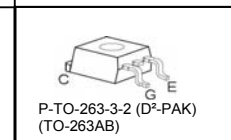
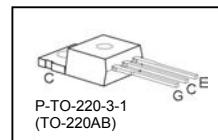
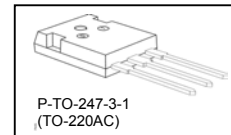
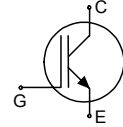


## Low Loss IGBT in Trench and Fieldstop technology

- Very low  $V_{CE(sat)}$  1.5 V (typ.)
- Maximum Junction Temperature 175 °C
- Short circuit withstand time – 5 $\mu$ 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
- 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 |
|-----------|----------|-------|-------------------------------|-------------|--------------|---------|---------------|
| IGP50N60T | 600 V    | 50 A  | 1.5 V                         | 175 °C      | G50T60       | TO-220  | Q67040S4723   |
| IGB50N60T | 600 V    | 50 A  | 1.5 V                         | 175 °C      | G50T60       | TO-263  | Q67040S4721   |
| IGW50N60T | 600 V    | 50 A  | 1.5 V                         | 175 °C      | G50T60       | TO-247  | Q67040S4725   |

### Maximum Ratings

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

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

### Thermal Resistance

| Parameter                                | Symbol     | Conditions                       | Max. Value | Unit |
|--|------------|----------------------------------|------------|------|
| <b>Characteristic</b>                    |            |                                  |            |      |
| IGBT thermal resistance, junction – case | $R_{thJC}$ |                                  | 0.45       | K/W  |
| Thermal resistance, junction – ambient   | $R_{thJA}$ | TO-220-3-1                       | 62         |      |
|  |            | TO-247-3-1                       | 40         |      |
|  |            | TO-263-3-2 (6cm <sup>2</sup> Cu) | 40         |      |

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

| Parameter                            | Symbol        | Conditions   | Value |      |      | Unit          |
|--------------------------------------|---------------|--|-------|------|------|---------------|
|                                      |               |  | min.  | Typ. | max. |               |
| <b>Static Characteristic</b>         |               |  |       |      |      |               |
| Collector-emitter breakdown voltage  | $V_{(BR)CES}$ | $V_{GE}=0V, I_C=0.2mA$   | 600   | -    | -    | V             |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $V_{GE} = 15V, I_C=50A$<br>$T_j=25^\circ\text{C}$<br>$T_j=175^\circ\text{C}$       | -     | 1.5  | 2.0  |               |
|                                      |               |  | -     | 1.9  | -    |               |
| 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  | $I_{CES}$     | $V_{CE}=600V,$<br>$V_{GE}=0V$<br>$T_j=25^\circ\text{C}$<br>$T_j=175^\circ\text{C}$ | -     | -    | 40   | $\mu\text{A}$ |
|                                      |               |  | -     | -    | 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             | $R_{Gint}$    |  |       | -    |      | $\Omega$      |

### Dynamic Characteristic

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

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

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

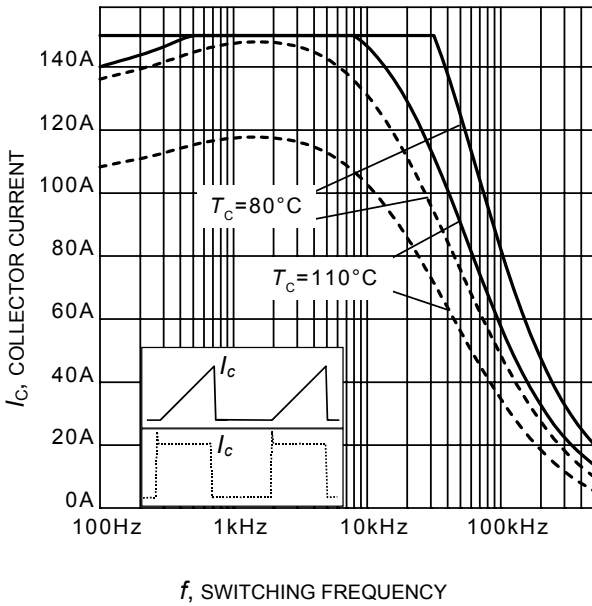
| Parameter                  | Symbol       | Conditions  | Value |      |      | Unit |
|----------------------------|--------------|---|-------|------|------|------|
|                            |              |   | min.  | Typ. | max. |      |
| <b>IGBT Characteristic</b> |              |   |       |      |      |      |
| Turn-on delay time         | $t_{d(on)}$  | $T_j=25^\circ\text{C}$ ,<br>$V_{CC}=400\text{V}$ , $I_C=50\text{A}$ ,<br>$V_{GE}=0/15\text{V}$ ,<br>$R_G=7\ \Omega$ ,<br>$L_\sigma^{1)}$ = 103nH,<br>$C_\sigma^{1)}$ = 39pF<br>Energy losses include<br>"tail" and diode<br>reverse recovery. <sup>2)</sup> | -     | 26   | -    | ns   |
| Rise time                  | $t_r$        |   | -     | 29   | -    |      |
| Turn-off delay time        | $t_{d(off)}$ |   | -     | 299  | -    |      |
| Fall time                  | $t_f$        |   | -     | 29   | -    | mJ   |
| Turn-on energy             | $E_{on}$     |   | -     | 1.2  | -    |      |
| Turn-off energy            | $E_{off}$    |   | -     | 1.4  | -    |      |
| Total switching energy     | $E_{ts}$     |   | -     | 2.6  | -    |      |

**Switching Characteristic, Inductive Load, at  $T_j=150^\circ\text{C}$**

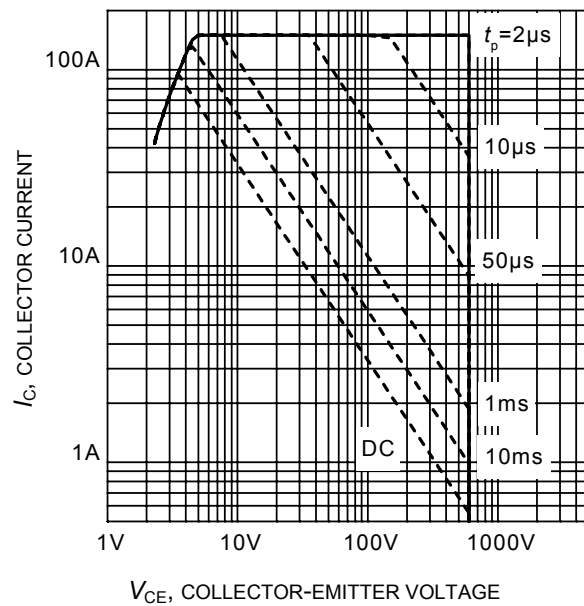
| Parameter                  | Symbol       | Conditions   | Value |      |      | Unit |
|----------------------------|--------------|--|-------|------|------|------|
|                            |              |  | min.  | Typ. | max. |      |
| <b>IGBT Characteristic</b> |              |  |       |      |      |      |
| Turn-on delay time         | $t_{d(on)}$  | $T_j=175^\circ\text{C}$ ,<br>$V_{CC}=400\text{V}$ , $I_C=50\text{A}$ ,<br>$V_{GE}=0/15\text{V}$ ,<br>$R_G=7\ \Omega$ ,<br>$L_\sigma^{1)}$ = 103nH,<br>$C_\sigma^{1)}$ = 39pF<br>Energy losses include<br>"tail" and diode<br>reverse recovery. <sup>2)</sup> | -     | 27   | -    | ns   |
| Rise time                  | $t_r$        |  | -     | 33   | -    |      |
| Turn-off delay time        | $t_{d(off)}$ |  | -     | 341  | -    |      |
| Fall time                  | $t_f$        |  | -     | 55   | -    | mJ   |
| Turn-on energy             | $E_{on}$     |  | -     | 1.8  | -    |      |
| Turn-off energy            | $E_{off}$    |  | -     | 1.8  | -    |      |
| Total switching energy     | $E_{ts}$     |  | -     | 3.6  | -    |      |

<sup>1)</sup> Leakage inductance  $L_\sigma$  and Stray capacity  $C_\sigma$  due to dynamic test circuit in Figure E.

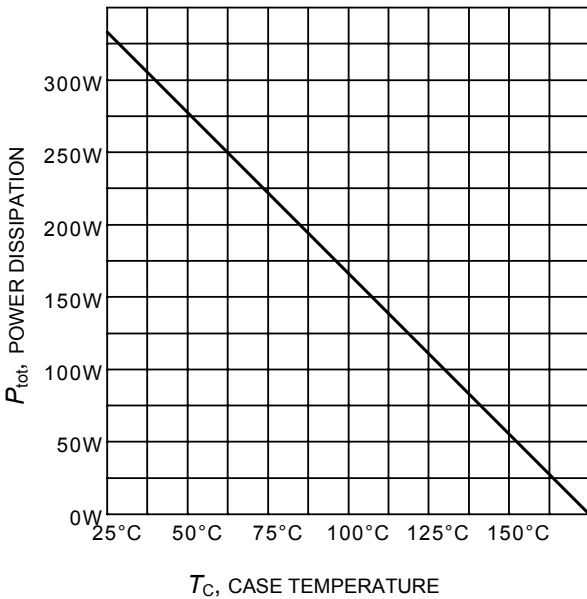
<sup>2)</sup> Includes Reverse Recovery Losses from IKW50N60T due to dynamic test circuit in Figure E.



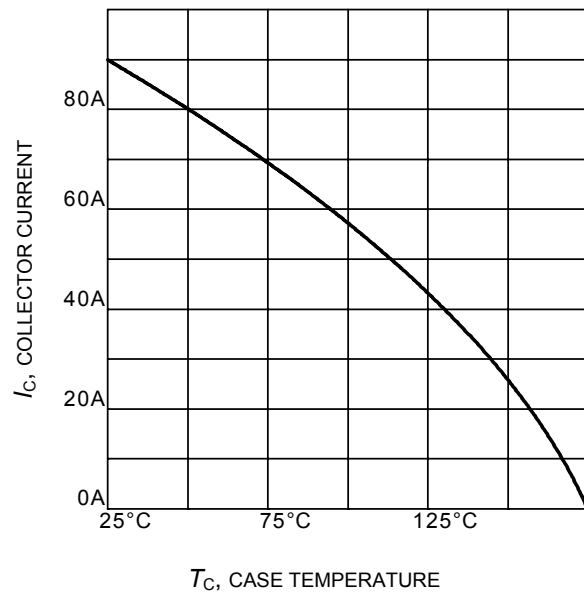
**Figure 1. Collector current as a function of switching frequency**  
 $(T_j \leq 175^\circ\text{C}, D = 0.5, V_{CE} = 400\text{V}, V_{GE} = 0/+15\text{V}, R_G = 7\Omega)$



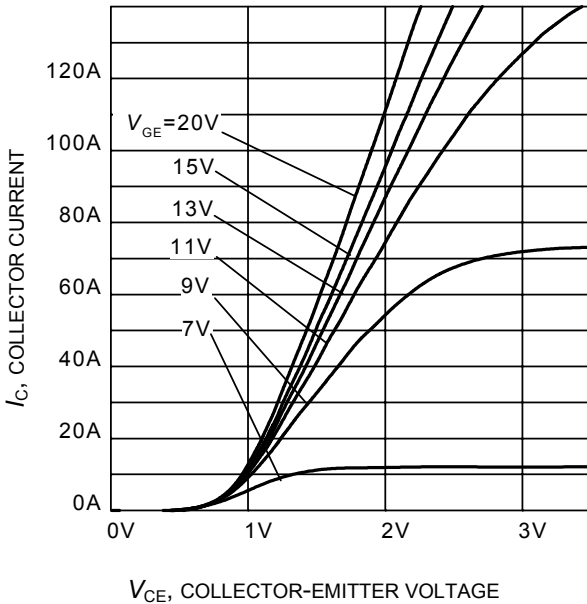
**Figure 2. Safe operating area**  
 $(D = 0, T_C = 25^\circ\text{C}, T_j \leq 175^\circ\text{C}; V_{GE} = 15\text{V})$



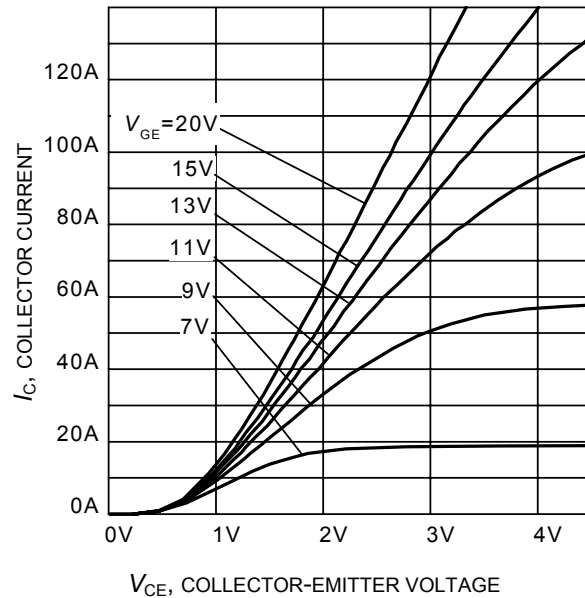
**Figure 3. Power dissipation as a function of case temperature**  
 $(T_j \leq 175^\circ\text{C})$



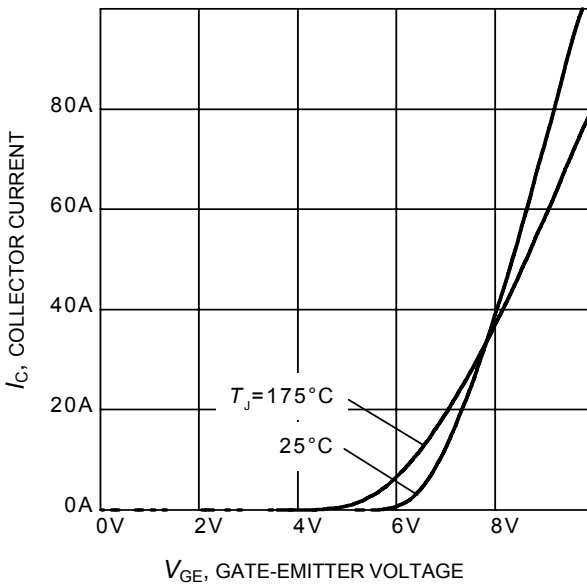
**Figure 4. Collector current as a function of case temperature**  
 $(V_{GE} \geq 15\text{V}, T_j \leq 175^\circ\text{C})$



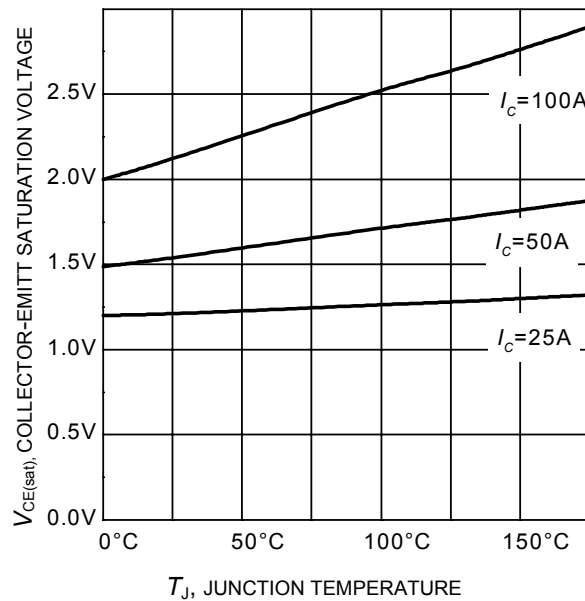
**Figure 5. Typical output characteristic**  
( $T_J = 25^\circ\text{C}$ )



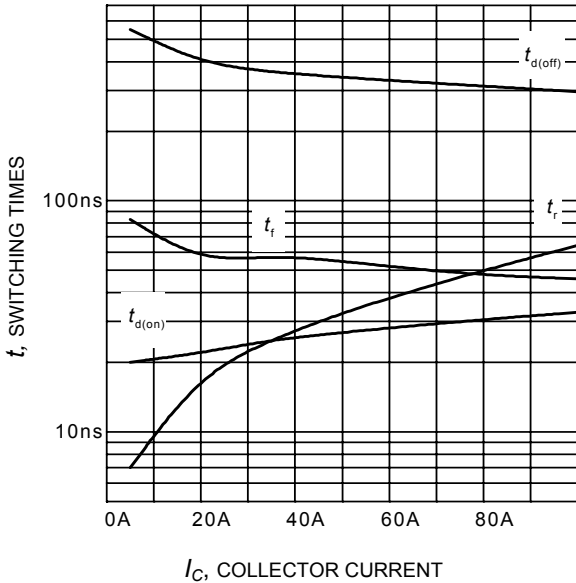
**Figure 6. Typical output characteristic**  
( $T_J = 175^\circ\text{C}$ )



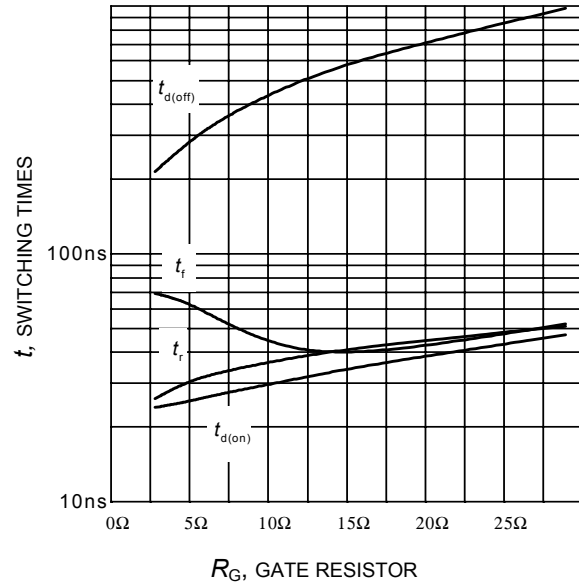
**Figure 7. Typical transfer characteristic**  
( $V_{CE} = 20\text{V}$ )



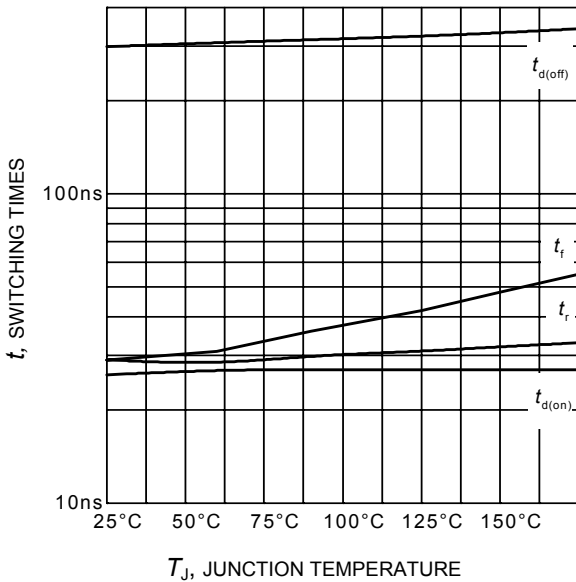
**Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE} = 15\text{V}$ )



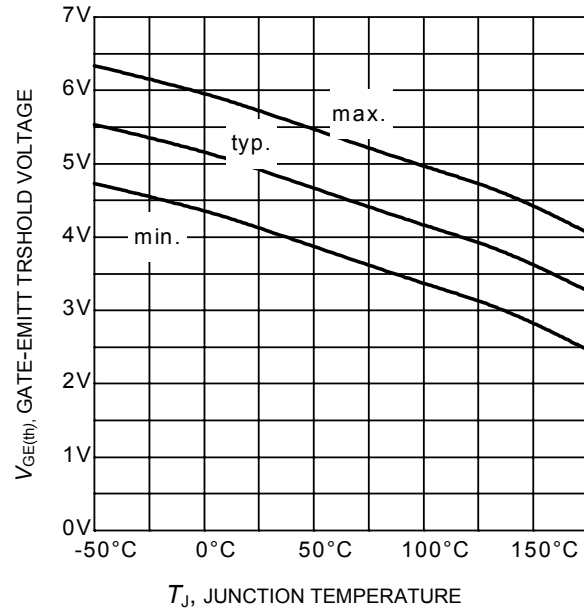
**Figure 9. Typical switching times as a function of collector current**  
(inductive load,  $T_J=175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $R_G = 7\Omega$ ,  
Dynamic test circuit in Figure E)



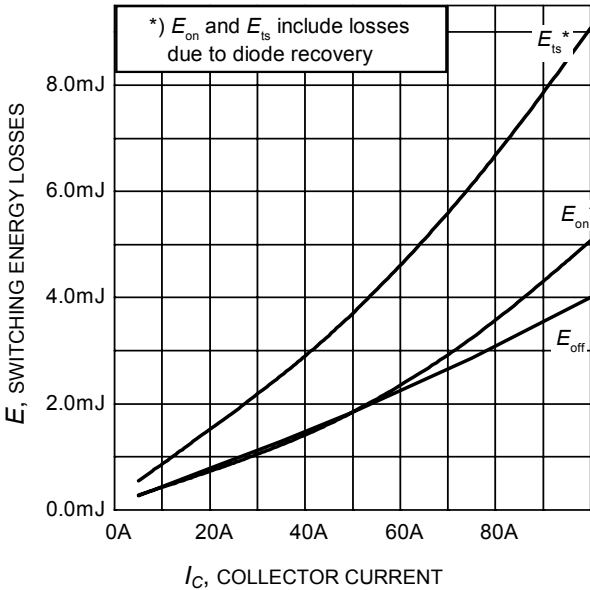
**Figure 10. Typical switching times as a function of gate resistor**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  
 $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  
Dynamic test circuit in Figure E)



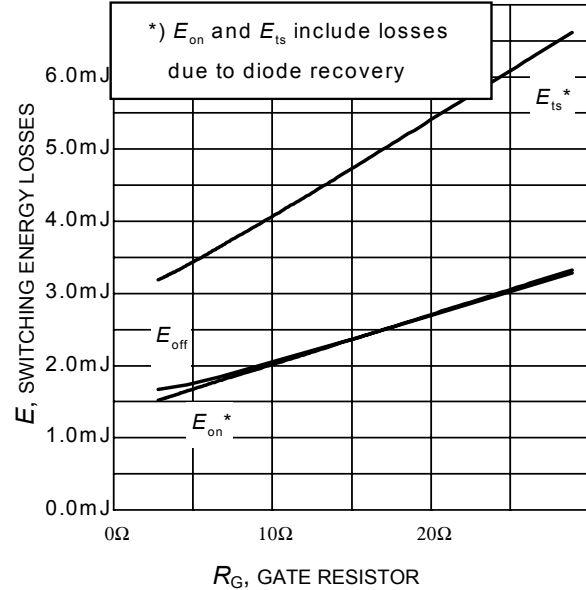
**Figure 11. Typical switching times as a function of junction temperature**  
(inductive load,  $V_{CE} = 400\text{V}$ ,  
 $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  $R_G = 7\Omega$ ,  
Dynamic test circuit in Figure E)



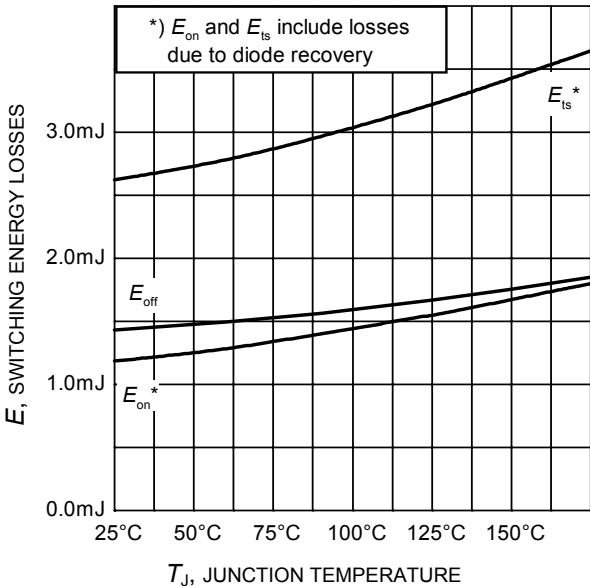
**Figure 12. Gate-emitter threshold voltage as a function of junction temperature**  
( $I_C = 0.8\text{mA}$ )



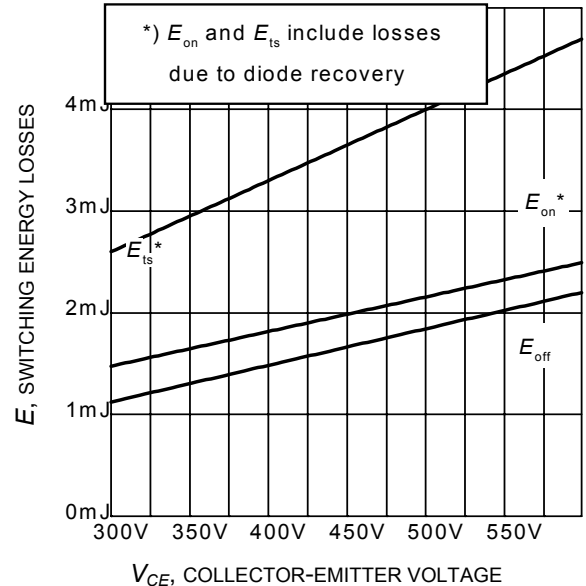
**Figure 13. Typical switching energy losses as a function of collector current**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $R_G = 7\Omega$ , Dynamic test circuit in Figure E)



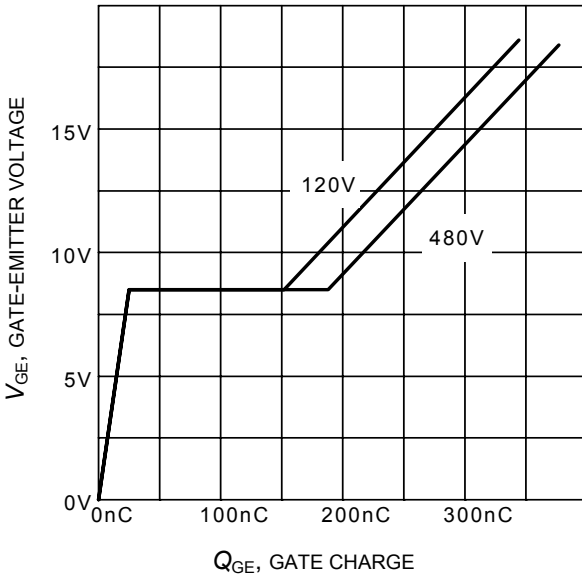
**Figure 14. Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ , Dynamic test circuit in Figure E)



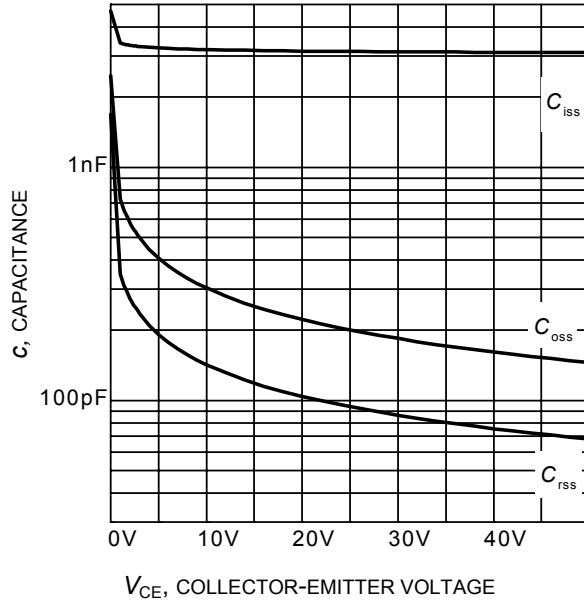
**Figure 15. Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE} = 400\text{V}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  $R_G = 7\Omega$ , Dynamic test circuit in Figure E)



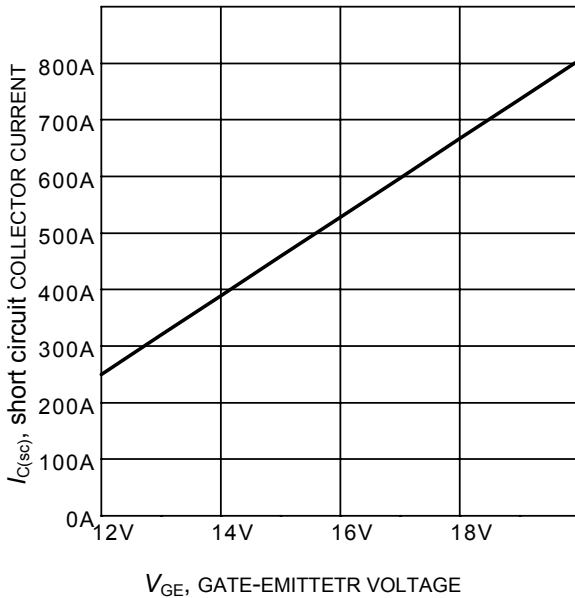
**Figure 16. Typical switching energy losses as a function of collector emitter voltage**  
(inductive load,  $T_J = 175^\circ\text{C}$ ,  $V_{GE} = 0/15\text{V}$ ,  $I_C = 50\text{A}$ ,  $R_G = 7\Omega$ , Dynamic test circuit in Figure E)



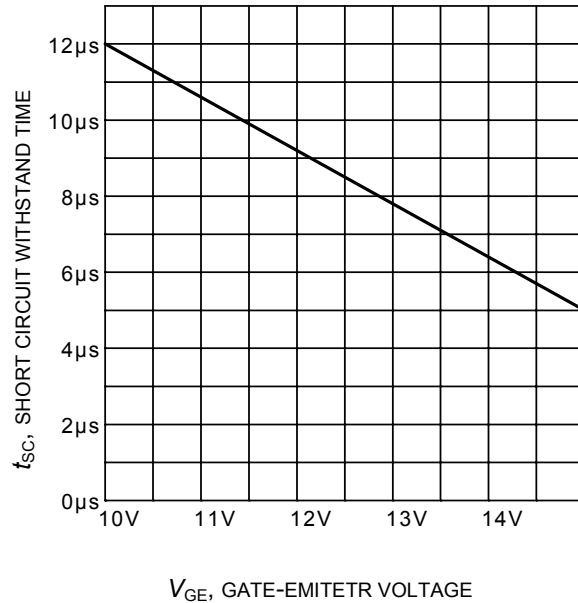
**Figure 17. Typical gate charge**  
( $I_C=50\text{ A}$ )



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

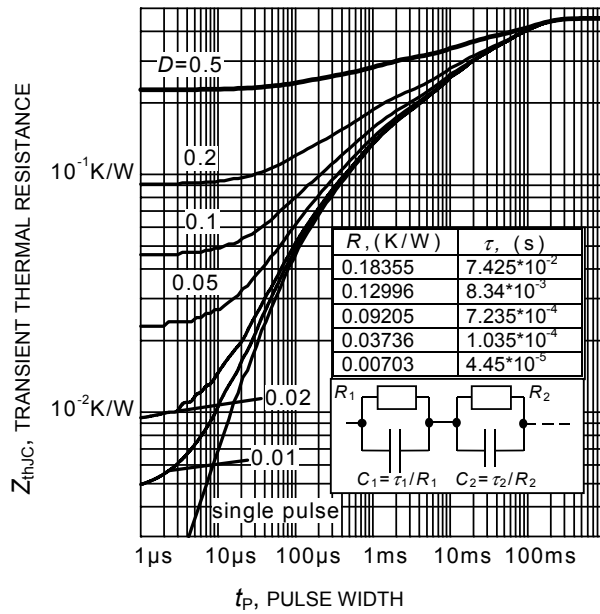


**Figure 19. Typical short circuit collector current as a function of gate-emitter voltage**  
( $V_{CE} \leq 400\text{V}$ ,  $T_j \leq 150^\circ\text{C}$ )



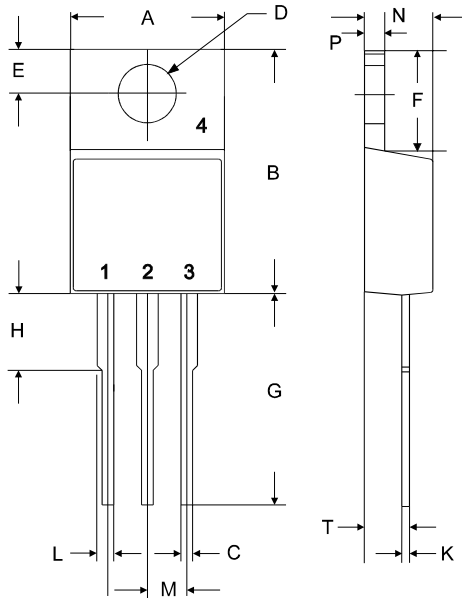
**Figure 20. Short circuit withstand time as a function of gate-emitter voltage**  
( $V_{CE}=600\text{V}$ , start at  $T_j=25^\circ\text{C}$ ,  $T_{jmax}<150^\circ\text{C}$ )





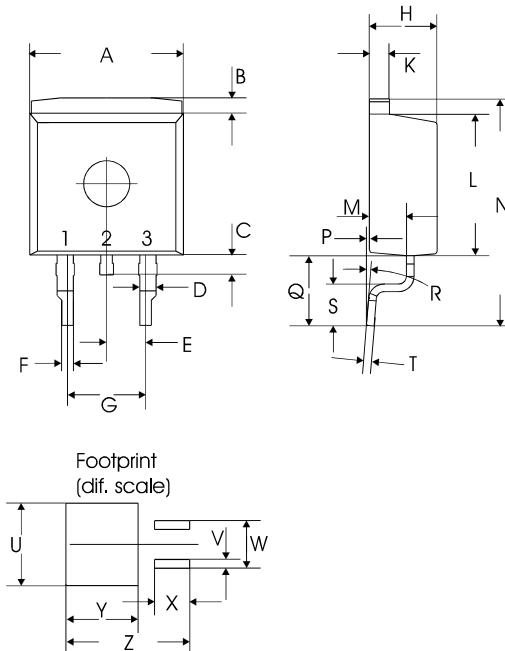
**Figure 21. IGBT transient thermal resistance**  
( $D = t_p / T$ )

TO-220AB

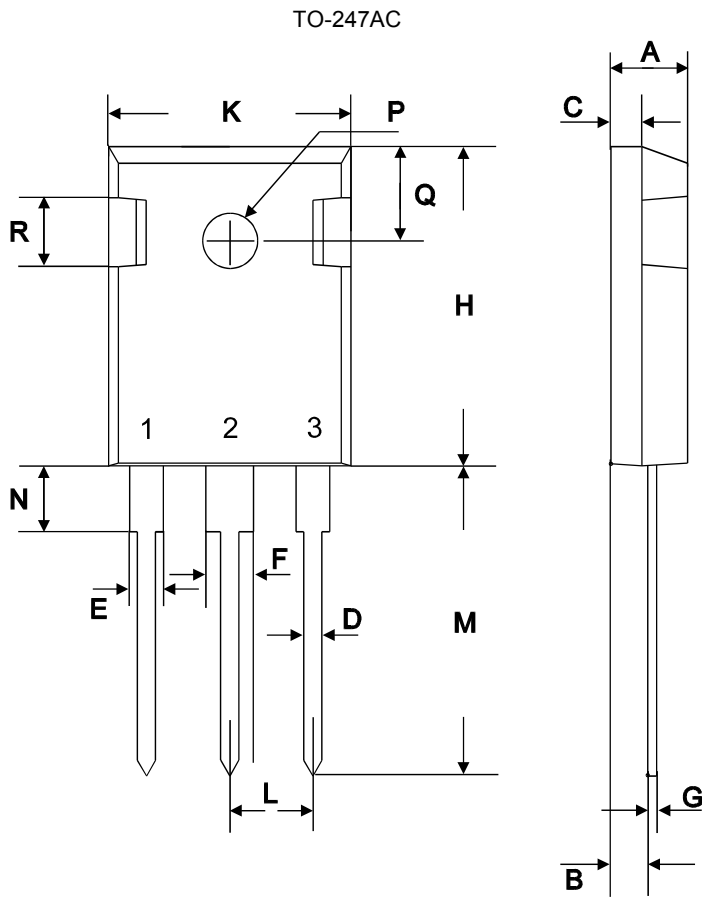


| symbol | Dimensions |       |          |        |
|--------|------------|-------|----------|--------|
|        | [mm]       |       | [inch]   |        |
|        | min        | max   | min      | max    |
| A      | 9.70       | 10.30 | 0.3819   | 0.4055 |
| B      | 14.88      | 15.95 | 0.5858   | 0.6280 |
| C      | 0.65       | 0.86  | 0.0256   | 0.0339 |
| D      | 3.55       | 3.7   | 0.1398   | 0.1457 |
| E      | 2.60       | 3.00  | 0.1024   | 0.1181 |
| F      | 6.00       | 6.80  | 0.2362   | 0.2677 |
| G      | 13.00      | 14.00 | 0.5118   | 0.5512 |
| H      | 4.35       | 4.75  | 0.1713   | 0.1870 |
| K      | 0.38       | 0.65  | 0.0150   | 0.0256 |
| L      | 0.95       | 1.32  | 0.0374   | 0.0520 |
| M      | 2.54 typ.  |       | 0.1 typ. |        |
| N      | 4.30       | 4.50  | 0.1693   | 0.1772 |
| P      | 1.17       | 1.40  | 0.0461   | 0.0551 |
| T      | 2.30       | 2.72  | 0.0906   | 0.1071 |

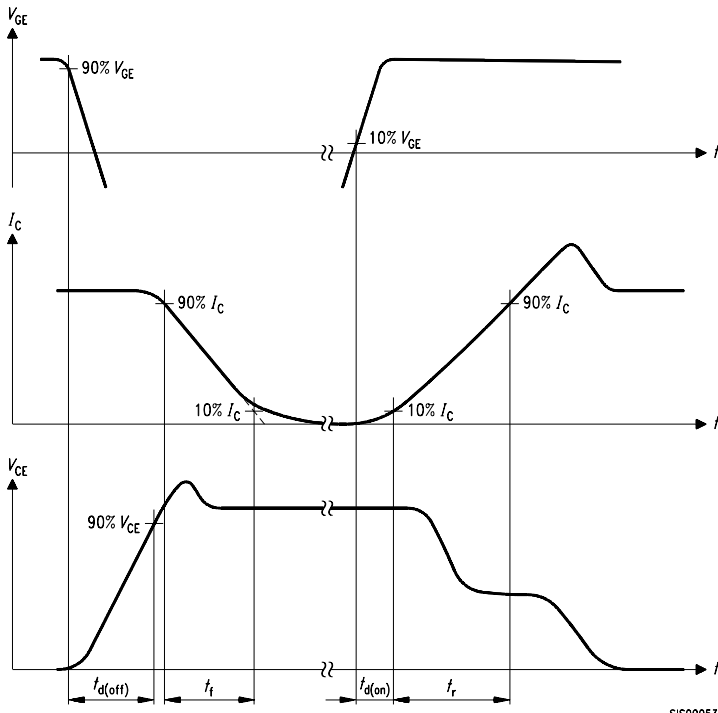
TO-263AB (D<sup>2</sup>Pak)



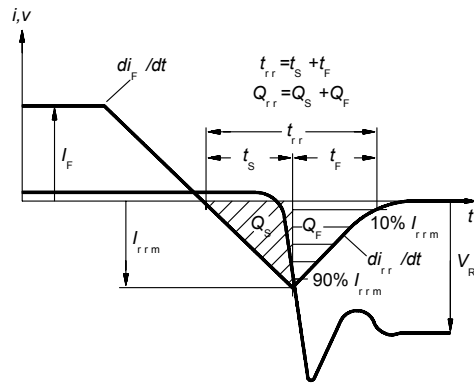
| symbol | dimensions |       |             |        |
|--------|------------|-------|-------------|--------|
|        | [mm]       |       | [inch]      |        |
|        | min        | max   | min         | max    |
| A      | 9.80       | 10.20 | 0.3858      | 0.4016 |
| B      | 0.70       | 1.30  | 0.0276      | 0.0512 |
| C      | 1.00       | 1.60  | 0.0394      | 0.0630 |
| D      | 1.03       | 1.07  | 0.0406      | 0.0421 |
| E      | 2.54 typ.  |       | 0.1 typ.    |        |
| F      | 0.65       | 0.85  | 0.0256      | 0.0335 |
| G      | 5.08 typ.  |       | 0.2 typ.    |        |
| H      | 4.30       | 4.50  | 0.1693      | 0.1772 |
| K      | 1.17       | 1.37  | 0.0461      | 0.0539 |
| L      | 9.05       | 9.45  | 0.3563      | 0.3720 |
| M      | 2.30       | 2.50  | 0.0906      | 0.0984 |
| N      | 15 typ.    |       | 0.5906 typ. |        |
| P      | 0.00       | 0.20  | 0.0000      | 0.0079 |
| Q      | 4.20       | 5.20  | 0.1654      | 0.2047 |
| R      | 8° max     |       | 8° max      |        |
| S      | 2.40       | 3.00  | 0.0945      | 0.1181 |
| T      | 0.40       | 0.60  | 0.0157      | 0.0236 |
| U      | 10.80      |       | 0.4252      |        |
| V      | 1.15       |       | 0.0453      |        |
| W      | 6.23       |       | 0.2453      |        |
| X      | 4.60       |       | 0.1811      |        |
| Y      | 9.40       |       | 0.3701      |        |
| Z      | 16.15      |       | 0.6358      |        |



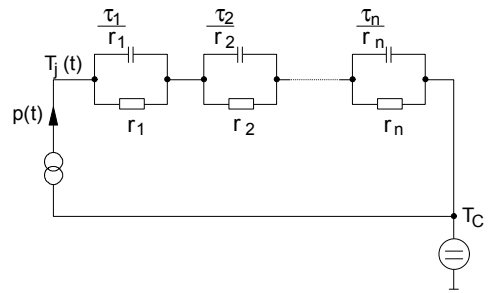
| symbol | dimensions |       |            |        |
|--------|------------|-------|------------|--------|
|        | [mm]       |       | [inch]     |        |
|        | min        | max   | min        | max    |
| A      | 4.78       | 5.28  | 0.1882     | 0.2079 |
| B      | 2.29       | 2.51  | 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 |
| ØP     | 3.61       |       | 0.1421     |        |
| Q      | 6.12       | 6.22  | 0.2409     | 0.2449 |



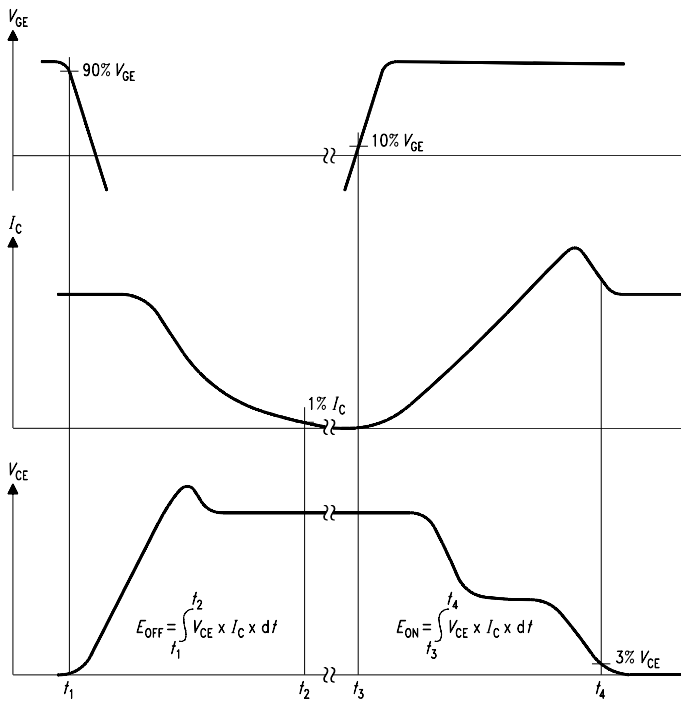
**Figure A. Definition of switching times**



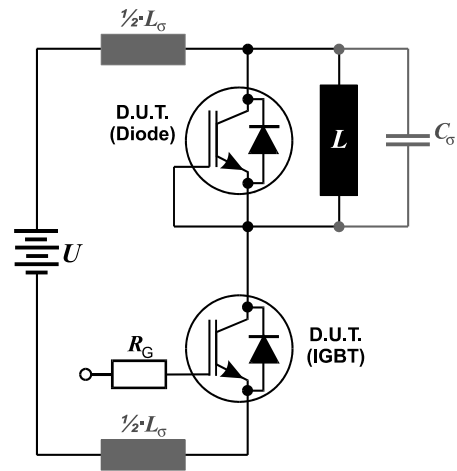
**Figure C. Definition of diodes switching characteristics**



**Figure D. Thermal equivalent circuit**



**Figure B. Definition of switching losses**



**Figure E. Dynamic test circuit**



# IGP50N60T, IGB50N60T TrenchStop Series IGW50N60T

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