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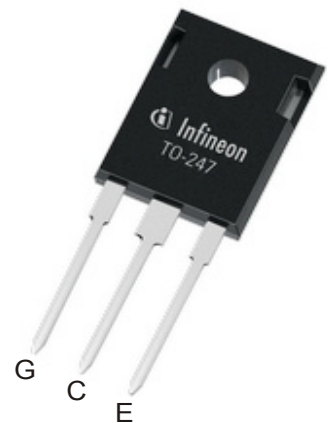
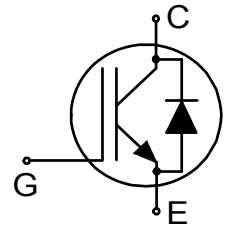


Sixth generation, high speed soft switching series

High speed soft switching TRENCHSTOP™ IGBT 6 in Trench and Fieldstop technology copacked with soft and fast recovery anti-parallel diode

#### Features:

- 1200V TRENCHSTOP™ IGBT6 technology offering:
- High efficiency in hard switching and resonant topologies
  - Easy paralleling capability due to positive temperature coefficient in  $V_{CEsat}$
  - Low EMI
  - Low Gate Charge  $Q_g$
  - Very soft, fast recovery full current anti-parallel diode
  - Maximum junction temperature 175°C
  - Pb-free lead plating; RoHS compliant
  - Complete product spectrum and PSpice Models:  
<http://www.infineon.com/igbt/>



#### Applications:

- Industrial UPS
- Charger
- Energy storage
- Three-level Solar String Inverter
- Welding

#### Product Validation:

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22



#### Key Performance and Package Parameters

| Type         | $V_{CE}$ | $I_C$ | $V_{CEsat}, T_{vj}=25^\circ\text{C}$ | $T_{vjmax}$ | Marking | Package    |
|--------------|----------|-------|--------------------------------------|-------------|---------|------------|
| IKW40N120CS6 | 1200V    | 40A   | 1.85V                                | 175°C       | K40MCS6 | 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, $T_{vj} \geq 25^{\circ}\text{C}$   | $V_{CE}$    | 1200           | V                  |
| DC collector current, limited by $T_{vjmax}$<br>$T_c = 25^{\circ}\text{C}$<br>$T_c = 100^{\circ}\text{C}$   | $I_C$       | 80.0<br>40.0   | A                  |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$  | $I_{Cpuls}$ | 160.0          | A                  |
| Turn off safe operating area $V_{CE} \leq 1200\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$   | -           | 160.0          | A                  |
| Diode forward current, limited by $T_{vjmax}$<br>$T_c = 25^{\circ}\text{C}$<br>$T_c = 100^{\circ}\text{C}$  | $I_F$       | 80.0<br>40.0   | A                  |
| Diode pulsed current, $t_p$ limited by $T_{vjmax}$  | $I_{Fpuls}$ | 160.0          | A                  |
| Gate-emitter voltage<br>Transient Gate-emitter voltage ( $t_p \leq 0.5\mu\text{s}$ , $D < 0.001$ )  | $V_{GE}$    | $\pm 20$<br>25 | V                  |
| Short circuit withstand time<br>$V_{GE} = 15.0\text{V}$ , $V_{CC} \leq 500\text{V}$<br>Allowed number of short circuits < 1000<br>Time between short circuits: $\geq 1.0\text{s}$<br>$T_{vj} = 150^{\circ}\text{C}$ | $t_{SC}$    | 3              | $\mu\text{s}$      |
| Power dissipation $T_c = 25^{\circ}\text{C}$<br>Power dissipation $T_c = 100^{\circ}\text{C}$   | $P_{tot}$   | 500.0<br>250.0 | W                  |
| Operating junction temperature  | $T_{vj}$    | -40...+175     | $^{\circ}\text{C}$ |
| Storage temperature   | $T_{stg}$   | -55...+150     | $^{\circ}\text{C}$ |
| Soldering temperature,<br>wave soldering 1.6mm (0.063in.) from case for 10s   |             | 260            | $^{\circ}\text{C}$ |
| Mounting torque, M3 screw<br>Maximum of mounting processes: 3   | $M$         | 0.6            | Nm                 |

**Thermal Resistance**

| Parameter                                    | Symbol        | Conditions | Value |      |      | Unit |
|--|---------------|------------|-------|------|------|------|
|  |               |            | min.  | typ. | max. |      |
| <b><math>R_{th}</math> Characteristics</b>   |               |            |       |      |      |      |
| IGBT thermal resistance,<br>junction - case  | $R_{th(j-c)}$ |            | -     | -    | 0.30 | K/W  |
| Diode thermal resistance,<br>junction - case | $R_{th(j-c)}$ |            | -     | -    | 0.78 | K/W  |
| Thermal resistance<br>junction - ambient     | $R_{th(j-a)}$ |            | -     | -    | 40   | K/W  |



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

| Parameter                            | Symbol       | Conditions  | Value       |                      |                | Unit          |
|--------------------------------------|--------------|---|-------------|----------------------|----------------|---------------|
|                                      |              |   | min.        | typ.                 | max.           |               |
| <b>Static Characteristic</b>         |              |   |             |                      |                |               |
| Collector-emitter saturation voltage | $V_{CEsat}$  | $V_{GE} = 15.0\text{V}$ , $I_C = 40.0\text{A}$<br>$T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 125^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$ | -<br>-<br>- | 1.85<br>2.15<br>2.25 | 2.15<br>-<br>- | V             |
| Diode forward voltage                | $V_F$        | $V_{GE} = 0\text{V}$ , $I_F = 40.0\text{A}$<br>$T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                      | -<br>-      | 2.20<br>2.25         | 2.55<br>-      | V             |
| Gate-emitter threshold voltage       | $V_{GE(th)}$ | $I_C = 1.90\text{mA}$ , $V_{CE} = V_{GE}$   | 5.1         | 5.7                  | 6.3            | V             |
| Zero gate voltage collector current  | $I_{CES}$    | $V_{CE} = 1200\text{V}$ , $V_{GE} = 0\text{V}$<br>$T_{vj} = 25^{\circ}\text{C}$<br>$T_{vj} = 175^{\circ}\text{C}$                                   | -<br>-      | -<br>1600            | 850<br>-       | $\mu\text{A}$ |
| Gate-emitter leakage current         | $I_{GES}$    | $V_{CE} = 0\text{V}$ , $V_{GE} = 20\text{V}$  | -           | -                    | 600            | nA            |
| Transconductance                     | $g_{fs}$     | $V_{CE} = 20\text{V}$ , $I_C = 40.0\text{A}$  | -           | 32.0                 | -              | S             |

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

| Parameter  | Symbol    | Conditions   | Value |       |      | Unit |
|--|-----------|--|-------|-------|------|------|
|  |           |  | min.  | typ.  | max. |      |
| <b>Dynamic Characteristic</b>  |           |  |       |       |      |      |
| Input capacitance  | $C_{ies}$ | $V_{CE} = 25\text{V}$ , $V_{GE} = 0\text{V}$ , $f = 1\text{MHz}$         | -     | 2700  | -    | pF   |
| Output capacitance   | $C_{oes}$ |  | -     | 185   | -    |      |
| Reverse transfer capacitance   | $C_{res}$ |  | -     | 120   | -    |      |
| Gate charge  | $Q_G$     | $V_{CC} = 960\text{V}$ , $I_C = 40.0\text{A}$ ,<br>$V_{GE} = 15\text{V}$ | -     | 285.0 | -    | nC   |
| Internal emitter inductance<br>measured 5mm (0.197 in.) from<br>case | $L_E$     |  | -     | 13.0  | -    | nH   |

**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     | $t_{d(on)}$  | $T_{vj} = 25^{\circ}\text{C}$ ,<br>$V_{CC} = 600\text{V}$ , $I_C = 40.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(on)} = 9.0\Omega$ , $R_{G(off)} = 9.0\Omega$ ,<br>$L_{\sigma} = 70\text{nH}$ , $C_{\sigma} = 67\text{pF}$<br>$L_{\sigma}$ , $C_{\sigma}$ from Fig. E<br>Energy losses include "tail" and<br>diode reverse recovery. | - | 27   | - | ns |
| Rise time              | $t_r$        |  | - | 39   | - | ns |
| Turn-off delay time    | $t_{d(off)}$ |  | - | 315  | - | ns |
| Fall time              | $t_f$        |  | - | 27   | - | ns |
| Turn-on energy         | $E_{on}$     |  | - | 2.55 | - | mJ |
| Turn-off energy        | $E_{off}$    |  | - | 1.55 | - | mJ |
| Total switching energy | $E_{ts}$     |  | - | 4.10 | - | mJ |

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

|  |              |   |   |      |   |                        |
|--|--------------|---|---|------|---|------------------------|
| Diode reverse recovery time                                      | $t_{rr}$     | $T_{vj} = 25^{\circ}\text{C}$ ,<br>$V_R = 600\text{V}$ ,<br>$I_F = 40.0\text{A}$ ,<br>$di_F/dt = 700\text{A}/\mu\text{s}$ ,<br>$L\sigma = 70\text{nH}$ ,<br>$C\sigma = 67\text{pF}$ | - | 400  | - | ns                     |
| Diode reverse recovery charge                                    | $Q_{rr}$     |   | - | 2.65 | - | $\mu\text{C}$          |
| Diode peak reverse recovery current                              | $I_{rrm}$    |   | - | 18.0 | - | A                      |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ |   | - | -65  | - | $\text{A}/\mu\text{s}$ |

#### 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     | $t_{d(on)}$  | $T_{vj} = 175^{\circ}\text{C}$ ,<br>$V_{CC} = 600\text{V}$ , $I_C = 40.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(on)} = 9.0\Omega$ , $R_{G(off)} = 9.0\Omega$ ,<br>$L\sigma = 70\text{nH}$ , $C\sigma = 67\text{pF}$<br>$L\sigma$ , $C\sigma$ from Fig. E<br>Energy losses include "tail" and diode reverse recovery. | - | 27   | - | ns |
| Rise time              | $t_r$        |  | - | 38   | - | ns |
| Turn-off delay time    | $t_{d(off)}$ |  | - | 390  | - | ns |
| Fall time              | $t_f$        |  | - | 55   | - | ns |
| Turn-on energy         | $E_{on}$     |  | - | 3.50 | - | mJ |
| Turn-off energy        | $E_{off}$    |  | - | 2.95 | - | mJ |
| Total switching energy | $E_{ts}$     |  | - | 6.45 | - | mJ |

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

|  |              |  |   |      |   |                        |
|--|--------------|--|---|------|---|------------------------|
| Diode reverse recovery time                                      | $t_{rr}$     | $T_{vj} = 175^{\circ}\text{C}$ ,<br>$V_R = 600\text{V}$ ,<br>$I_F = 40.0\text{A}$ ,<br>$di_F/dt = 800\text{A}/\mu\text{s}$ ,<br>$L\sigma = 70\text{nH}$ ,<br>$C\sigma = 67\text{pF}$ | - | 720  | - | ns                     |
| Diode reverse recovery charge                                    | $Q_{rr}$     |  | - | 6.40 | - | $\mu\text{C}$          |
| Diode peak reverse recovery current                              | $I_{rrm}$    |  | - | 27.0 | - | A                      |
| Diode peak rate of fall of reverse recovery current during $t_b$ | $di_{rr}/dt$ |  | - | -70  | - | $\text{A}/\mu\text{s}$ |

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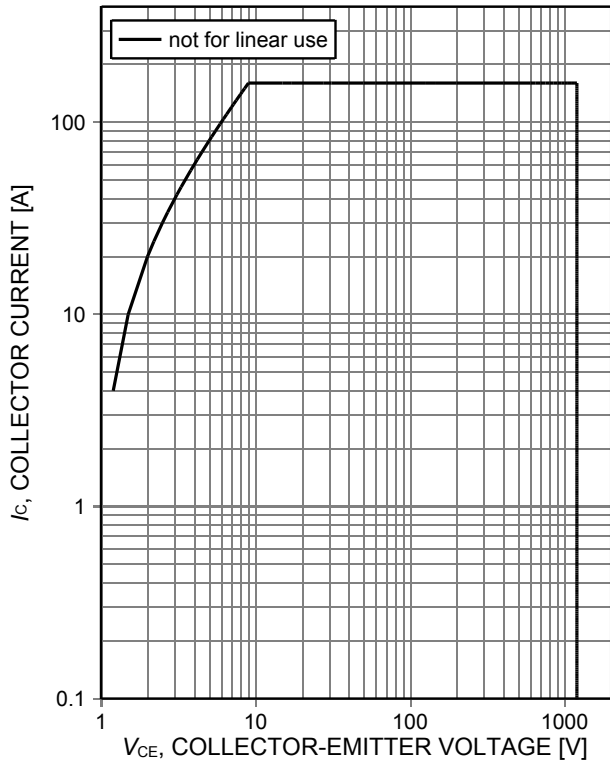


Figure 1. **Forward bias safe operating area**  
 ( $D=0$ ,  $T_{vj} \leq 175^{\circ}\text{C}$ ;  $V_{GE}=15\text{V}$ , pulse width limited by  $T_{vjmax}$ )

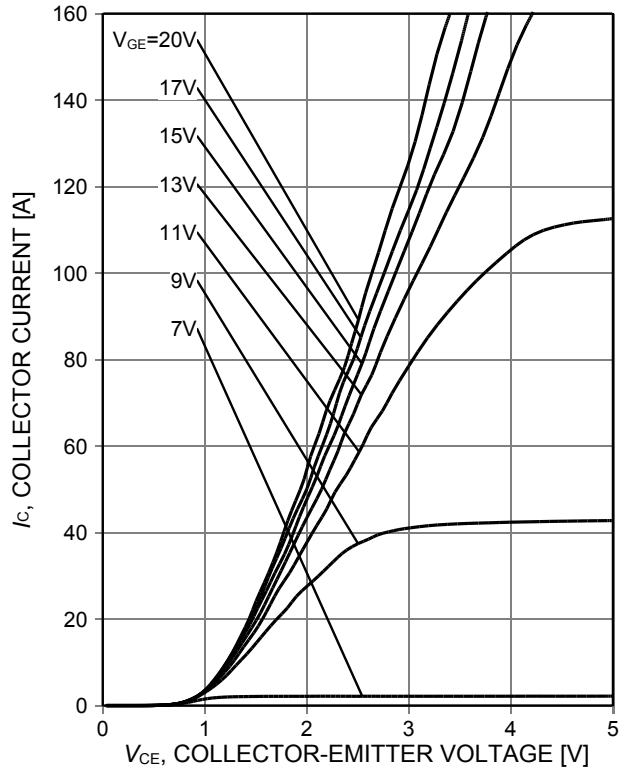


Figure 2. **Typical output characteristic**  
 ( $T_{vj}=25^{\circ}\text{C}$ )

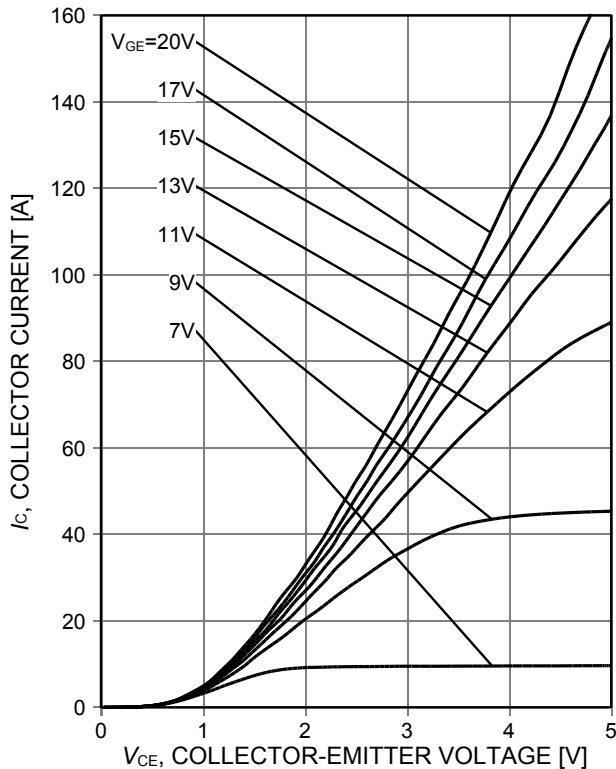


Figure 3. **Typical output characteristic**  
 ( $T_{vj}=175^{\circ}\text{C}$ )

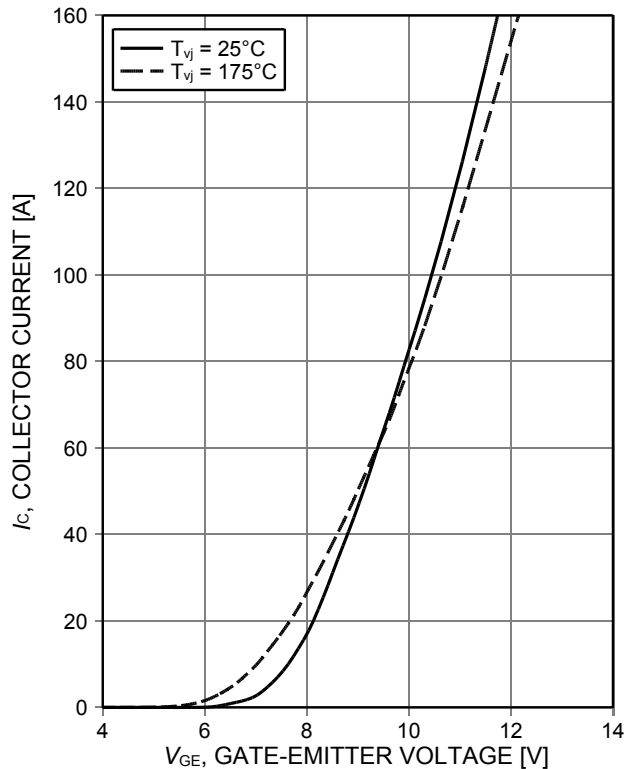


Figure 4. **Typical transfer characteristic**  
 ( $V_{CE}=20\text{V}$ )

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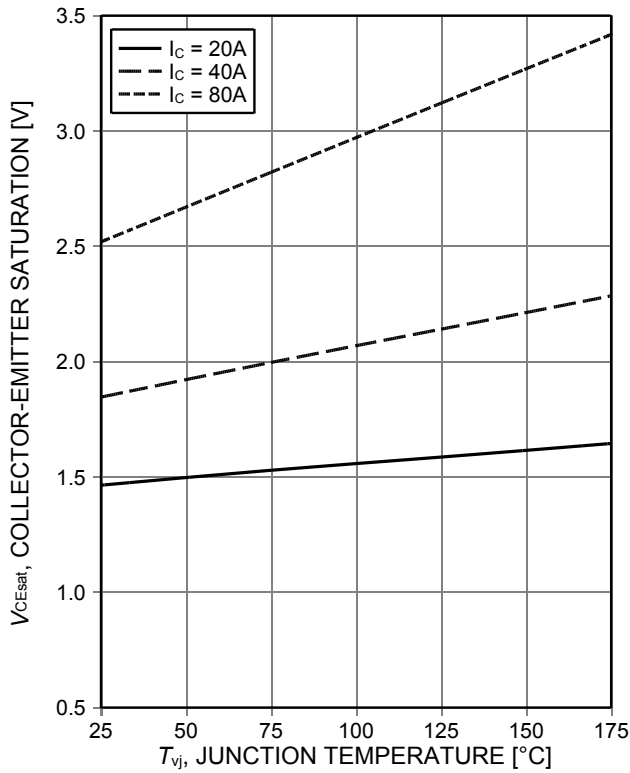


Figure 5. **Typical collector-emitter saturation voltage as a function of junction temperature** ( $V_{GE}=15V$ )

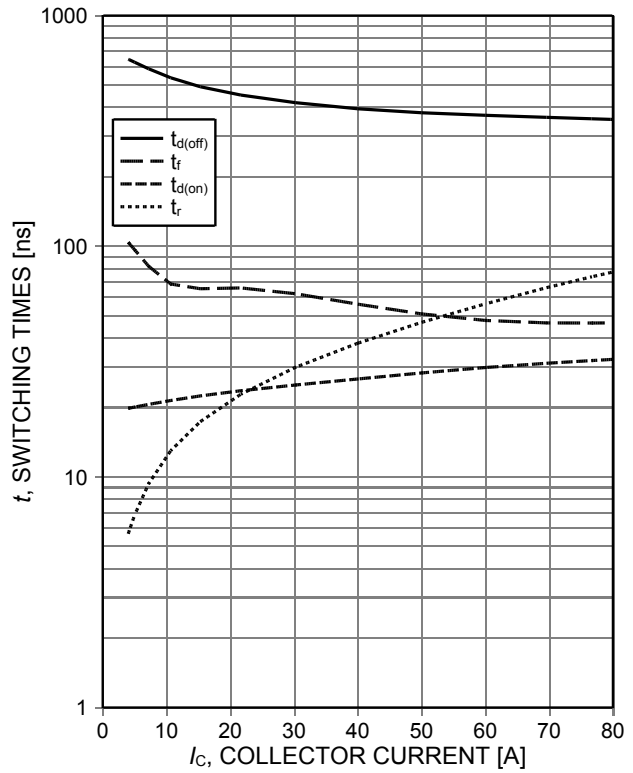


Figure 6. **Typical switching times as a function of collector current** (inductive load,  $T_{vj}=175^{\circ}C$ ,  $V_{CE}=600V$ ,  $V_{GE}=0/15V$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

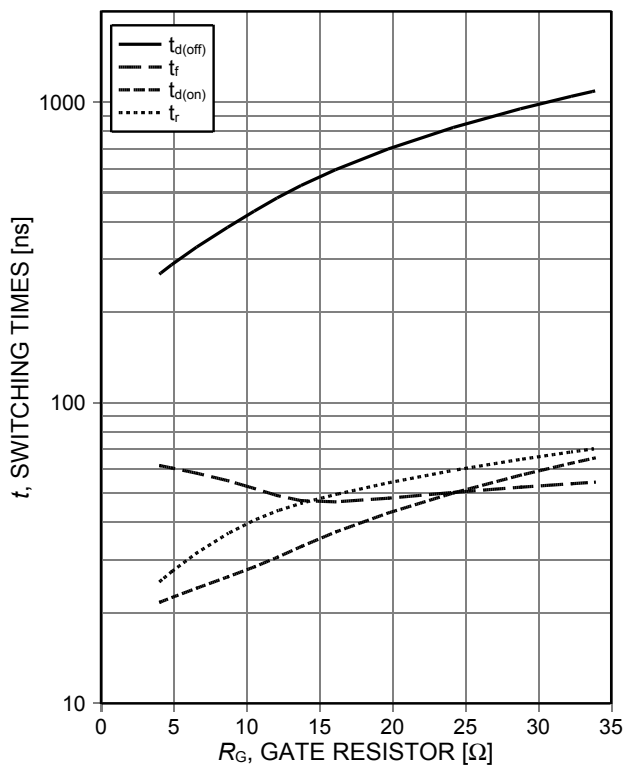


Figure 7. **Typical switching times as a function of gate resistor** (inductive load,  $T_{vj}=175^{\circ}C$ ,  $V_{CE}=600V$ ,  $V_{GE}=0/15V$ ,  $I_C=40A$ , Dynamic test circuit in Figure E)

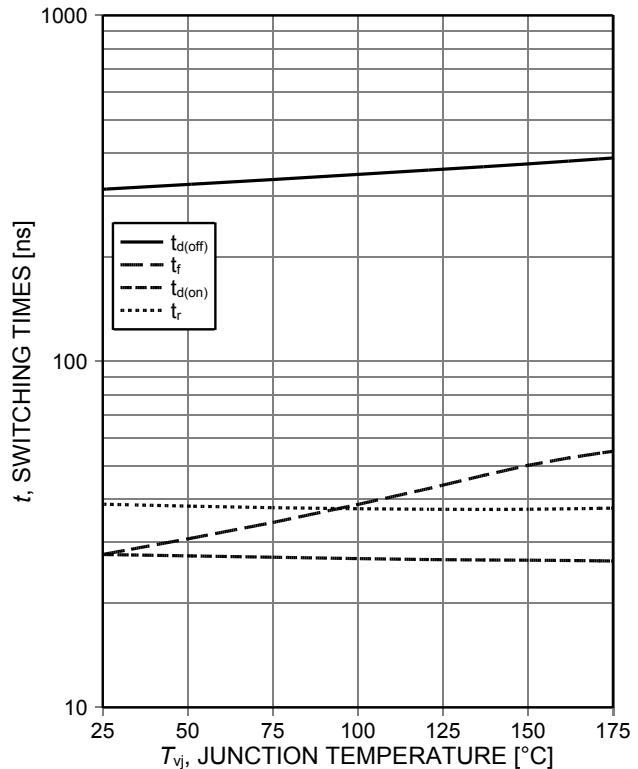


Figure 8. **Typical switching times as a function of junction temperature** (inductive load,  $V_{CE}=600V$ ,  $V_{GE}=0/15V$ ,  $I_C=40A$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)



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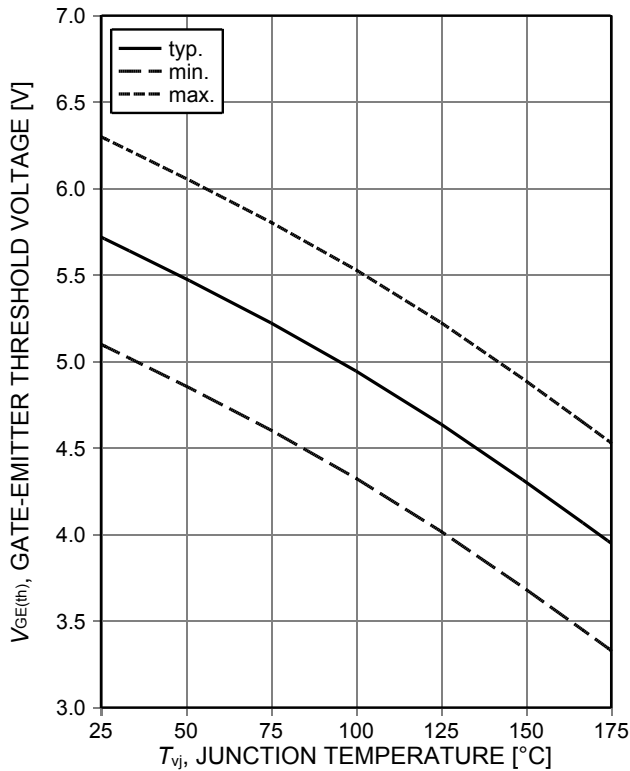


Figure 9. Gate-emitter threshold voltage as a function of junction temperature ( $I_C=1.9\text{mA}$ )

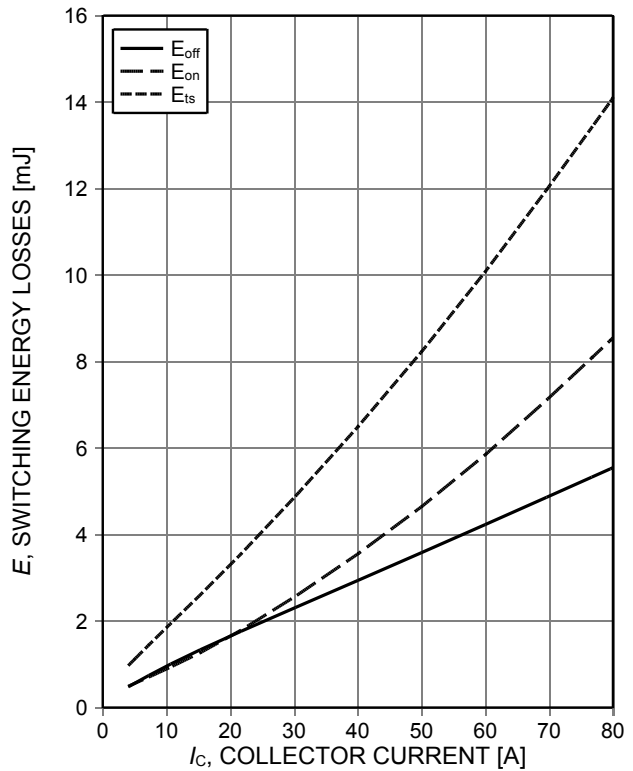


Figure 10. Typical switching energy losses as a function of collector current (inductive load,  $T_{vj}=175^\circ\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

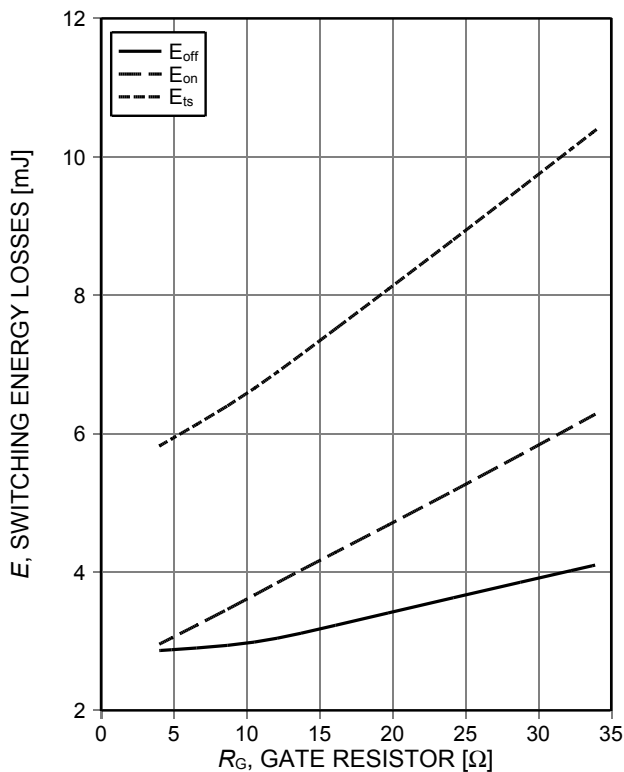


Figure 11. Typical switching energy losses as a function of gate resistor (inductive load,  $T_{vj}=175^\circ\text{C}$ ,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ , Dynamic test circuit in Figure E)

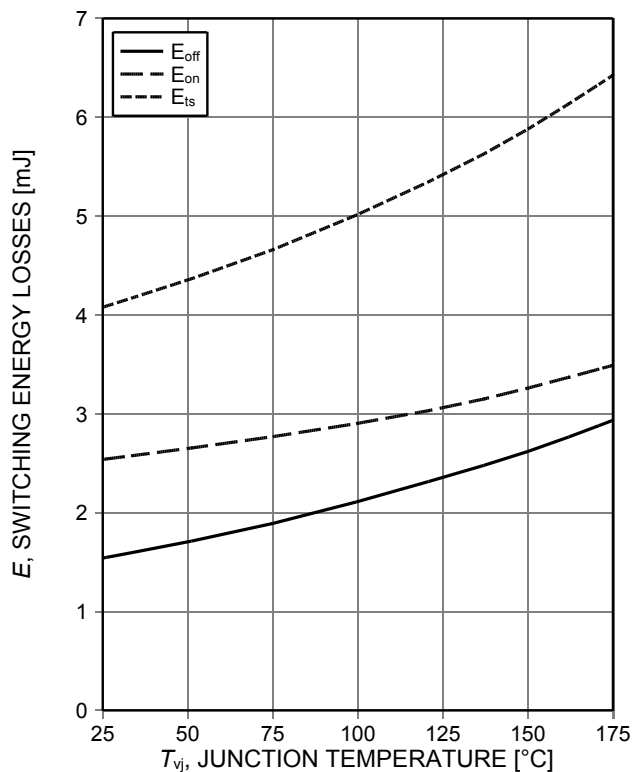


Figure 12. Typical switching energy losses as a function of junction temperature (inductive load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

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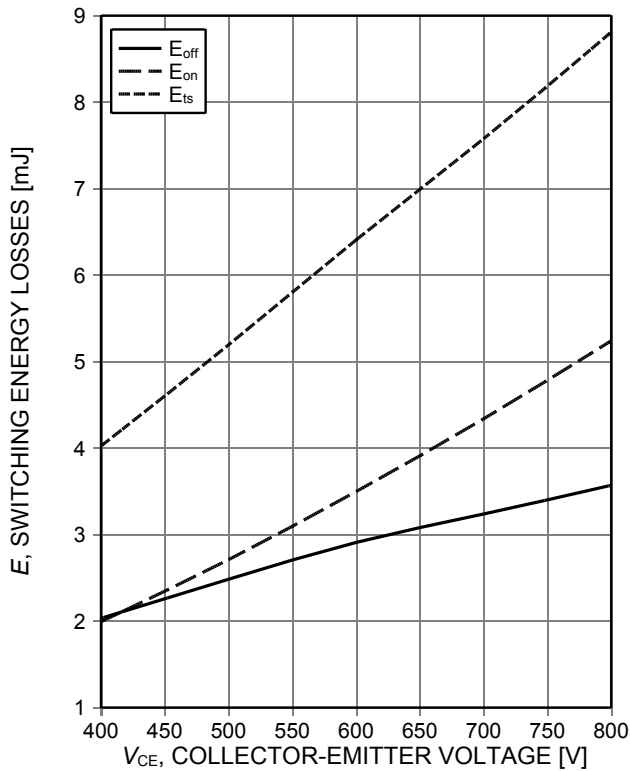


Figure 13. **Typical switching energy losses as a function of collector emitter voltage** (inductive load,  $T_{vj}=175^{\circ}\text{C}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ ,  $R_G=9\Omega$ , Dynamic test circuit in Figure E)

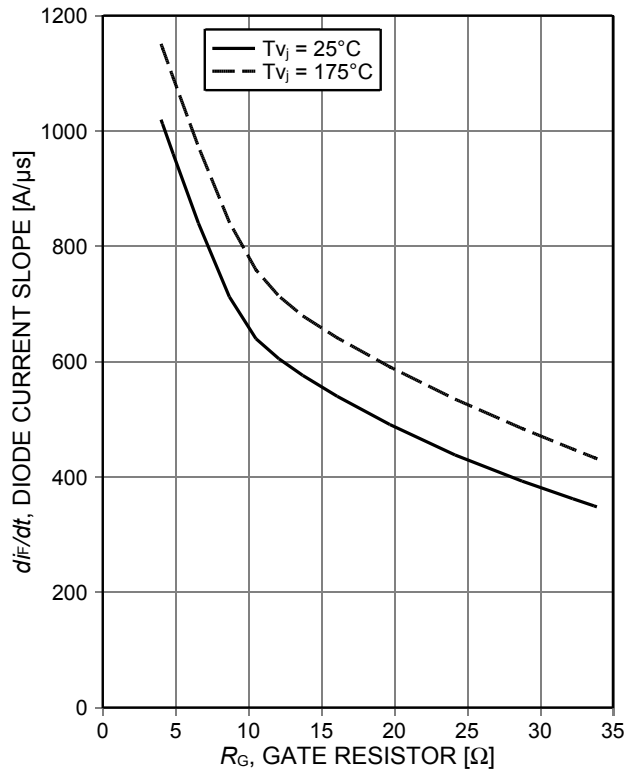


Figure 14. **Typical diode current slope as a function of gate resistor** (inductive load,  $V_{CE}=600\text{V}$ ,  $V_{GE}=0/15\text{V}$ ,  $I_C=40\text{A}$ , Dynamic test circuit in Figure E)

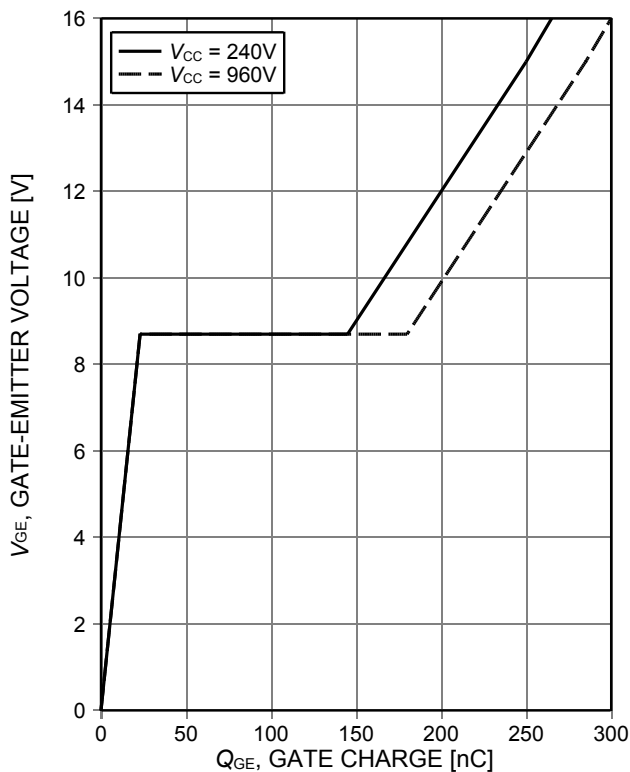


Figure 15. **Typical gate charge** ( $I_C=40\text{A}$ )

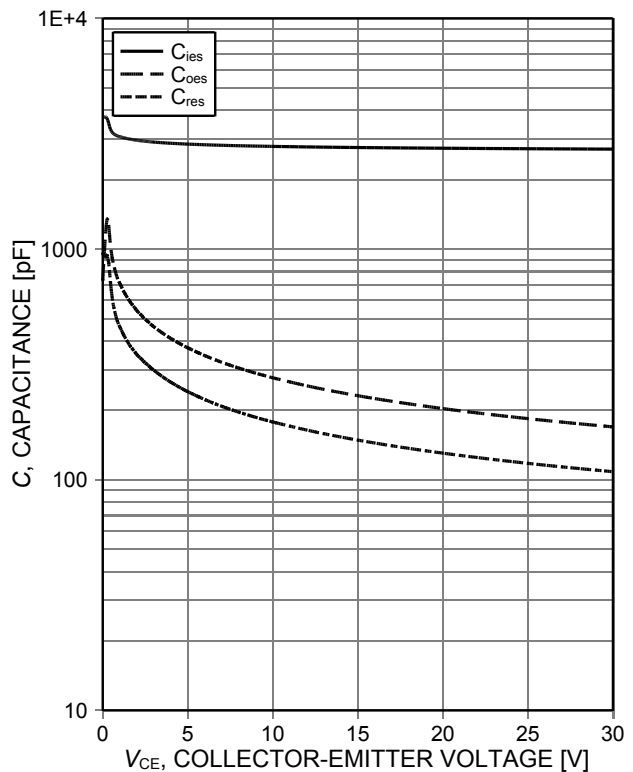


Figure 16. **Typical capacitance as a function of collector-emitter voltage** ( $V_{GE}=0\text{V}$ ,  $f=1\text{MHz}$ )

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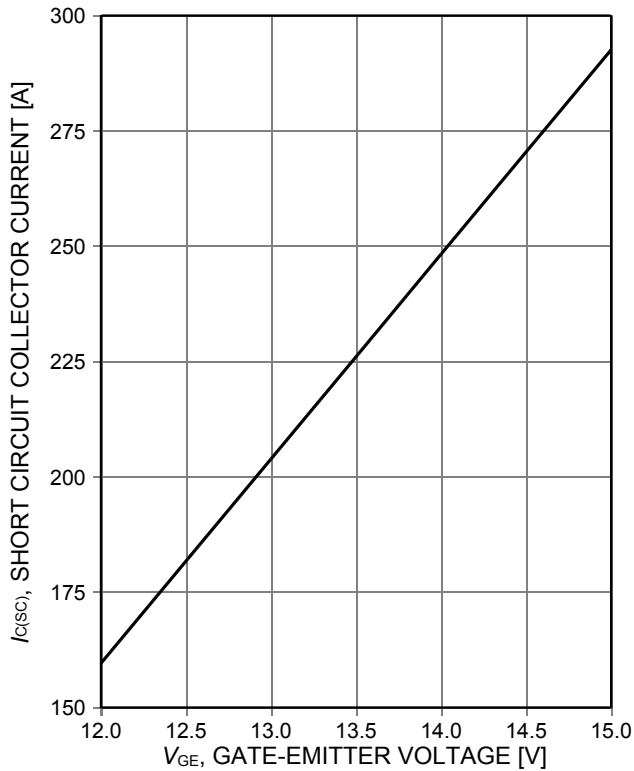


Figure 17. Typical short circuit collector current as a function of gate-emitter voltage ( $V_{CE} \leq 500V$ ,  $T_{vj} \leq 175^\circ C$ )

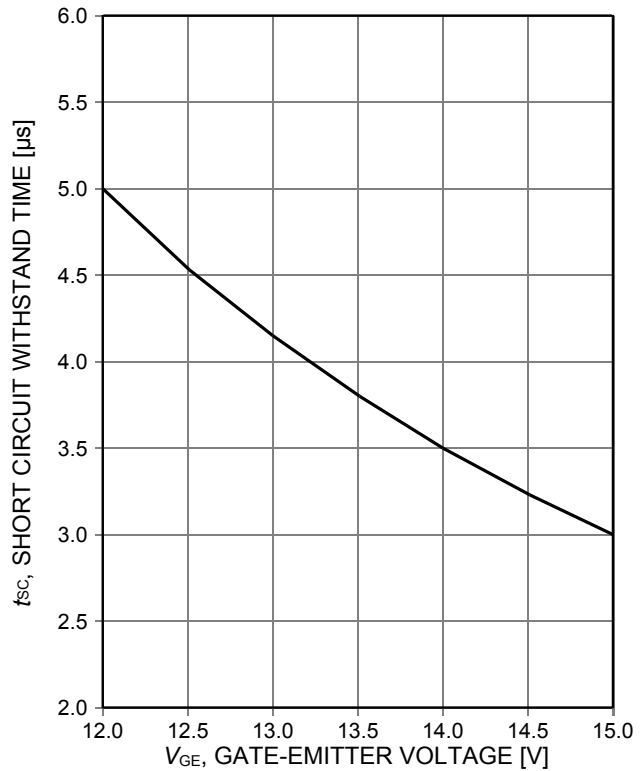


Figure 18. Short circuit withstand time as a function of gate-emitter voltage ( $V_{CE} \leq 500V$ , start at  $T_{vj} \leq 175^\circ C$ )

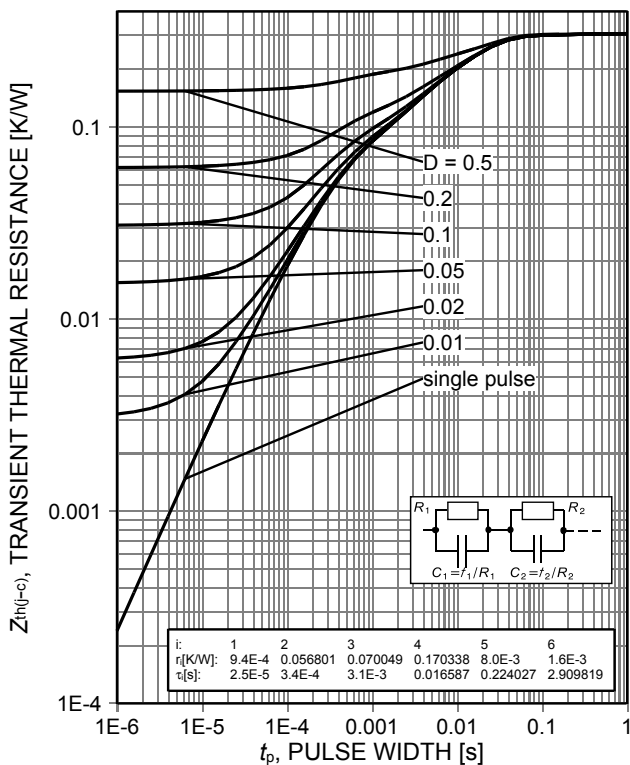


Figure 19. IGBT transient thermal resistance ( $D = t_p/T$ )

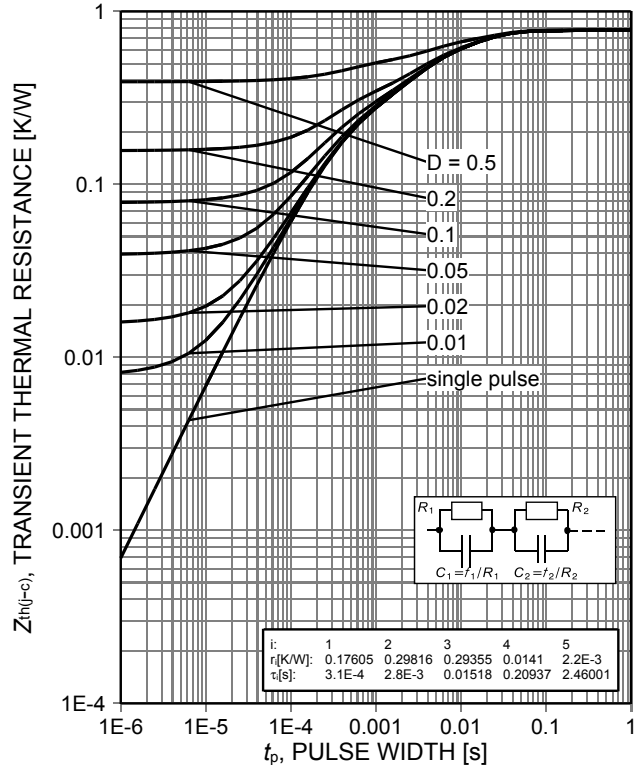


Figure 20. Diode transient thermal impedance as a function of pulse width ( $D = t_p/T$ )

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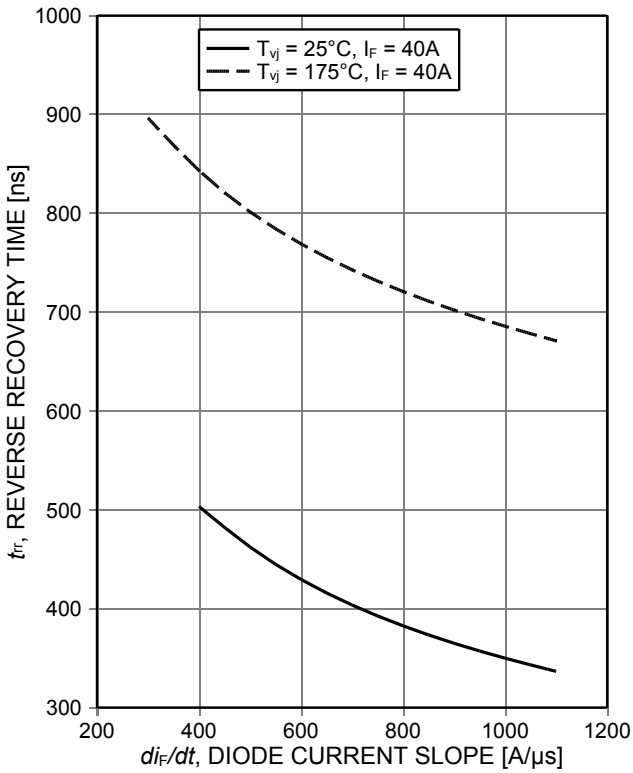


Figure 21. Typical reverse recovery time as a function of diode current slope (VR=600V)

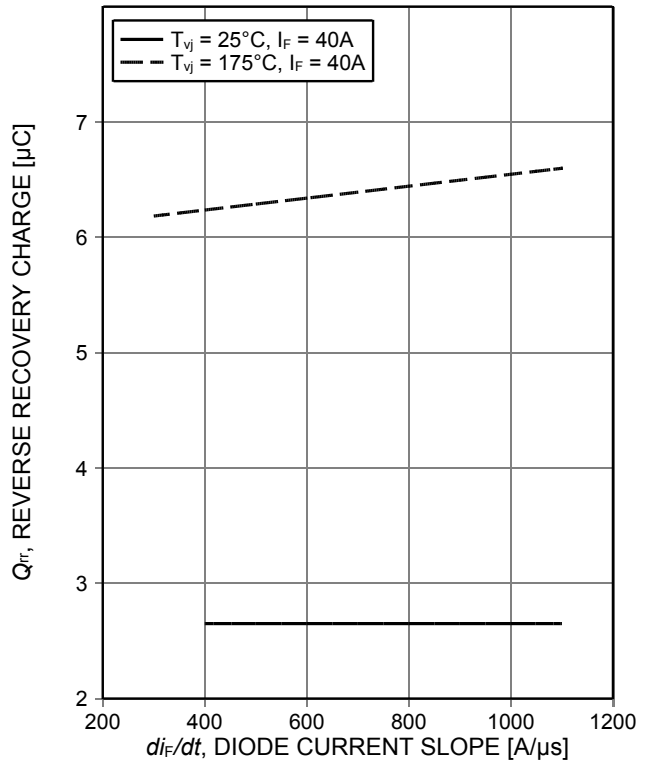


Figure 22. Typical reverse recovery charge as a function of diode current slope (VR=600V)

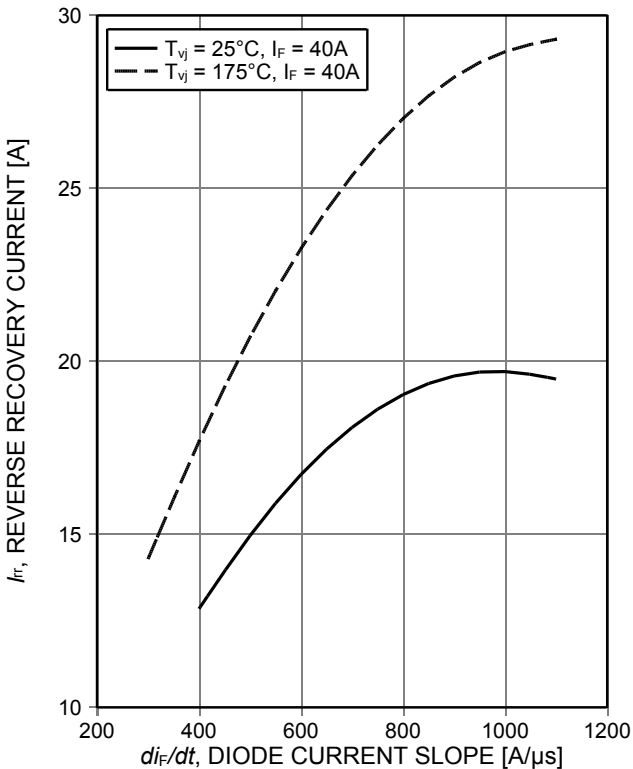


Figure 23. Typical reverse recovery current as a function of diode current slope (VR=600V)

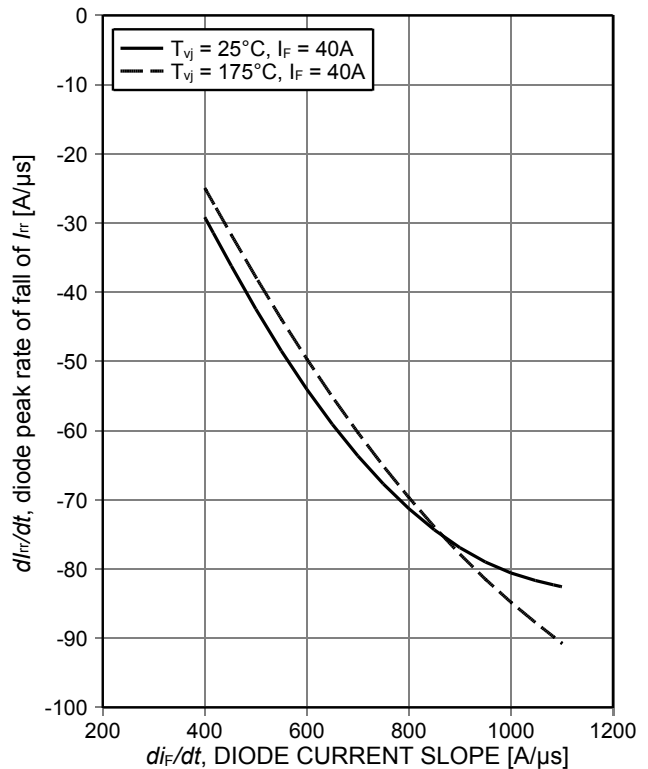


Figure 24. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope (VR=600V)

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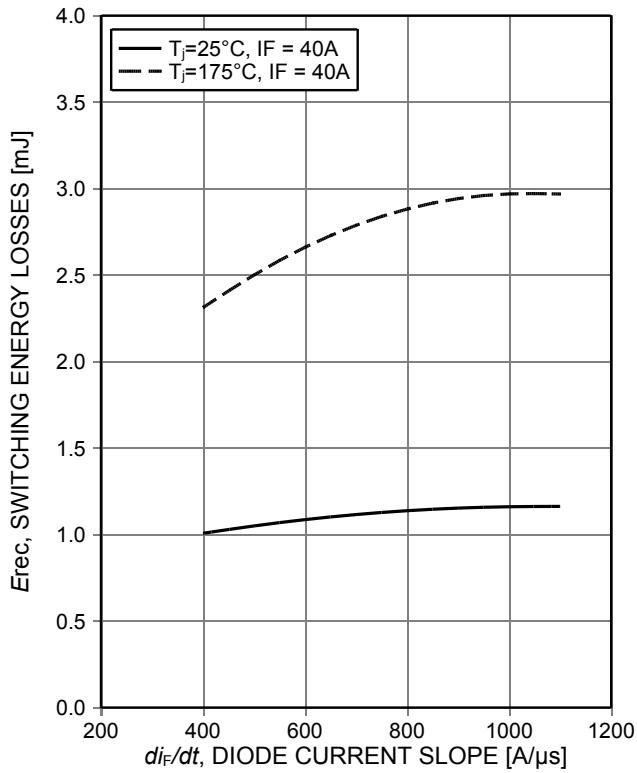


Figure 25. **Typical reverse energy losses as a function of diode current slope** ( $V_R=600V$ )

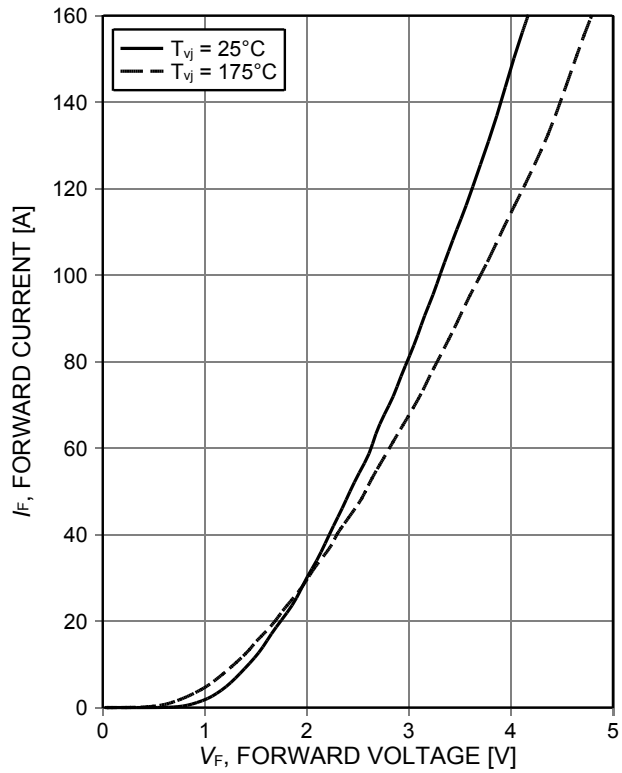


Figure 26. **Typical diode forward current as a function of forward voltage**

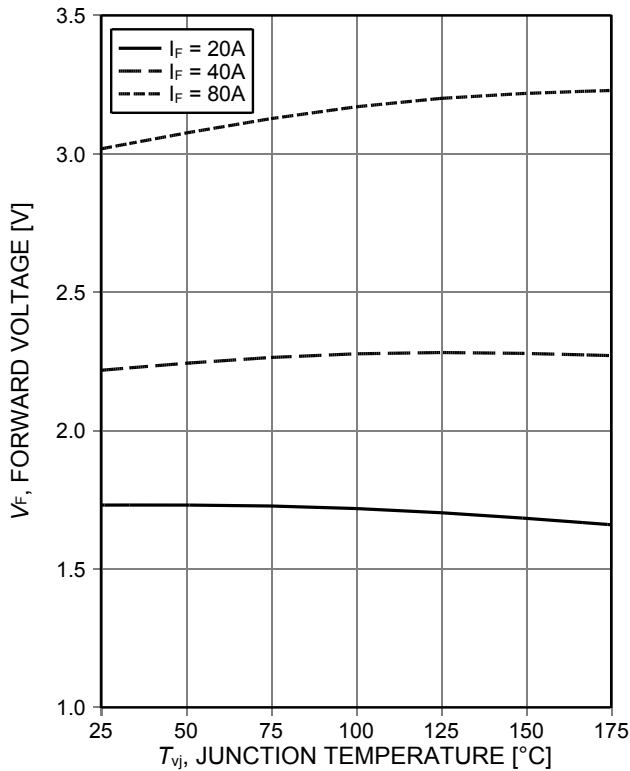
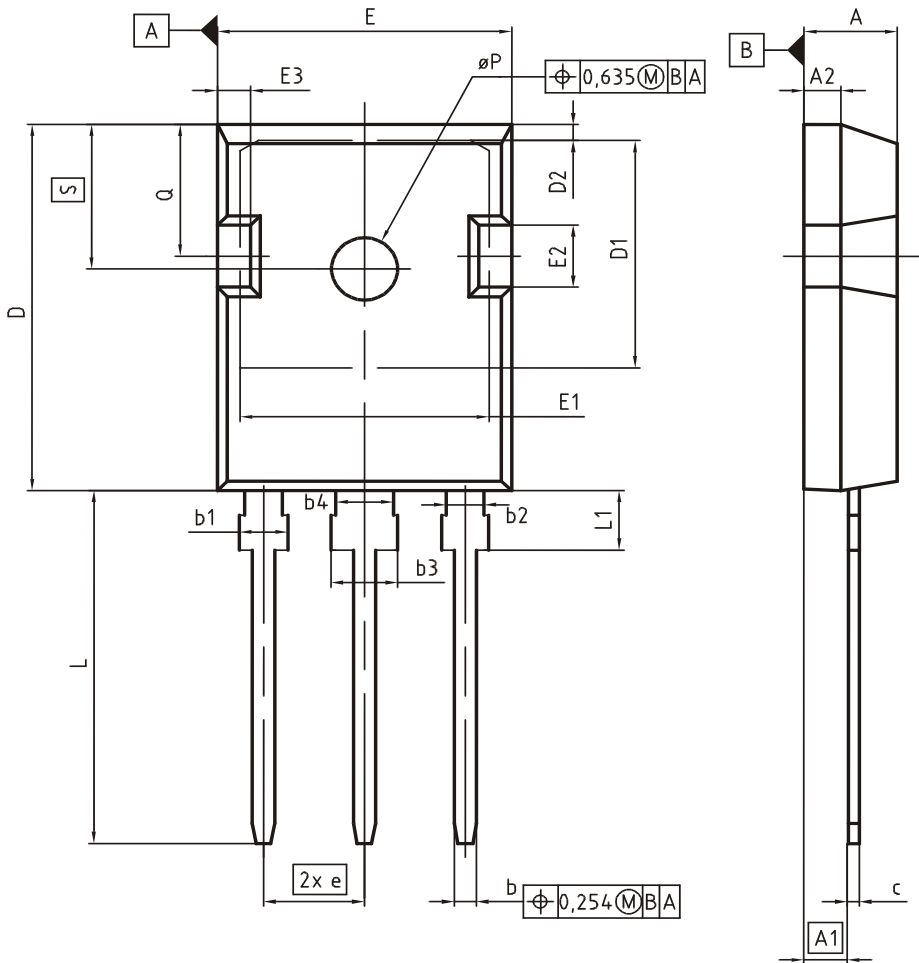


Figure 27. **Typical diode forward voltage as a function of junction temperature**

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Package Drawing PG-TO247-3



| DIM | MILLIMETERS |       | INCHES      |       |
|-----|-------------|-------|-------------|-------|
|     | MIN         | MAX   | MIN         | MAX   |
| A   | 4.83        | 5.21  | 0.190       | 0.205 |
| A1  | 2.27        | 2.54  | 0.089       | 0.100 |
| A2  | 1.85        | 2.16  | 0.073       | 0.085 |
| b   | 1.07        | 1.33  | 0.042       | 0.052 |
| b1  | 1.90        | 2.41  | 0.075       | 0.095 |
| b2  | 1.90        | 2.16  | 0.075       | 0.085 |
| b3  | 2.87        | 3.38  | 0.113       | 0.133 |
| b4  | 2.87        | 3.13  | 0.113       | 0.123 |
| c   | 0.55        | 0.68  | 0.022       | 0.027 |
| D   | 20.80       | 21.10 | 0.819       | 0.831 |
| D1  | 16.25       | 17.65 | 0.640       | 0.695 |
| D2  | 0.95        | 1.35  | 0.037       | 0.053 |
| E   | 15.70       | 16.13 | 0.618       | 0.635 |
| E1  | 13.10       | 14.15 | 0.516       | 0.557 |
| E2  | 3.68        | 5.10  | 0.145       | 0.201 |
| E3  | 1.00        | 2.60  | 0.039       | 0.102 |
| e   | 5.44 (BSC)  |       | 0.214 (BSC) |       |
| N   | 3           |       | 3           |       |
| L   | 19.80       | 20.32 | 0.780       | 0.800 |
| L1  | 4.10        | 4.47  | 0.161       | 0.176 |
| øP  | 3.50        | 3.70  | 0.138       | 0.146 |
| Q   | 5.49        | 6.00  | 0.216       | 0.236 |
| S   | 6.04        | 6.30  | 0.238       | 0.248 |

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SCALE

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Testing Conditions

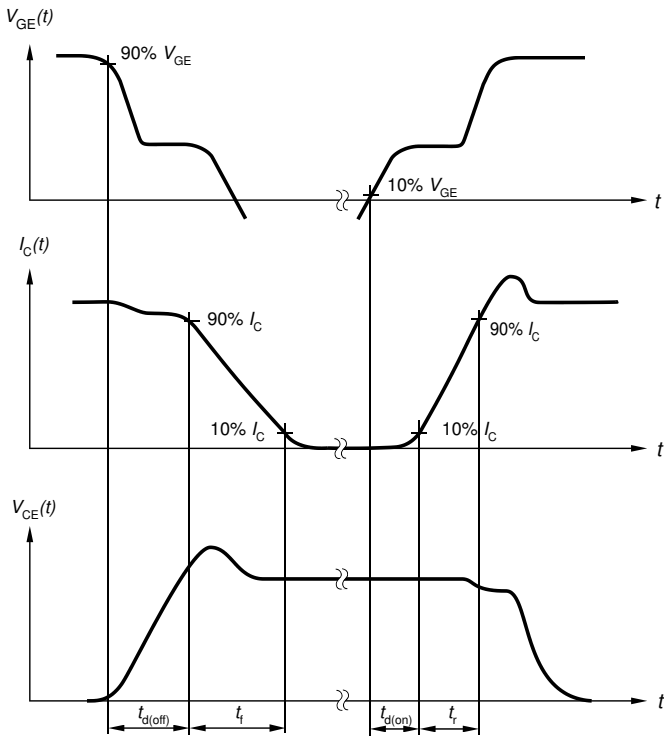


Figure A. Definition of switching times

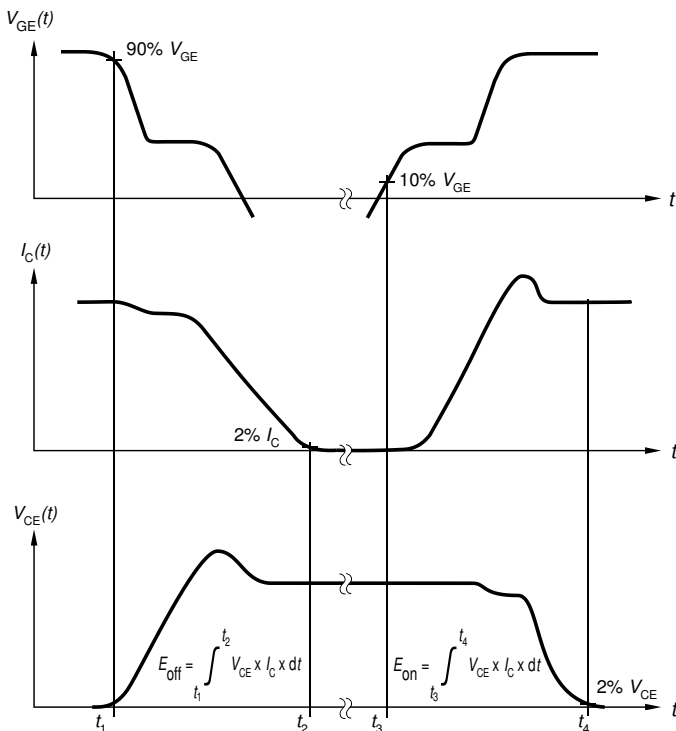


Figure B. Definition of switching losses

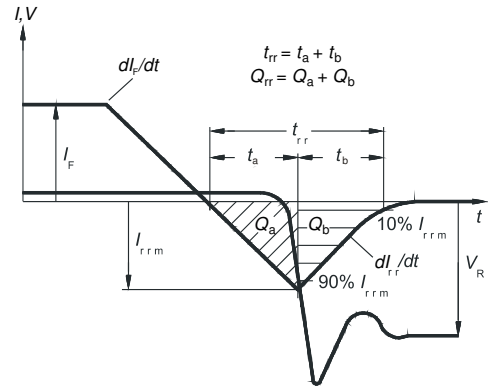


Figure C. Definition of diode switching characteristics

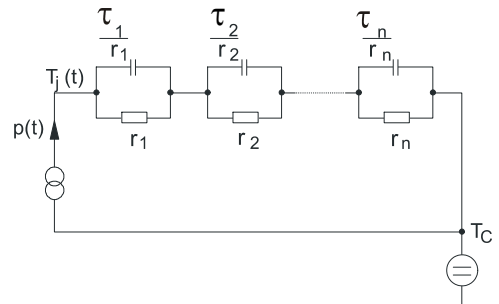


Figure D. Thermal equivalent circuit

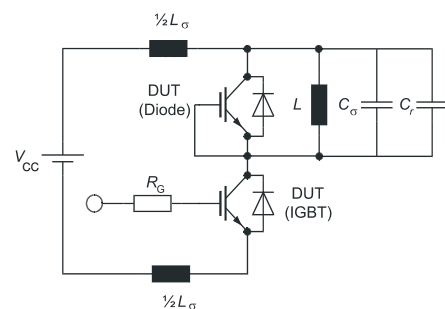


Figure E. Dynamic test circuit  
Parasitic inductance  $L_{\sigma}$ ,  
parasitic capacitor  $C_{\sigma}$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)

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Sixth generation, high speed soft switching series

## Revision History

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IKW40N120CS6

**Revision: 2018-05-07, Rev. 2.1**

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Previous Revision

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| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.1      | 2018-05-07 | Final data sheet                             |

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