br>$T_j$=25°C<br>$T_j$=150°C<br>$V_{GE}$ = 10V, $I_C$=1A, $T_j$=25°C | <br>-<br>-<br>- | <br>2.2<br>2.5<br>2.4 | <br>2.8<br>-<br>- | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C$=30µA, $V_{CE}$=$V_{GE}$ | 2.1 | 3 | 3.9 | |
| Zero gate voltage collector current | $I_{CES}$ | $V_{CE}$=1200V, $V_{GE}$=0V<br>$T_j$=25°C<br>$T_j$=150°C | <br>-<br>- | <br>-<br>- | <br>20<br>80 | µA |
| Diode forward voltage | $V_F$ | $V_{GE}$ = 0, $I_F$=0.5A<br>$T_j$=25°C<br>$T_j$=150°C | <br>-<br>- | <br>2.0<br>1.75 | <br>2.5<br>- | V |
| Gate-emitter leakage current | $I_{GES}$ | $V_{CE}$=0V, $V_{GE}$=20V | - | - | 40 | nA |
| Transconductance | $g_{fs}$ | $V_{CE}$=20V, $I_C$=1A | - | 0.75 | - | S |
| **Dynamic Characteristic** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{CE}$=25V, | - | 91.6 | - | pF |
| Output capacitance | $C_{oss}$ | $V_{GE}$=0V, | - | 9.8 | - | |
| Reverse transfer capacitance | $C_{rss}$ | $f$=1MHz | - | 3.4 | - | |
| Gate charge | $Q_{Gate}$ | $V_{CC}$=960V, $I_C$=1A<br>$V_{GE}$=15V | - | 8.6 | - | nC |
| Internal emitter inductance measured 5mm (0.197 in.) from case | $L_E$ | | - | 7 | - | nH |

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

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | Typ. | max. | |
| **IGBT Characteristic** | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j$=25°C, $V_{CC}$=800V, $I_C$=1A, $V_{GE}$=15V/0V, $R_G$=241Ω, $L_σ$[2]=180nH, $C_σ$[2]=40pF Energy losses include "tail" and diode [3] reverse recovery. | - | 13 | - | ns |
| Rise time | $t_r$ | | - | 6.3 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 370 | - | |
| Fall time | $t_f$ | | - | 28 | - | |
| Turn-on energy | $E_{on}$ | | - | 0.08 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.06 | - | |
| Total switching energy | $E_{ts}$ | | - | 0.14 | - | |
| **Anti-Parallel Diode Characteristic** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $T_j$=25°C, $V_R$=800V, $I_F$=1A, $R_G$=241Ω | - | 83 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 89 | - | µC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 2.5 | - | A |
| Diode current slope | $di_F/dt$ | | - | 289 | - | A/µs |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | 178 | - | |

**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 $V_{CC}$=800V, $I_C$=1A, $V_{GE}$=15V/0V, $R_G$=241Ω, $L_σ$[2]=180nH, $C_σ$[2]=40pF Energy losses include "tail" and diode [3] reverse recovery. | - | 12 | - | ns |
| Rise time | $t_r$ | | - | 8.9 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 450 | - | |
| Fall time | $t_f$ | | - | 43 | - | |
| Turn-on energy | $E_{on}$ | | - | 0.11 | - | mJ |
| Turn-off energy | $E_{off}$ | | - | 0.09 | - | |
| Total switching energy | $E_{ts}$ | | - | 0.2 | - | |
| **Anti-Parallel Diode Characteristic** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $T_j$=150°C $V_R$=800V, $I_F$=1A, $R_G$=241Ω | - | 213 | - | ns |
| Diode reverse recovery charge | $Q_{rr}$ | | - | 180 | - | µC |
| Diode peak reverse recovery current | $I_{rrm}$ | | - | 2.7 | - | A |
| Diode current slope | $di_F/dt$ | | - | 240 | - | A/µs |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ | | - | 135 | - | |

[2] Leakage inductance $L_σ$ and stray capacity $C_σ$ due to dynamic test circuit in figure E
[3] Commutation diode from device IKP01N120H2

**Switching Energy ZVT, Inductive Load**

| Parameter | Symbol | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **IGBT Characteristic** | | | | | | |
| Turn-off energy | $E_{off}$ | $V_{CC}$=800V, $I_C$=1A, $V_{GE}$=15V/0V, $R_G$=241Ω, $C_r$[2)]=1nF | | | | mJ |
| | | $T_j$=25°C | - | 0.02 | - | |
| | | $T_j$=150°C | - | 0.044 | - | |

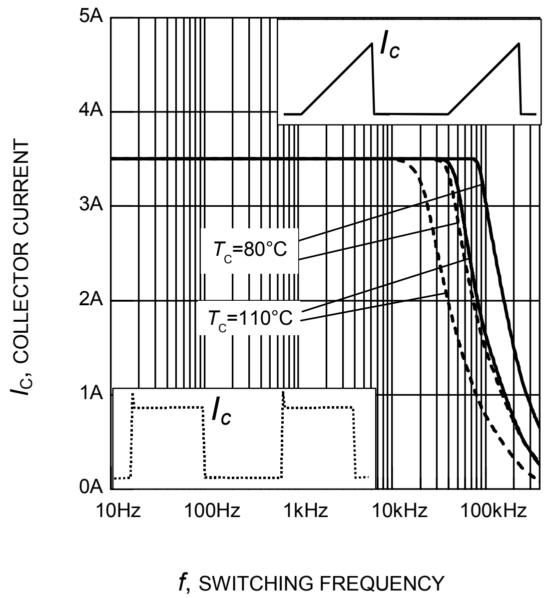



**Figure 1. Collector current as a function of switching frequency**
($T_j \le 150°C$, $D = 0.5$, $V_{CE} = 800V$, $V_{GE} = +15V/0V$, $R_G = 241\Omega$)

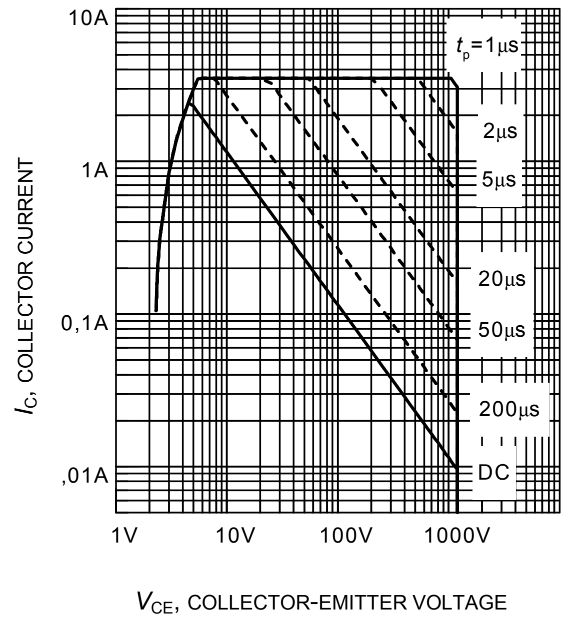



**Figure 2. Safe operating area**
($D = 0$, $T_C = 25°C$, $T_j \le 150°C$)

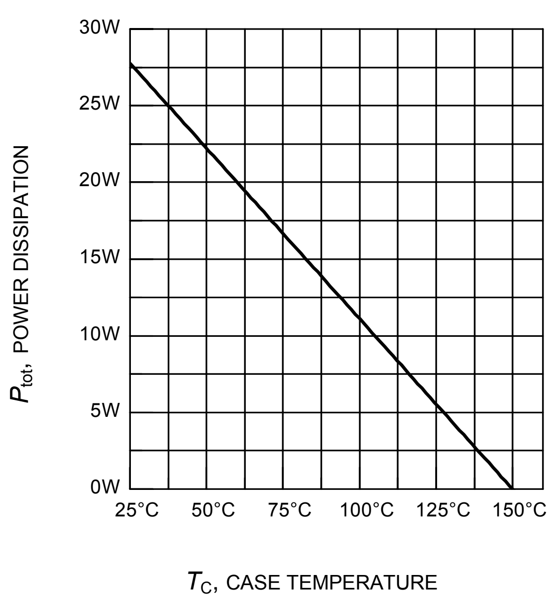



**Figure 3. Power dissipation as a function of case temperature**
($T_j \le 150°C$)

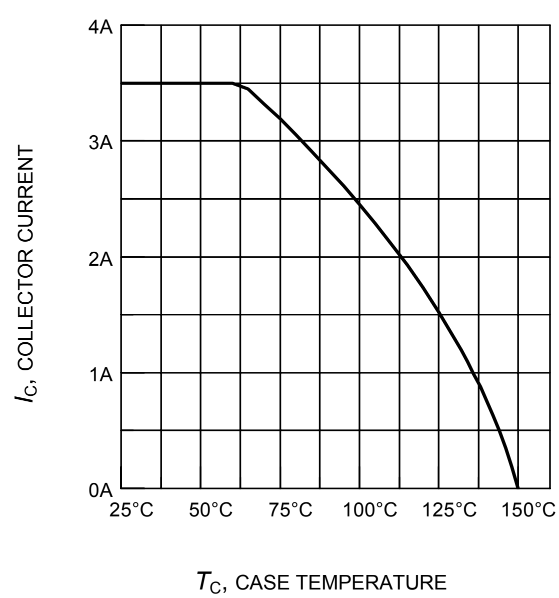



**Figure 4. Collector current as a function of case temperature**
($V_{GE} \le 15V$, $T_j \le 150°C$)

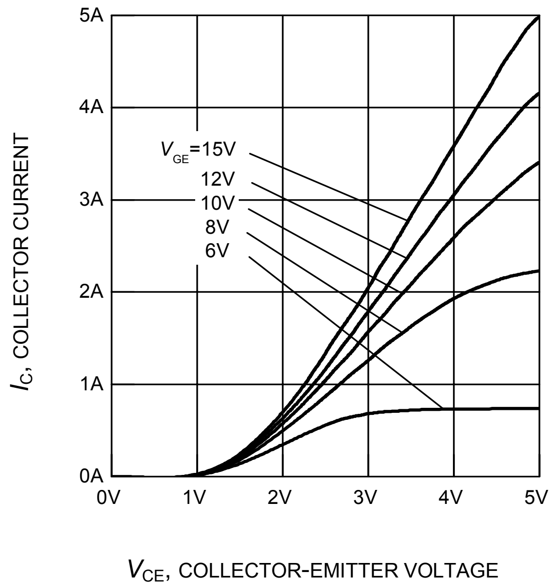



**Figure 5. Typical output characteristics**
($T_j$ = 25°C)

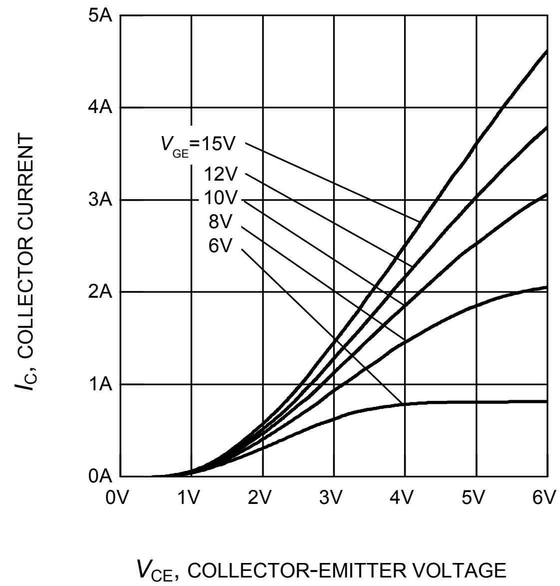



**Figure 6. Typical output characteristics**
($T_j$ = 150°C)

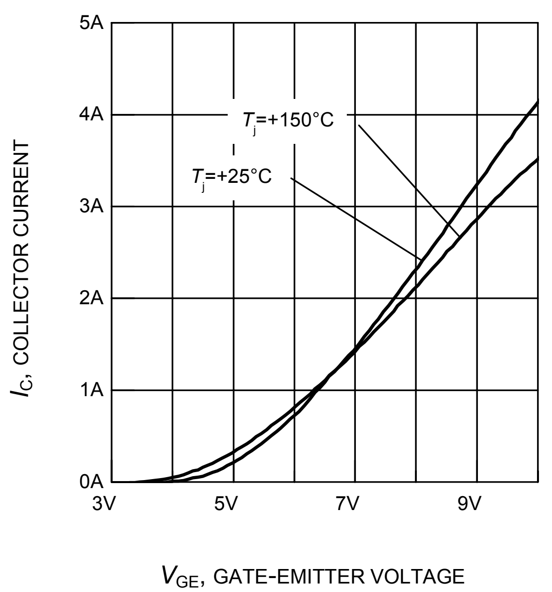



**Figure 7. Typical transfer characteristics**
($V_{CE}$ = 20V)

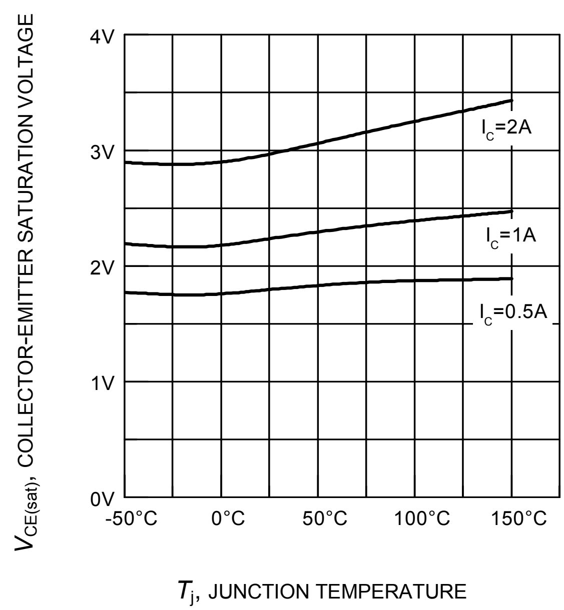
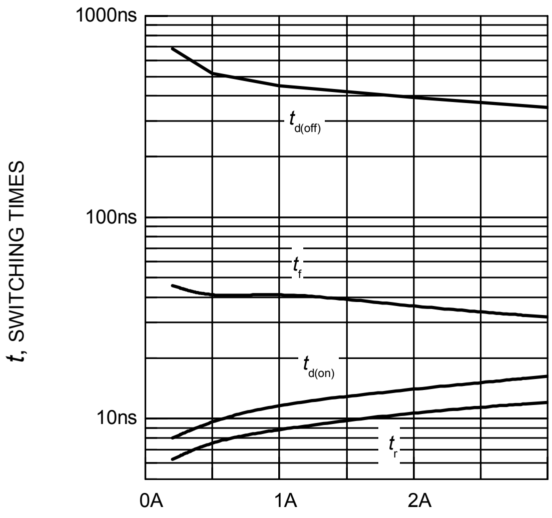
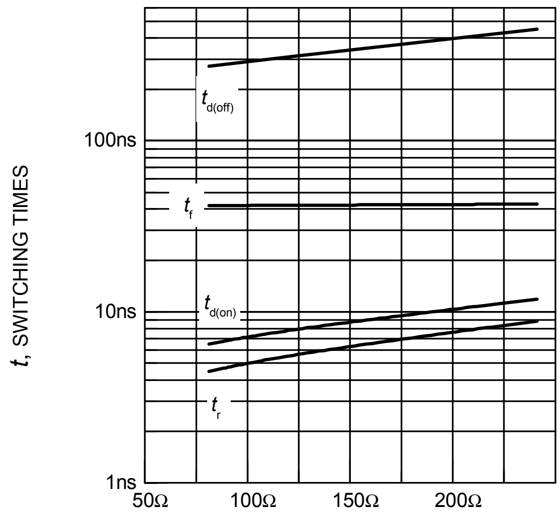



**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}$ = 15V)



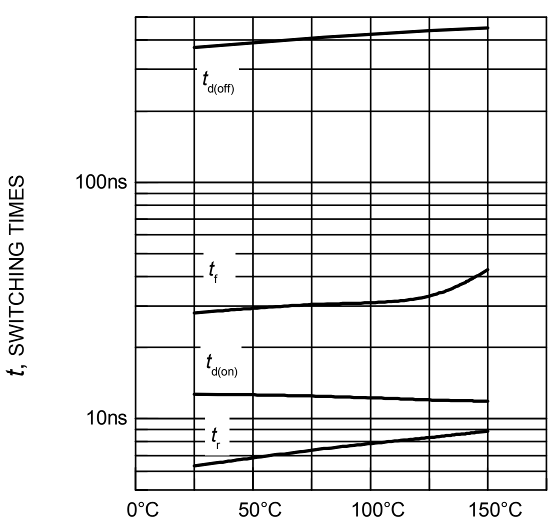

$I_C$, COLLECTOR CURRENT

**Figure 9. Typical switching times as a function of collector current**
(inductive load, $T_j$ = 150°C, $V_{CE}$ = 800V, $V_{GE}$ = +15V/0V, $R_G$ = 241Ω, dynamic test circuit in Fig.E)



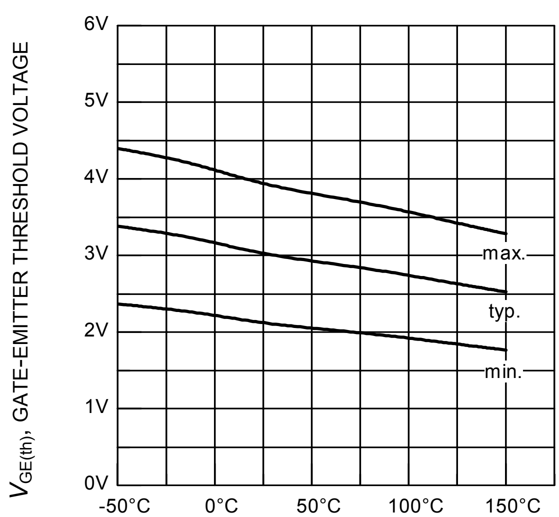

$R_G$, GATE RESISTOR

**Figure 10. Typical switching times as a function of gate resistor**
(inductive load, $T_j$ = 150°C, $V_{CE}$ = 800V, $V_{GE}$ = +15V/0V, $I_C$ = 1A, dynamic test circuit in Fig.E)




$T_j$, JUNCTION TEMPERATURE

**Figure 11. Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}$ = 800V, $V_{GE}$ = +15V/0V, $I_C$ = 1A, $R_G$ = 241Ω, dynamic test circuit in Fig.E)




$T_j$, JUNCTION TEMPERATURE

**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**
($I_C$ = 0.03mA)

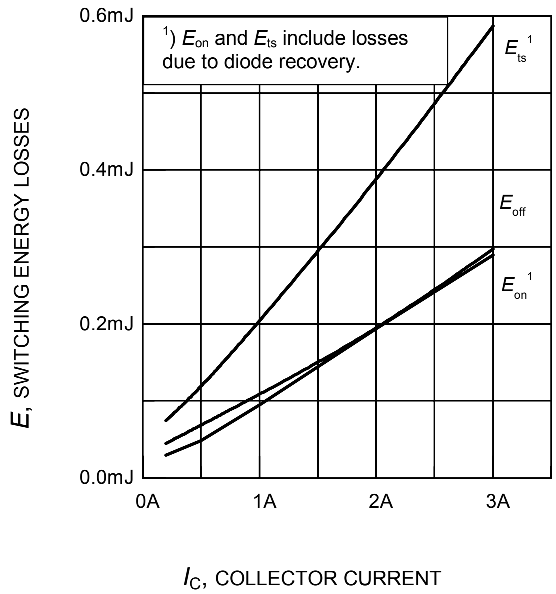



**Figure 13. Typical switching energy losses as a function of collector current**
(inductive load, $T_j$ = 150°C, $V_{CE}$ = 800V, $V_{GE}$ = +15V/0V, $R_G$ = 241Ω, dynamic test circuit in Fig.E )

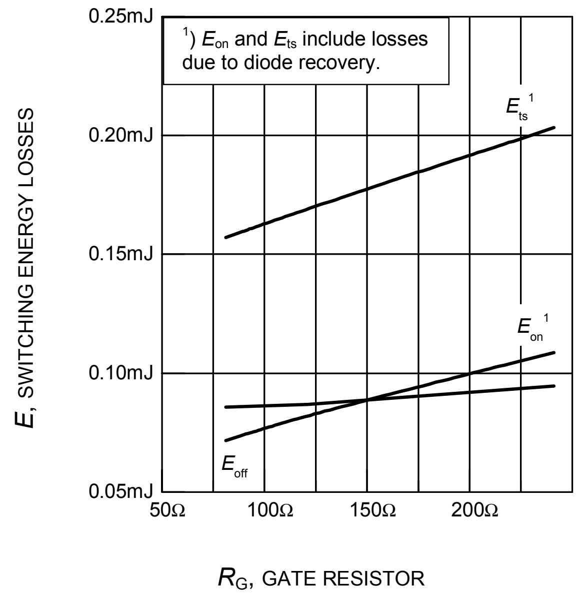



**Figure 14. Typical switching energy losses as a function of gate resistor**
(inductive load, $T_j$ = 150°C, $V_{CE}$ = 800V, $V_{GE}$ = +15V/0V, $I_C$ = 1A, dynamic test circuit in Fig.E )

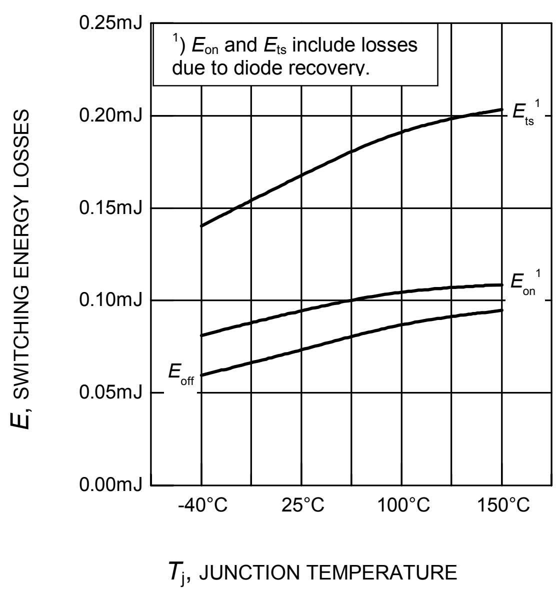



**Figure 15. Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}$ = 800V, $V_{GE}$ = +15V/0V, $I_C$ = 1A, $R_G$ = 241Ω, dynamic test circuit in Fig.E )

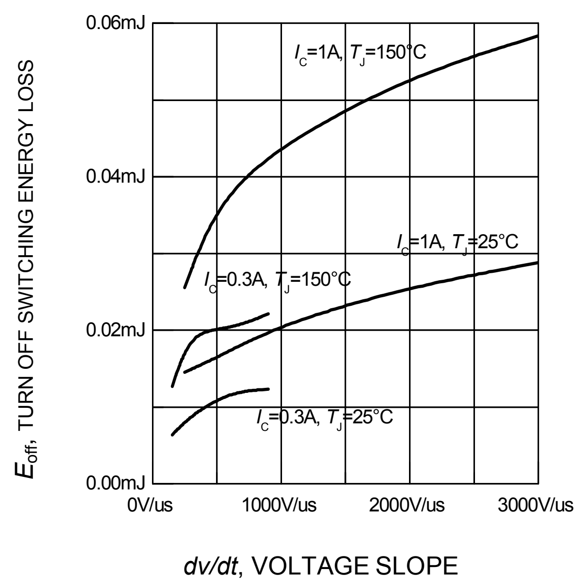



**Figure 16. Typical turn off switching energy loss for soft switching**
(*dynamic test circuit in Fig. E*)

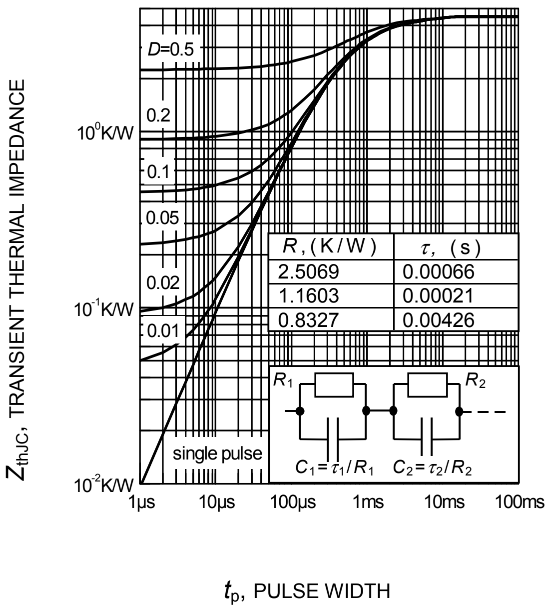



**Figure 17. IGBT transient thermal impedance as a function of pulse width**
($D = t_p / T$)

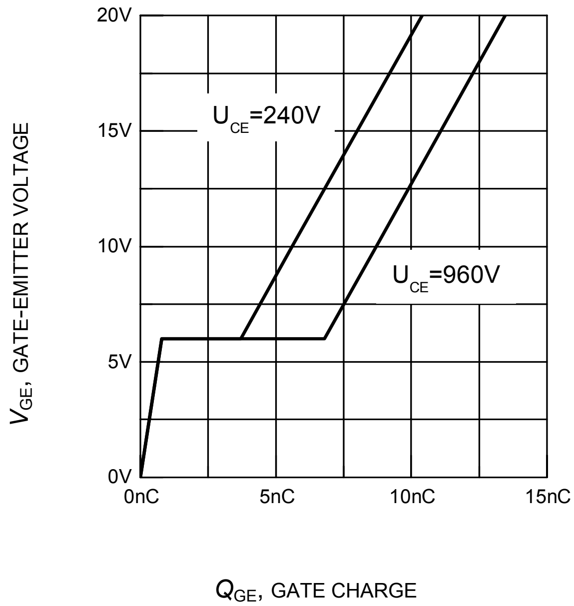



**Figure 18. Typical gate charge**
($I_C$ = 1A)

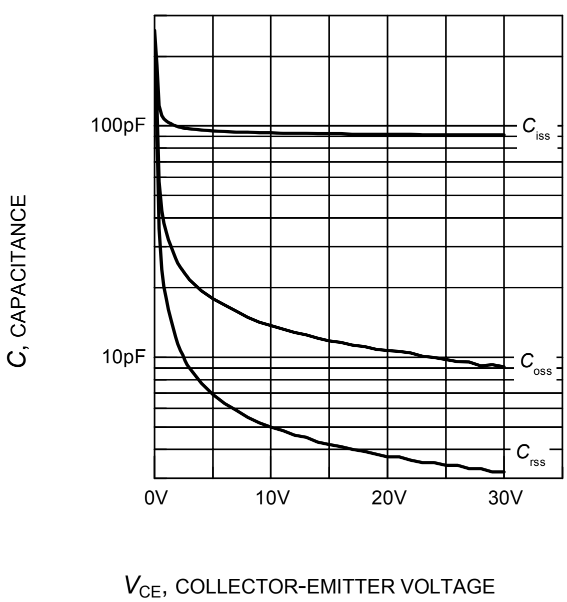



**Figure 19. Typical capacitance as a function of collector-emitter voltage**
($V_{GE}$ = 0V, $f$ = 1MHz)

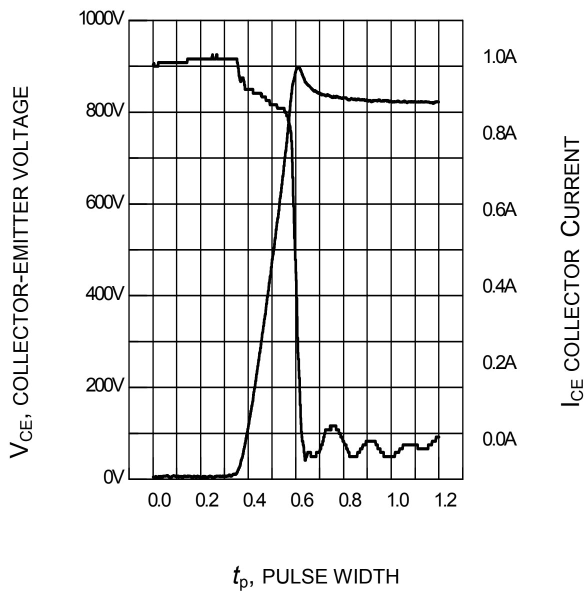
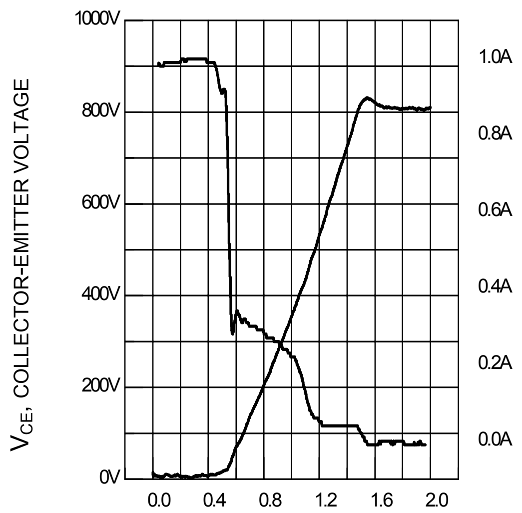
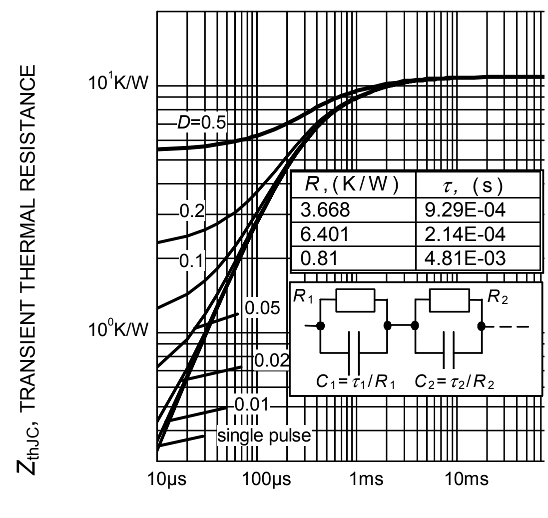



**Figure 20. Typical turn off behavior, hard switching**
($V_{GE}$=15/0V, $R_G$=220Ω, $T_j$ = 150°C, Dynamic test circuit in Figure E)



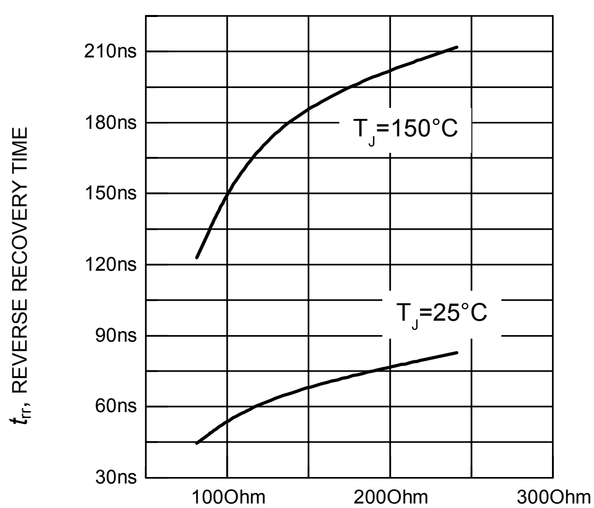

$t_p$, PULSE WIDTH

**Figure 21. Typical turn off behavior, soft switching**
($V_{GE}$=15/0V, $R_G$=220Ω, $T_j$ = 150°C, Dynamic test circuit in Figure E)



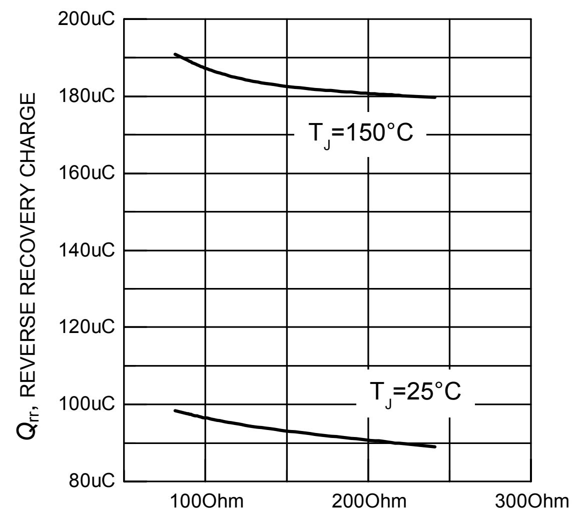

$t_P$, PULSE WIDTH

**Figure 22. Diode transient thermal impedance as a function of pulse width**
($D$=$t_P$/$T$)



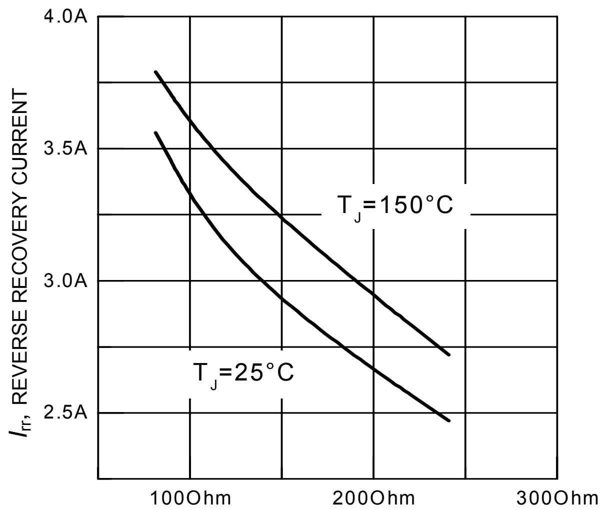

$R_G$, GATE RESISTANCE

**Figure 23. Typical reverse recovery time as a function of diode current slope**
$V_R$=800V, $I_F$=3A,
Dynamic test circuit in Figure E)



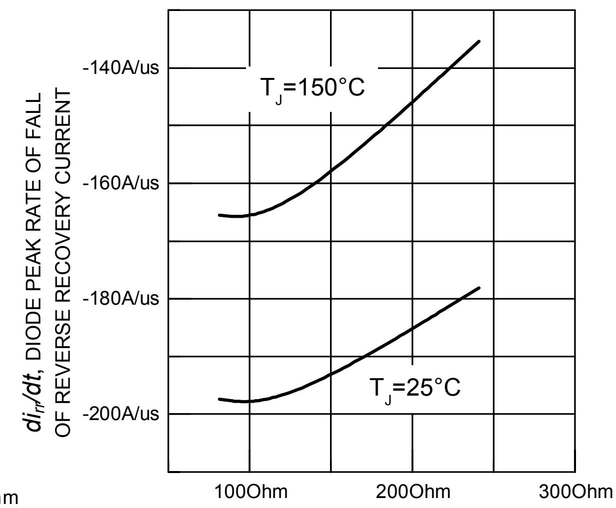

$R_G$, GATE RESISTANCE

**Figure 24. Typical reverse recovery charge as a function of diode current slope**
($V_R$=800V, $I_F$=3A,
Dynamic test circuit in Figure E)



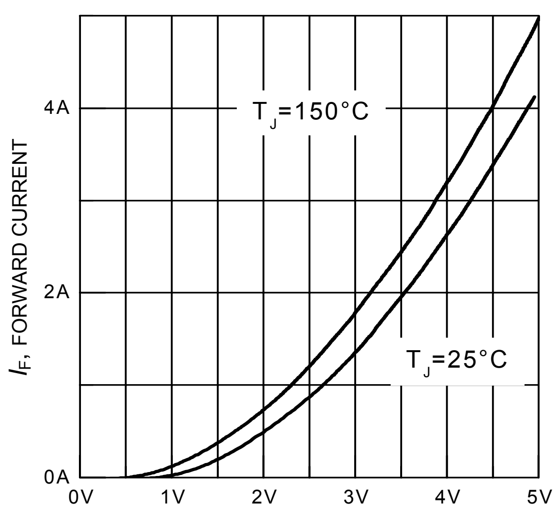

$R_G$, GATE RESISTANCE

**Figure 25. Typical reverse recovery current as a function of diode current slope**
($V_R$=800V, $I_F$=3A,
Dynamic test circuit in Figure E)



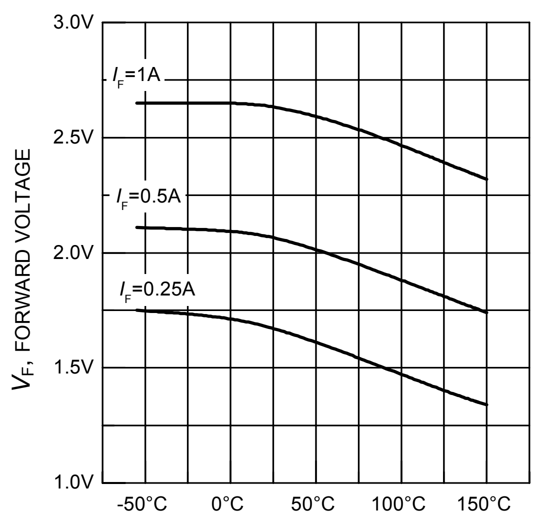

$R_G$, GATE RESISTANCE

**Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R$=800V, $I_F$=3A,
Dynamic test circuit in Figure E)




$V_F$, FORWARD VOLTAGE

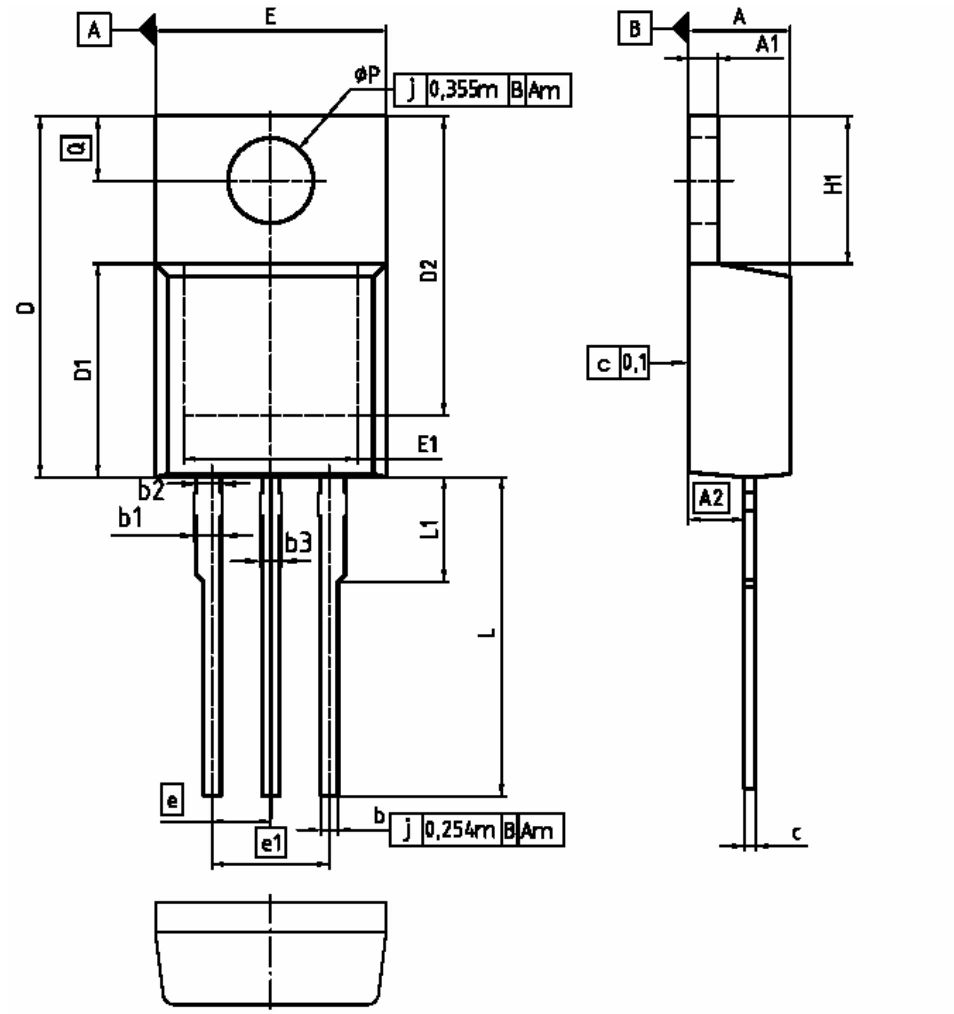
**Figure 27. Typical diode forward current as a function of forward voltage**




$T_J$, JUNCTION TEMPERATURE

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

PG-TO220-3-1




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.30 | 4.57 | 0.169 | 0.180 |
| A1 | 1.17 | 1.40 | 0.046 | 0.055 |
| A2 | 2.15 | 2.72 | 0.085 | 0.107 |
| b | 0.65 | 0.86 | 0.026 | 0.034 |
| b1 | 0.95 | 1.40 | 0.037 | 0.055 |
| b2 | 0.95 | 1.15 | 0.037 | 0.045 |
| b3 | 0.65 | 1.15 | 0.026 | 0.045 |
| c | 0.33 | 0.60 | 0.013 | 0.024 |
| D | 14.81 | 15.95 | 0.583 | 0.628 |
| D1 | 8.51 | 9.45 | 0.335 | 0.372 |
| D2 | 12.19 | 13.10 | 0.480 | 0.516 |
| E | 9.70 | 10.36 | 0.382 | 0.408 |
| E1 | 6.50 | 8.60 | 0.256 | 0.339 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 3 | | 3 | |
| H1 | 5.90 | 6.90 | 0.232 | 0.272 |
| L | 13.00 | 14.00 | 0.512 | 0.551 |
| L1 | - | 4.80 | - | 0.189 |
| øP | 3.60 | 3.89 | 0.142 | 0.153 |
| Q | 2.60 | 3.00 | 0.102 | 0.118 |

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EUROPEAN PROJECTION

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REVISION
05

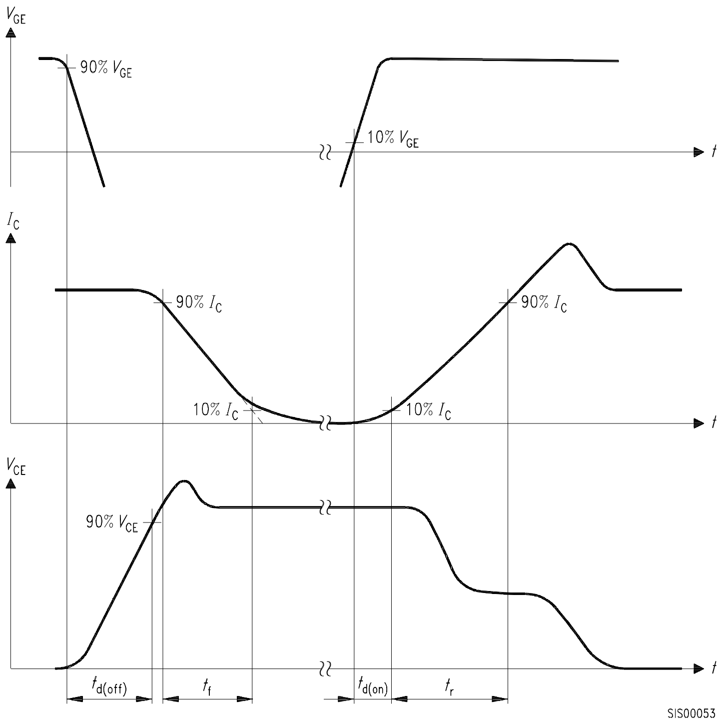


**Figure A. Definition of switching times**

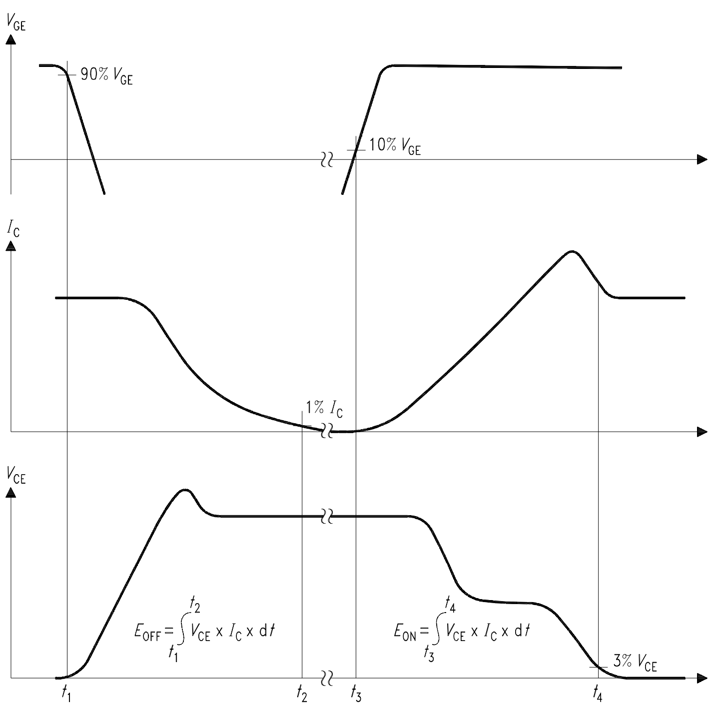


**Figure B. Definition of switching losses**

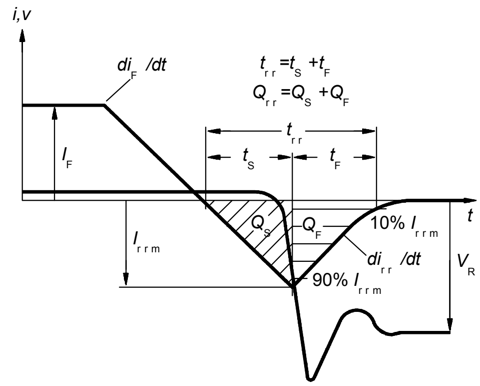


**Figure C. Definition of diodes switching characteristics**

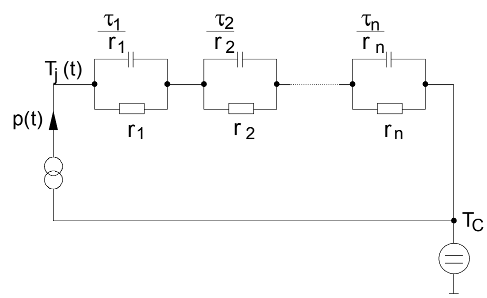


**Figure D. Thermal equivalent circuit**

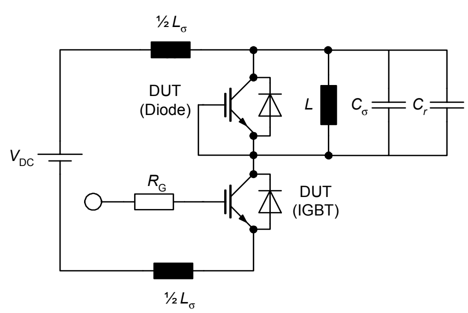


**Figure E. Dynamic test circuit**
Leakage inductance $L_\sigma$= 180nH,
Stray capacitor $C_\sigma$ = 40pF,
Relief capacitor $C_r$ = 1nF (only for ZVT switching)

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