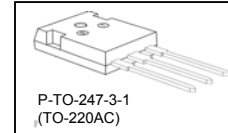
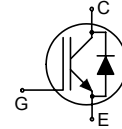


Low Loss DuoPack : IGBT in Trench and Fieldstop technology
with soft, fast recovery anti-parallel EmCon HE diode

- Very low $V_{CE(sat)}$ 1.5 V (typ.)
- Maximum Junction Temperature 175 °C
- Short circuit withstand time – 5 μ s
- Designed for :
 - Frequency Converters
 - Uninterrupted Power Supply
- Trench and Fieldstop technology for 600 V applications offers :
 - very tight parameter distribution
 - high ruggedness, temperature stable behavior
 - very high switching speed
 - low $V_{CE(sat)}$
- Positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Very soft, fast recovery anti-parallel EmCon HE diode
- Complete product spectrum and PSpice Models : <http://www.infineon.com/igbt/>



| Type | V_{CE} | I_C | $V_{CE(sat), T_j=25^\circ C}$ | $T_{j,max}$ | Marking Code | Package | Ordering Code |
|-----------|----------|-------|-------------------------------|-------------|--------------|---------|---------------|
| IKW50N60T | 600V | 50A | 1.5V | 175°C | K50T60 | TO-247 | Q67040S4718 |

Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|-------------|------------------|---------|
| Collector-emitter voltage | V_{CE} | 600 | V |
| DC collector current, limited by $T_{j,max}$ | I_C | 80 ¹⁾ | A |
| $T_C = 25^\circ C$ | | 50 | |
| $T_C = 100^\circ C$ | | | |
| Pulsed collector current, t_p limited by $T_{j,max}$ | I_{Cpuls} | 150 | |
| Turn off safe operating area ($V_{CE} \leq 600V, T_j \leq 175^\circ C$) | - | 150 | |
| Diode forward current, limited by $T_{j,max}$ | I_F | 100 | A |
| $T_C = 25^\circ C$ | | 50 | |
| $T_C = 100^\circ C$ | | | |
| Diode pulsed current, t_p limited by $T_{j,max}$ | I_{Fpuls} | 150 | |
| Gate-emitter voltage | V_{GE} | ± 20 | V |
| Short circuit withstand time ²⁾ | t_{SC} | 5 | μ s |
| $V_{GE} = 15V, V_{CC} \leq 400V, T_j \leq 150^\circ C$ | | | |
| Power dissipation $T_C = 25^\circ C$ | P_{tot} | 333 | W |
| Operating junction temperature | T_j | -40...+175 | °C |
| Storage temperature | T_{stg} | -55...+175 | |
| Soldering temperature, 1.6mm (0.063 in.) from case for 10s | - | 260 | |

¹⁾ Value limited by bond wire

²⁾ 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} | TO-247 AC | 0.45 | K/W |
| Diode thermal resistance, junction – case | R_{thJCD} | TO-247 AC | 0.8 | |
| Thermal resistance, junction – ambient | R_{thJA} | TO-247 AC | 40 | |

Electrical Characteristic, at $T_j = 25^\circ\text{C}$, unless otherwise specified

| Parameter | Symbol | Conditions | Value | | | Unit |
|--------------------------------------|---------------|---|-------|------|------|---------------|
| | | | min. | Typ. | max. | |
| Static Characteristic | | | | | | |
| Collector-emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE}=0V, I_C=0.2mA$ | 600 | - | - | V |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $V_{GE} = 15V, I_C=50A$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$ | - | 1.5 | 2 | |
| Diode forward voltage | V_F | $V_{GE}=0V, I_F=50A$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$ | - | 1.65 | 2.05 | |
| | | | - | 1.6 | - | |
| Gate-emitter threshold voltage | $V_{GE(th)}$ | $I_C=0.8mA, V_{CE}=V_{GE}$ | 4.1 | 4.9 | 5.7 | |
| Zero gate voltage collector current | I_{CES} | $V_{CE}=600V, V_{GE}=0V$ $T_j=25^\circ\text{C}$ $T_j=175^\circ\text{C}$ | - | - | 40 | μA |
| | | | - | - | 1000 | |
| Gate-emitter leakage current | I_{GES} | $V_{CE}=0V, V_{GE}=20V$ | - | - | 100 | nA |
| Transconductance | g_{fs} | $V_{CE}=20V, I_C=50A$ | - | 31 | - | S |
| Integrated gate resistor | R_{Gint} | | | - | | Ω |

Dynamic Characteristic

| | | | | | | |
|--|-------------|---|---|-------|---|---------------|
| Input capacitance | C_{iss} | $V_{CE}=25V,$ $V_{GE}=0V,$ $f=1MHz$ | - | 3140 | - | μF |
| Output capacitance | C_{oss} | | - | 200 | - | |
| Reverse transfer capacitance | C_{riss} | | - | 93 | - | |
| Gate charge | Q_{Gate} | $V_{CC}=480V, I_C=50A$ $V_{GE}=15V$ | - | 310 | - | nC |
| Internal emitter inductance measured 5mm (0.197 in.) from case | L_E | TO-247-3-1 | - | 7 | - | nH |
| Short circuit collector current ¹⁾ | $I_{C(SC)}$ | $V_{GE}=15V, t_{SC}\leq 5\mu\text{s}$ $V_{CC} = 400V,$ $T_j \leq 150^\circ\text{C}$ | - | 458.3 | - | A |

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

Switching Characteristic, Inductive Load, at $T_j=25^\circ\text{C}$

| Parameter | Symbol | Conditions | Value | | | Unit |
|--|--------------|--|-------|------|------|------------------------|
| | | | min. | Typ. | max. | |
| IGBT Characteristic | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j=25^\circ\text{C}$, $V_{CC}=400\text{V}$, $I_C=50\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=7\ \Omega$, $L_{\sigma}^{1)}=103\text{nH}$, $C_{\sigma}^{1)}=39\text{pF}$ Energy losses include "tail" and diode reverse recovery. | - | 26 | - | ns |
| Rise time | t_r | | - | 29 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 299 | - | |
| Fall time | t_f | | - | 29 | - | |
| Turn-on energy | E_{on} | | - | 1.2 | - | mJ |
| Turn-off energy | E_{off} | | - | 1.4 | - | |
| Total switching energy | E_{ts} | | - | 2.6 | - | |
| Anti-Parallel Diode Characteristic | | | | | | |
| Diode reverse recovery time | t_{rr} | $T_j=25^\circ\text{C}$, $V_R=400\text{V}$, $I_F=50\text{A}$, $di_F/dt=1280\text{A}/\mu\text{s}$ | - | 143 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 1.8 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 27.7 | - | A |
| Diode peak rate of fall of reverse recovery current during t_b | di_{rr}/dt | | - | 671 | - | $\text{A}/\mu\text{s}$ |

Switching Characteristic, Inductive Load, at $T_j=175^\circ\text{C}$

| Parameter | Symbol | Conditions | Value | | | Unit |
|--|--------------|---|-------|------|------|------------------------|
| | | | min. | Typ. | max. | |
| IGBT Characteristic | | | | | | |
| Turn-on delay time | $t_{d(on)}$ | $T_j=175^\circ\text{C}$, $V_{CC}=400\text{V}$, $I_C=50\text{A}$, $V_{GE}=0/15\text{V}$, $R_G=7\ \Omega$, $L_{\sigma}^{1)}=103\text{nH}$, $C_{\sigma}^{1)}=39\text{pF}$ Energy losses include "tail" and diode reverse recovery. | - | 27 | - | ns |
| Rise time | t_r | | - | 33 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 341 | - | |
| Fall time | t_f | | - | 55 | - | |
| Turn-on energy | E_{on} | | - | 1.8 | - | mJ |
| Turn-off energy | E_{off} | | - | 1.8 | - | |
| Total switching energy | E_{ts} | | - | 3.6 | - | |
| Anti-Parallel Diode Characteristic | | | | | | |
| Diode reverse recovery time | t_{rr} | $T_j=175^\circ\text{C}$, $V_R=400\text{V}$, $I_F=50\text{A}$, $di_F/dt=1280\text{A}/\mu\text{s}$ | - | 205 | - | ns |
| Diode reverse recovery charge | Q_{rr} | | - | 4.3 | - | μC |
| Diode peak reverse recovery current | I_{rrm} | | - | 40.7 | - | A |
| Diode peak rate of fall of reverse recovery current during t_b | di_{rr}/dt | | - | 449 | - | $\text{A}/\mu\text{s}$ |

¹⁾ Leakage inductance L_{σ} and Stray capacity C_{σ} due to dynamic test circuit in Figure E.

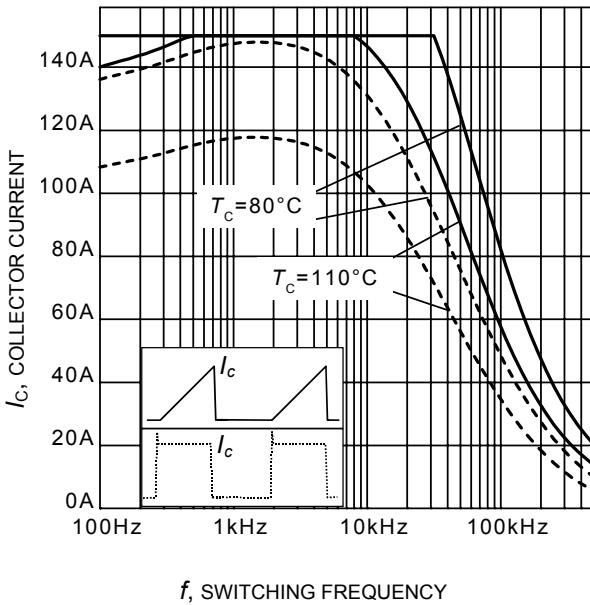


Figure 1. Collector current as a function of switching frequency
 ($T_j \leq 175^\circ\text{C}$, $D = 0.5$, $V_{CE} = 400\text{V}$,
 $V_{GE} = 0/+15\text{V}$, $R_G = 7\Omega$)

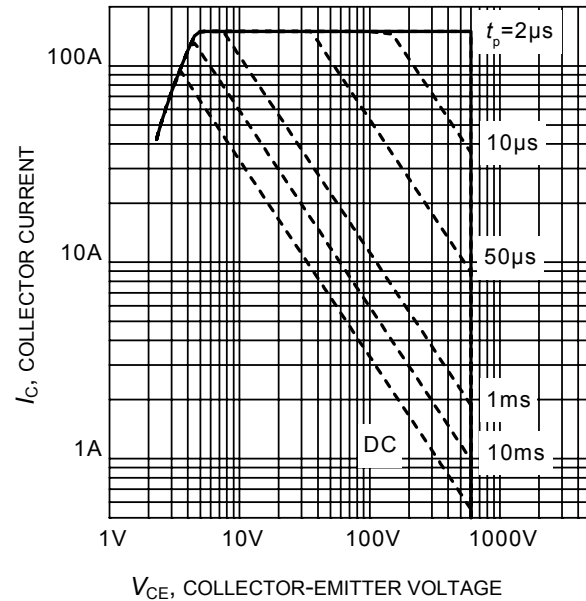


Figure 2. Safe operating area
 ($D = 0$, $T_C = 25^\circ\text{C}$, $T_j \leq 175^\circ\text{C}$;
 $V_{GE} = 15\text{V}$)

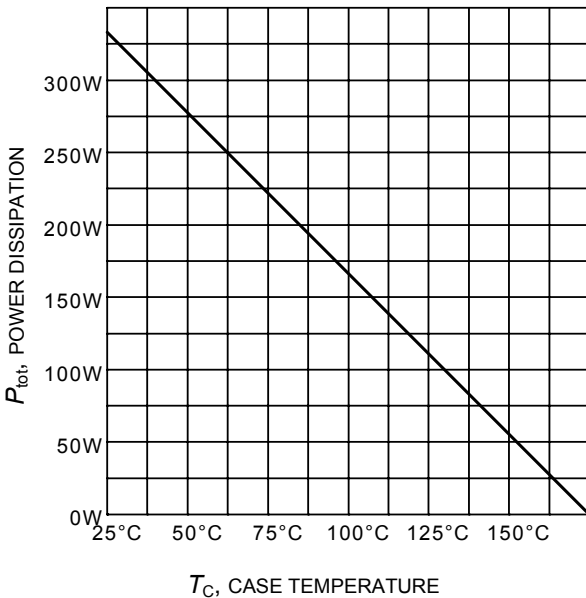


Figure 3. Power dissipation as a function of case temperature
 ($T_j \leq 175^\circ\text{C}$)

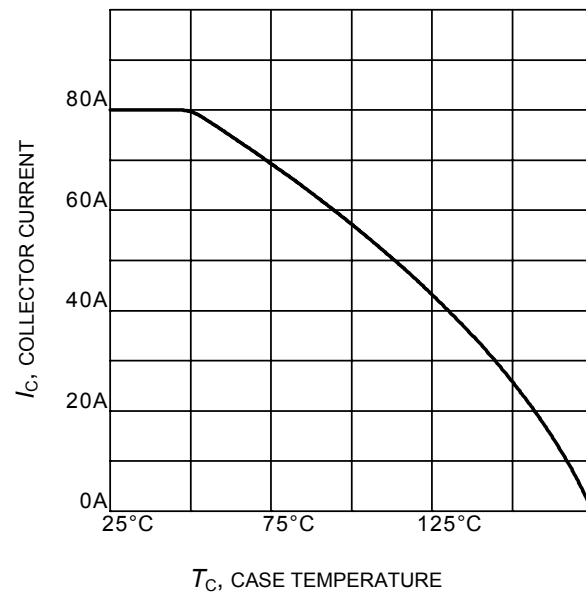


Figure 4. Collector current as a function of case temperature
 ($V_{GE} \geq 15\text{V}$, $T_j \leq 175^\circ\text{C}$)

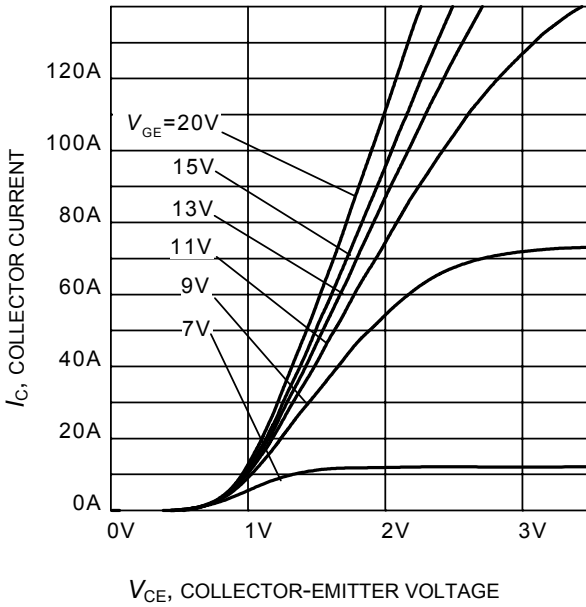


Figure 5. Typical output characteristic
($T_J = 25^\circ\text{C}$)

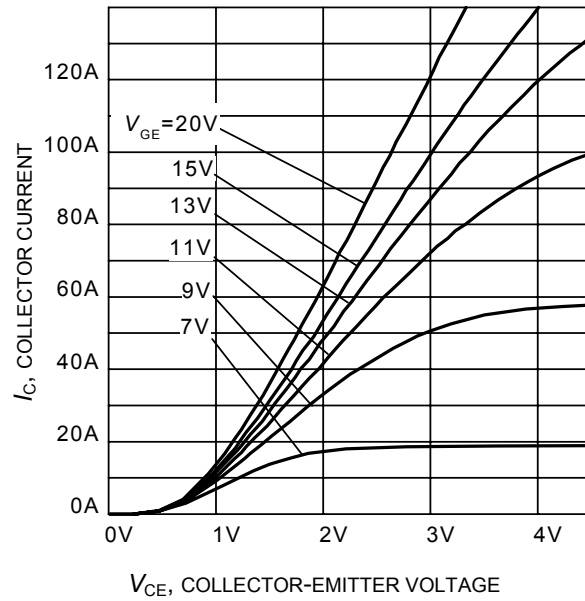


Figure 6. Typical output characteristic
($T_J = 175^\circ\text{C}$)

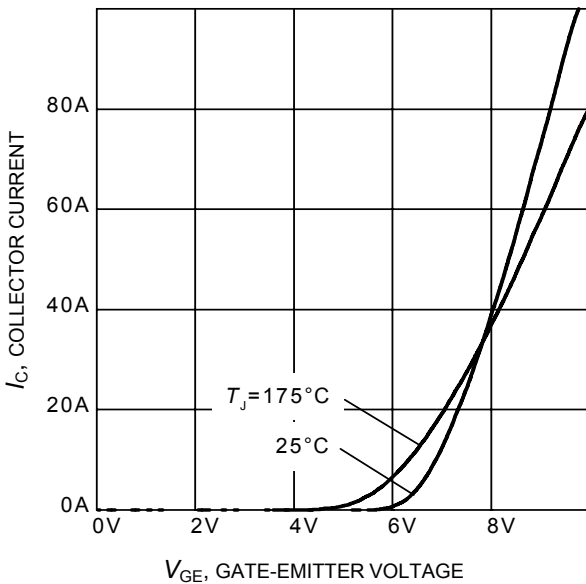


Figure 7. Typical transfer characteristic
($V_{CE} = 10\text{V}$)

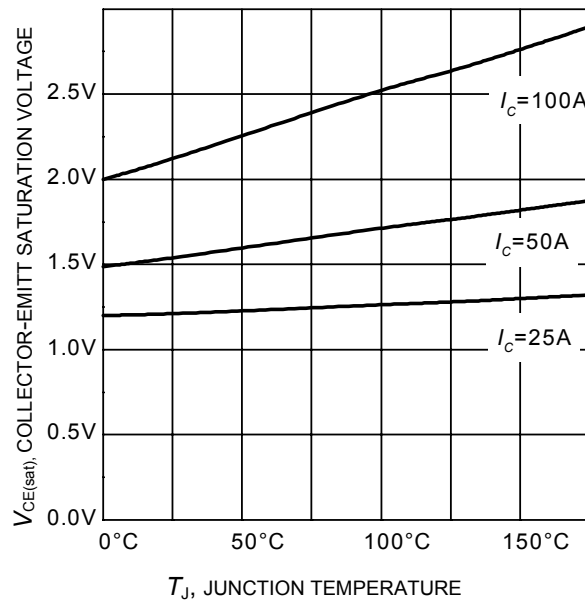


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
($V_{GE} = 15\text{V}$)

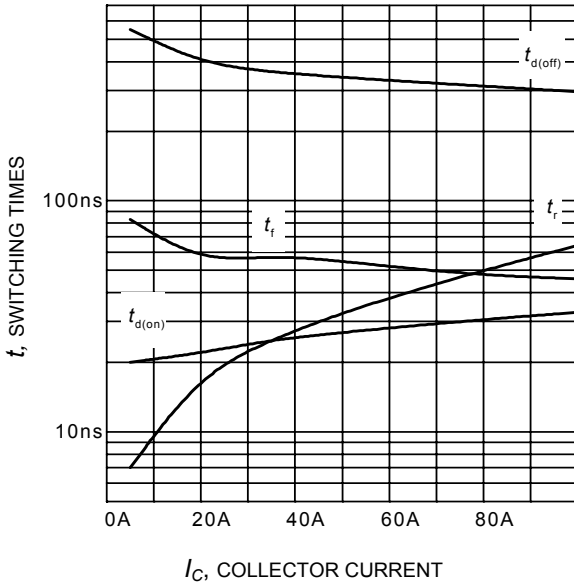


Figure 9. Typical switching times as a function of collector current
(inductive load, $T_J=175^\circ\text{C}$,
 $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $R_G = 7\Omega$,
Dynamic test circuit in Figure E)

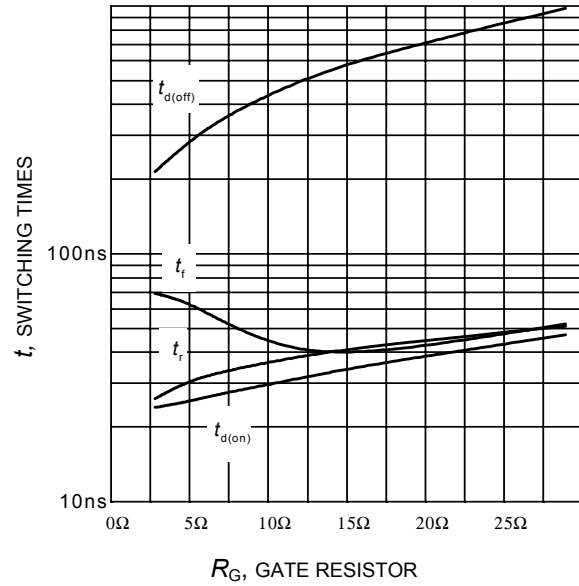


Figure 10. Typical switching times as a function of gate resistor
(inductive load, $T_J = 175^\circ\text{C}$,
 $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$,
Dynamic test circuit in Figure E)

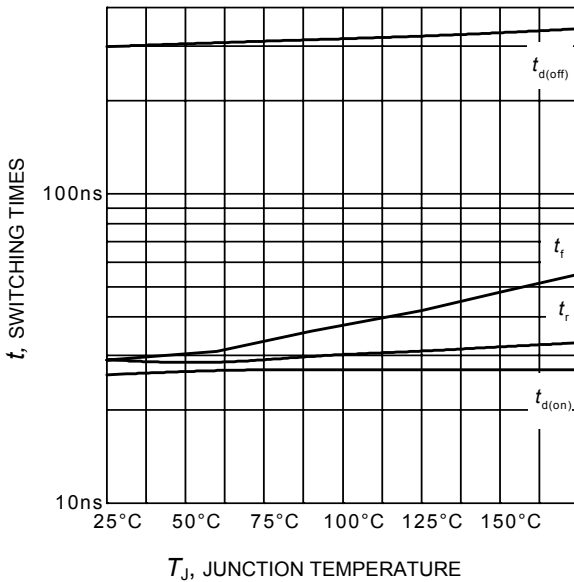


Figure 11. Typical switching times as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$,
 $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, $R_G = 7\Omega$,
Dynamic test circuit in Figure E)

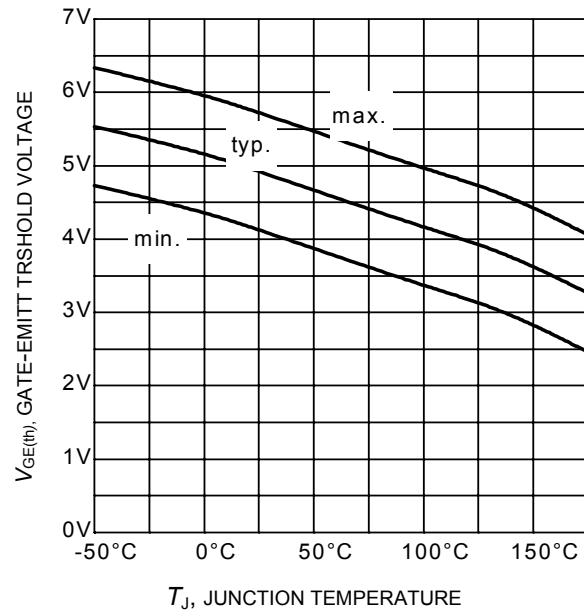


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
($I_C = 0.8\text{mA}$)

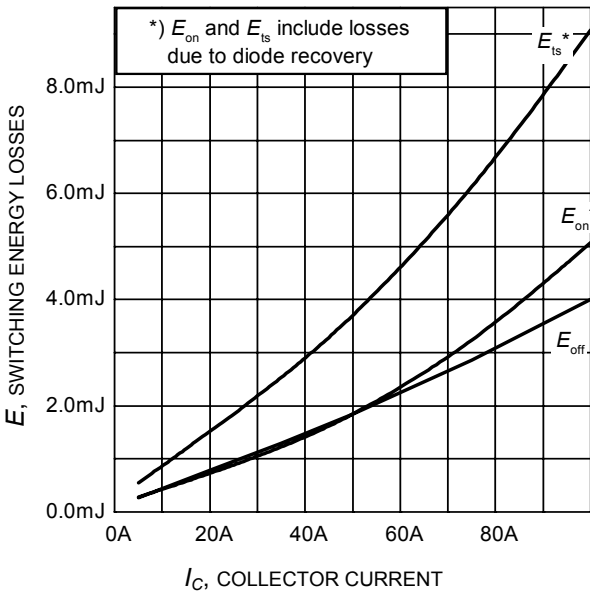


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $R_G = 7\Omega$, Dynamic test circuit in Figure E)

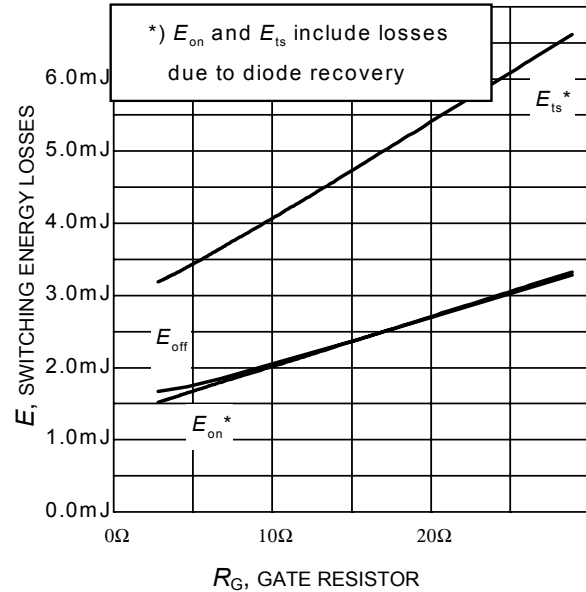


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, $T_J = 175^\circ\text{C}$, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, $R_G = 7\Omega$, Dynamic test circuit in Figure E)

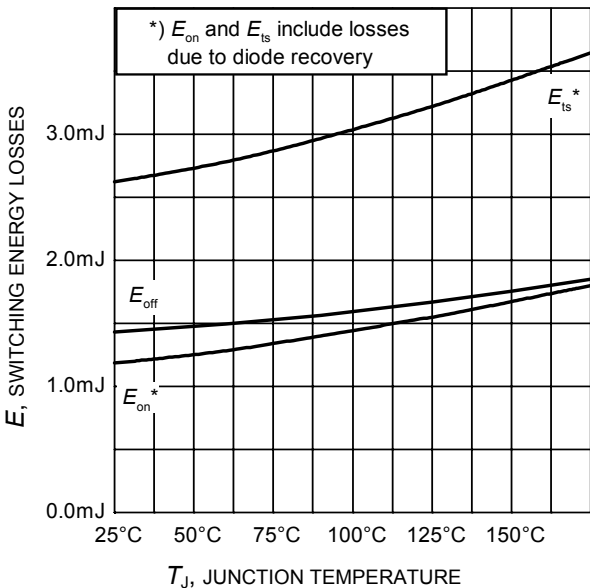


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, $V_{CE} = 400\text{V}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, $R_G = 7\Omega$, Dynamic test circuit in Figure E)

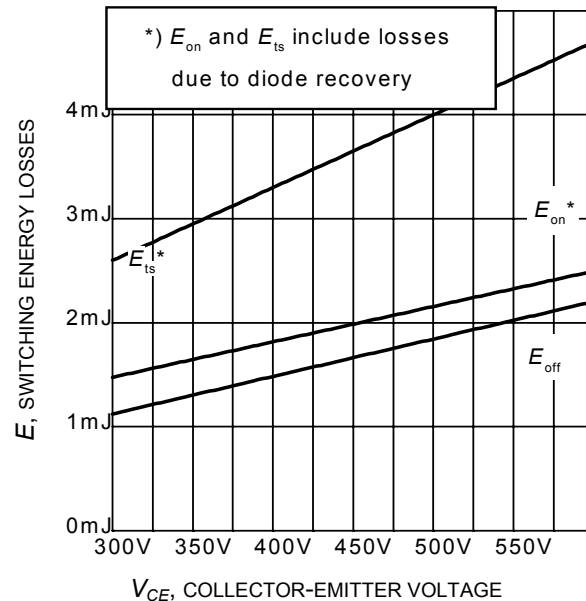


Figure 16. Typical switching energy losses as a function of collector emitter voltage
(inductive load, $T_J = 175^\circ\text{C}$, $V_{GE} = 0/15\text{V}$, $I_C = 50\text{A}$, $R_G = 7\Omega$, Dynamic test circuit in Figure E)

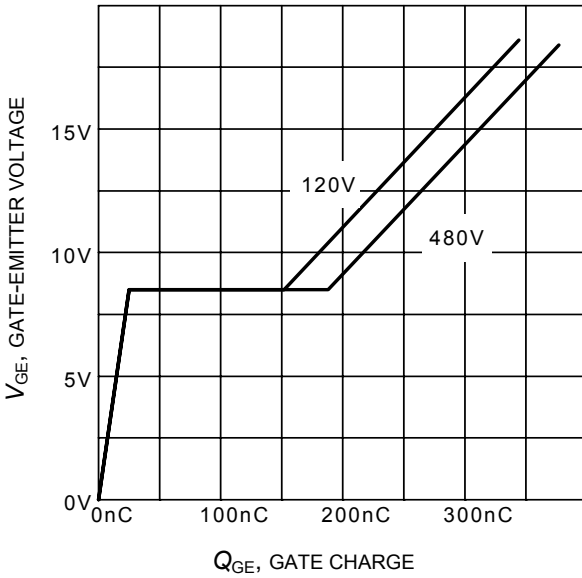


Figure 17. Typical gate charge
($I_C=50\text{ A}$)

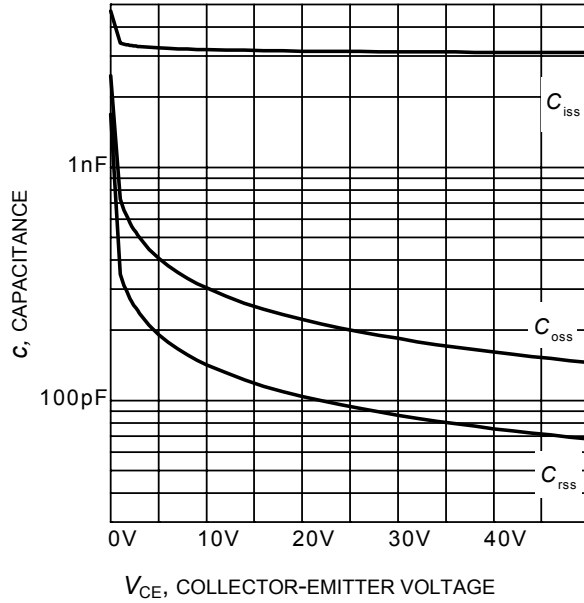


Figure 18. Typical capacitance as a function of collector-emitter voltage
($V_{GE}=0\text{V}$, $f=1\text{ MHz}$)

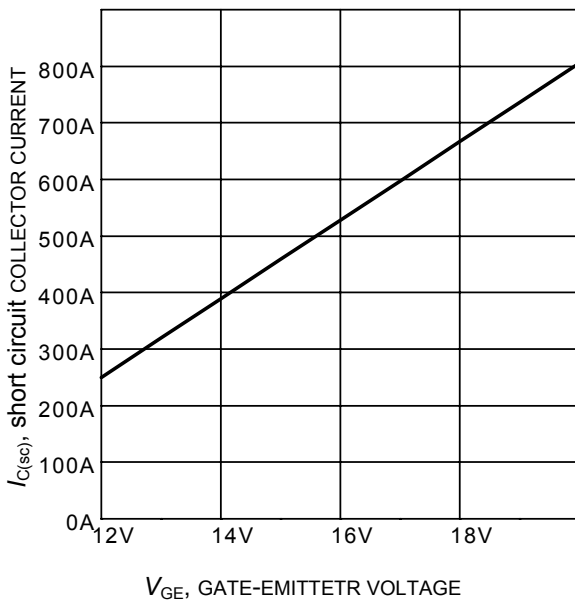


Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 400\text{V}$, $T_j \leq 150^\circ\text{C}$)

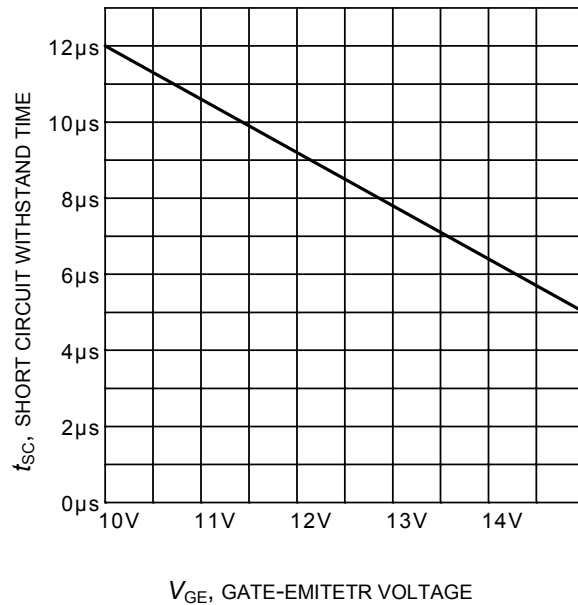


Figure 20. Short circuit withstand time as a function of gate-emitter voltage
($V_{CE}=600\text{V}$, start at $T_j=25^\circ\text{C}$, $T_{jmax}<150^\circ\text{C}$)

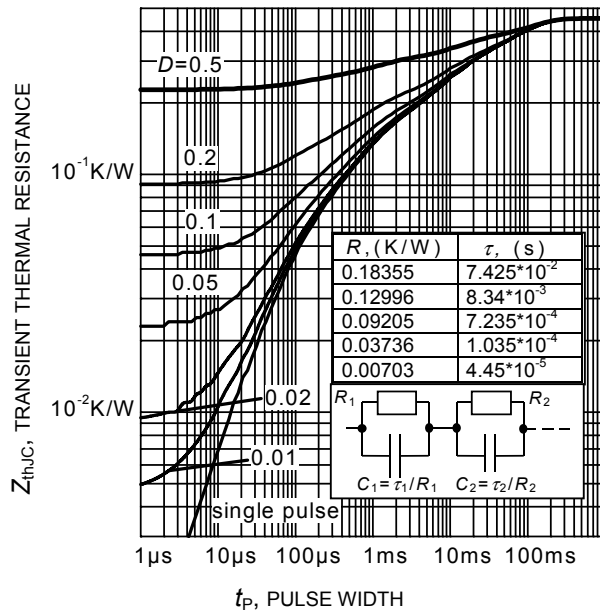


Figure 21. IGBT transient thermal resistance
($D = t_p / T$)

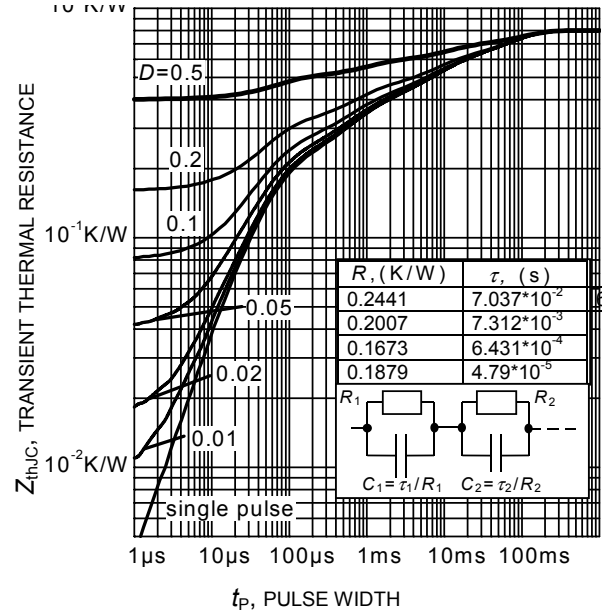


Figure 22. Diode transient thermal impedance as a function of pulse width
($D = t_p / T$)

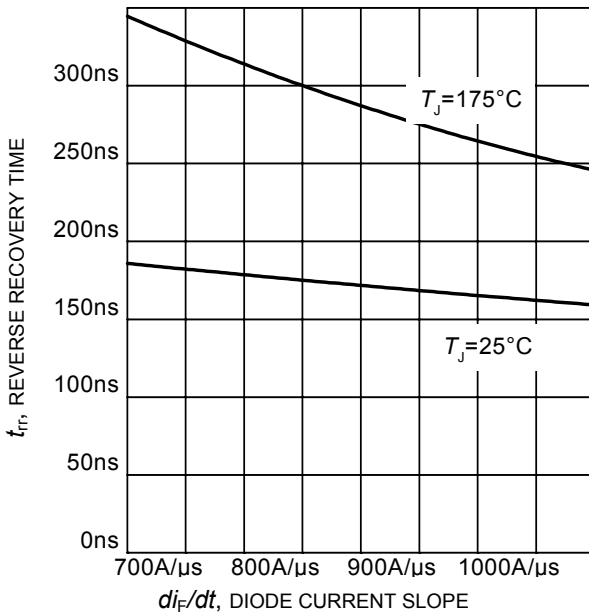


Figure 23. Typical reverse recovery time as a function of diode current slope
($V_R = 400V$, $I_F = 50A$,
Dynamic test circuit in Figure E)

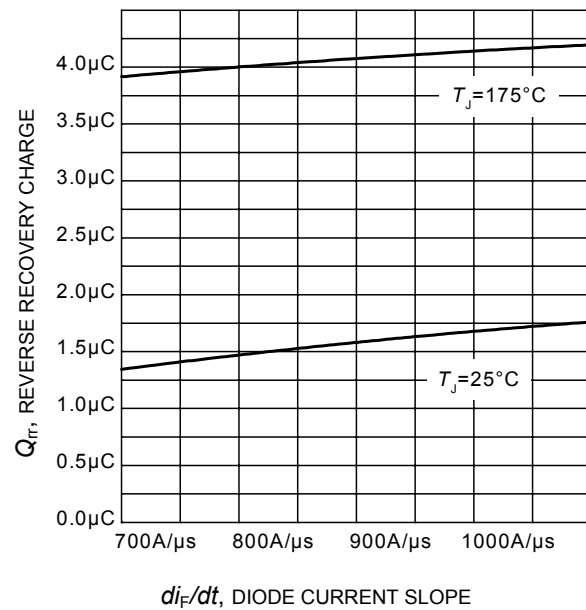
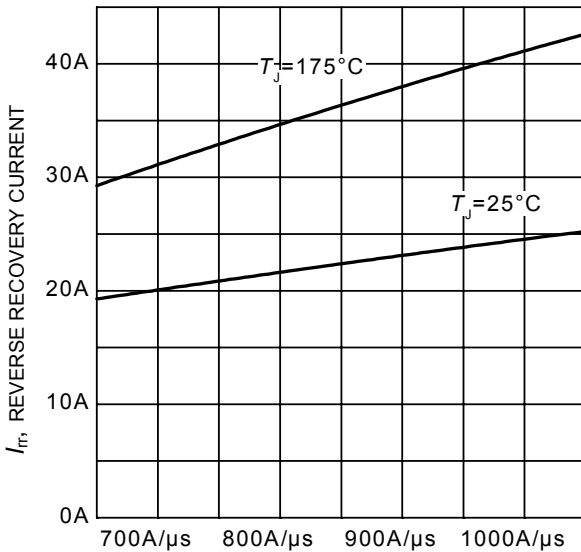


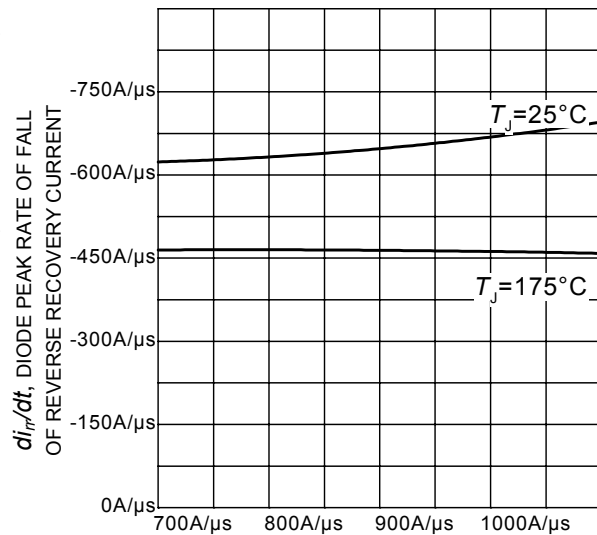
Figure 24. Typical reverse recovery charge as a function of diode current slope
($V_R = 400V$, $I_F = 50A$,
Dynamic test circuit in Figure E)



di_F/dt , DIODE CURRENT SLOPE

Figure 25. Typical reverse recovery current as a function of diode current slope

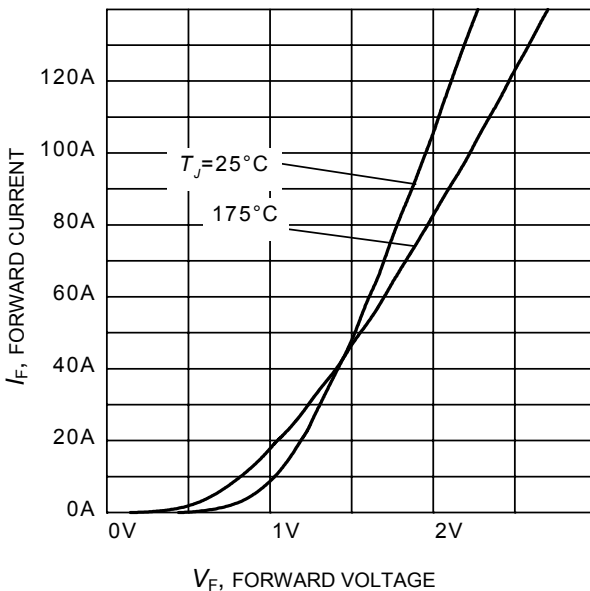
($V_R = 400V$, $I_F = 50A$,
Dynamic test circuit in Figure E)



di_F/dt , DIODE CURRENT SLOPE

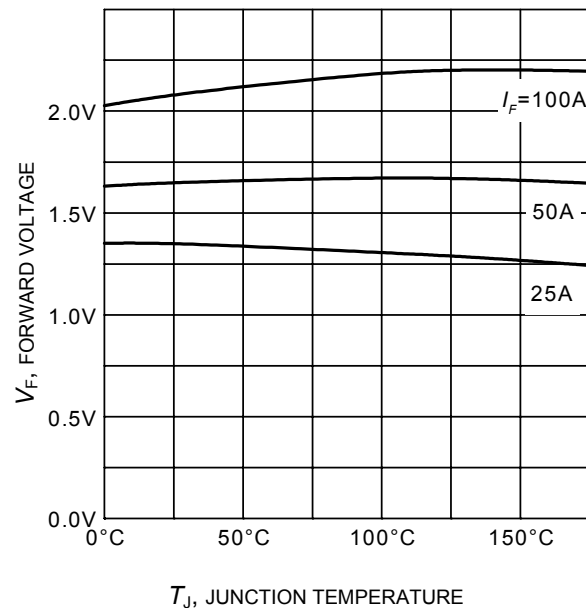
Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope

($V_R = 400V$, $I_F = 50A$,
Dynamic test circuit in Figure E)



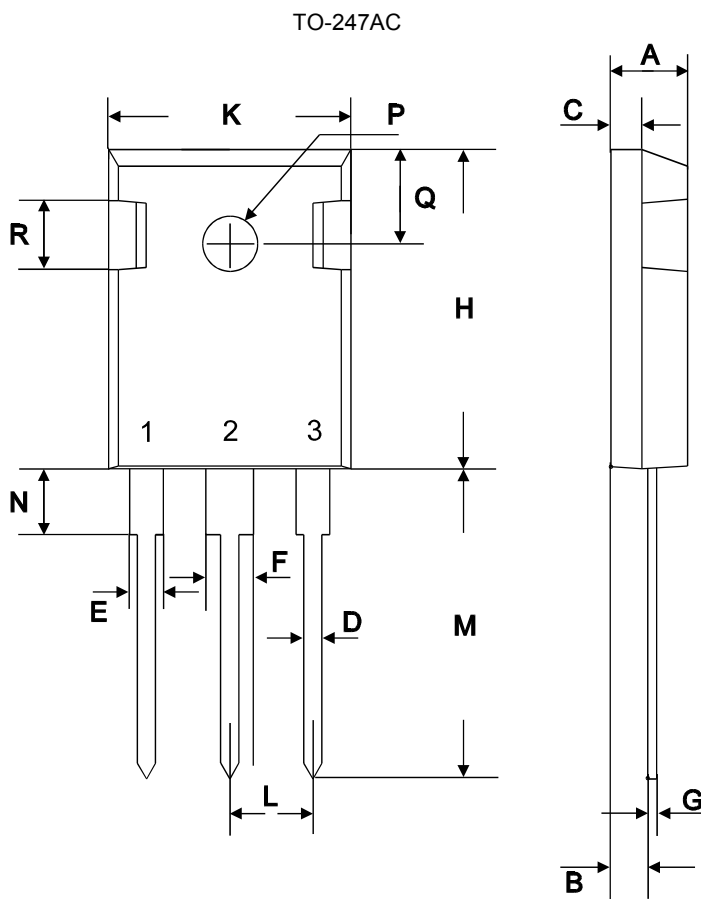
V_F , FORWARD VOLTAGE

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



| 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 |

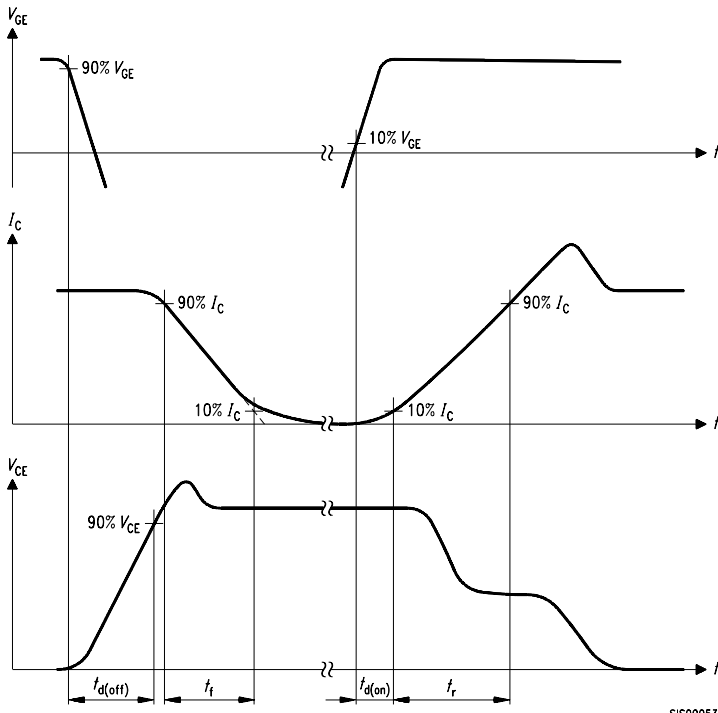


Figure A. Definition of switching times

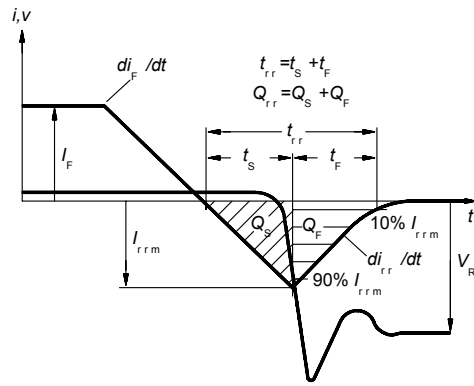


Figure C. Definition of diodes switching characteristics

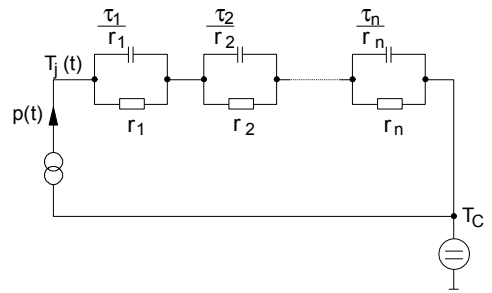


Figure D. Thermal equivalent circuit

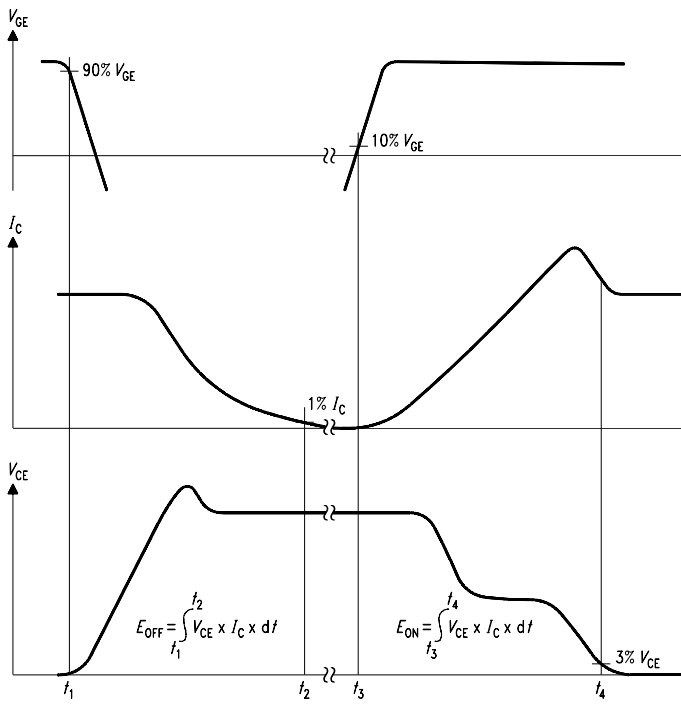


Figure B. Definition of switching losses

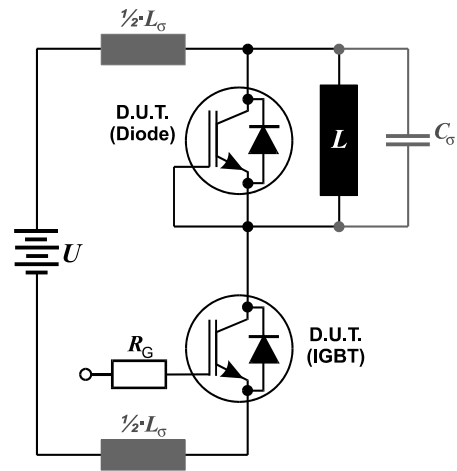


Figure E. Dynamic test circuit

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