

## IGBT

High speed 5 FAST IGBT in TRENCHSTOP™ 5 technology

## IGW50N65F5A

650V IGBT

High speed switching series fifth generation

Data sheet

### High speed 5 FAST IGBT in TRENCHSTOP™ 5 technology

#### Features and Benefits:

High speed F5 technology offering

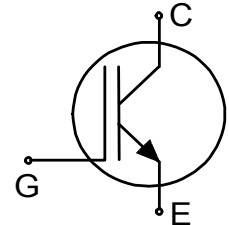
- Best-in-Class efficiency in hard switching and resonant topologies
- 650V breakdown voltage
- Low gate charge  $Q_G$
- Maximum junction temperature 175°C
- Qualified according to AEC-Q101
- Green package (RoHS compliant)
- Complete product spectrum and PSpice Models:  
<http://www.infineon.com/igbt/>

#### Applications:

- Battery charger
- DC/DC converter

#### Package pin definition:

- Pin 1 - gate
- Pin 2 & backside - collector
- Pin 3 - emitter



#### Key Performance and Package Parameters

| Type        | $V_{CE}$ | $I_C$ | $V_{CEsat}, T_{vj}=25^{\circ}C$ | $T_{vjmax}$ | Marking | Package    |
|-------------|----------|-------|---------------------------------|-------------|---------|------------|
| IGW50N65F5A | 650V     | 50A   | 1.66V                           | 175°C       | G50EF5A | PG-TO247-3 |

**Table of Contents**

|                                           |    |
|-------------------------------------------|----|
| Description .....                         | 2  |
| Table of Contents .....                   | 3  |
| Maximum Ratings .....                     | 4  |
| Thermal Resistance .....                  | 4  |
| Electrical Characteristics .....          | 4  |
| Electrical Characteristics Diagrams ..... | 7  |
| Package Drawing .....                     | 12 |
| Testing Conditions .....                  | 13 |
| Revision History .....                    | 14 |
| Disclaimer .....                          | 14 |

## 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, $T_{vj} \geq 25^{\circ}\text{C}$                                                                         | $V_{CE}$    | 650                  | V                  |
| DC collector current, limited by $T_{vjmax}$<br>$T_C = 25^{\circ}\text{C}$ value limited by bondwire<br>$T_C = 100^{\circ}\text{C}$ | $I_C$       | 80.0<br>53.5         | A                  |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}^{1)}$                                                                         | $I_{Cpuls}$ | 150.0                | A                  |
| Turn off safe operating area<br>$V_{CE} \leq 650\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p = 1\mu\text{s}^{1)}$           | -           | 150.0                | A                  |
| Gate-emitter voltage<br>Transient Gate-emitter voltage ( $t_p \leq 10\mu\text{s}$ , $D < 0.010$ )                                   | $V_{GE}$    | $\pm 20$<br>$\pm 30$ | V                  |
| Power dissipation $T_C = 25^{\circ}\text{C}$<br>Power dissipation $T_C = 100^{\circ}\text{C}$                                       | $P_{tot}$   | 270.0<br>136.0       | W                  |
| Operating junction temperature                                                                                                      | $T_{vj}$    | $-40 \dots +175$     | $^{\circ}\text{C}$ |
| Storage temperature                                                                                                                 | $T_{stg}$   | $-55 \dots +150$     | $^{\circ}\text{C}$ |
| Soldering temperature, <sup>2)</sup><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 | Max. Value | Unit |
|---------------------------------------------|---------------|------------|------------|------|
| <b>Characteristic</b>                       |               |            |            |      |
| IGBT thermal resistance,<br>junction - case | $R_{th(j-c)}$ |            | 0.55       | K/W  |
| Thermal resistance<br>junction - ambient    | $R_{th(j-a)}$ |            | 40         | K/W  |

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

| Parameter                            | Symbol        | Conditions                                                                                                    | Value       |                      |                | Unit    |
|--------------------------------------|---------------|---------------------------------------------------------------------------------------------------------------|-------------|----------------------|----------------|---------|
|                                      |               |                                                                                                               | min.        | typ.                 | max.           |         |
| Static Characteristic                |               |                                                                                                               |             |                      |                |         |
| Collector-emitter breakdown voltage  | $V_{(BR)CES}$ | $V_{GE} = 0V, I_C = 0.20mA$                                                                                   | 650         | -                    | -              | V       |
| Collector-emitter saturation voltage | $V_{CEsat}$   | $V_{GE} = 15.0V, I_C = 50.0A$<br>$T_{vj} = 25^{\circ}C$<br>$T_{vj} = 125^{\circ}C$<br>$T_{vj} = 175^{\circ}C$ | -<br>-<br>- | 1.66<br>1.90<br>2.03 | 2.10<br>-<br>- | V       |
| Gate-emitter threshold voltage       | $V_{GE(th)}$  | $I_C = 0.40mA, V_{CE} = V_{GE}$                                                                               | 3.2         | 4.0                  | 4.8            | V       |
| Zero gate voltage collector current  | $I_{CES}$     | $V_{CE} = 650V, V_{GE} = 0V$<br>$T_{vj} = 25^{\circ}C$<br>$T_{vj} = 175^{\circ}C$                             | -<br>-      | -<br>600.0           | 40.0<br>-      | $\mu A$ |
| Gate-emitter leakage current         | $I_{GES}$     | $V_{CE} = 0V, V_{GE} = 20V$                                                                                   | -           | -                    | 100            | nA      |
| Transconductance                     | $g_{fs}$      | $V_{CE} = 20V, I_C = 50.0A$                                                                                   | -           | 62.0                 | -              | S       |

<sup>1)</sup> Defined by design. Not subject to production test.

<sup>2)</sup> Package not recommended for surface mount applications

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

| Parameter                                                            | Symbol    | Conditions                                      | Value |       |      | Unit |
|----------------------------------------------------------------------|-----------|-------------------------------------------------|-------|-------|------|------|
|                                                                      |           |                                                 | min.  | typ.  | max. |      |
| Dynamic Characteristic                                               |           |                                                 |       |       |      |      |
| Input capacitance                                                    | $C_{ies}$ | $V_{CE} = 25V, V_{GE} = 0V, f = 1MHz$           | -     | 2800  | -    | pF   |
| Output capacitance                                                   | $C_{oes}$ |                                                 | -     | 51    | -    |      |
| Reverse transfer capacitance                                         | $C_{res}$ |                                                 | -     | 11    | -    |      |
| Gate charge                                                          | $Q_G$     | $V_{CC} = 520V, I_C = 50.0A,$<br>$V_{GE} = 15V$ | -     | 108.0 | -    | 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                                    | $t_{d(\text{on})}$  | $T_{vj} = 25^{\circ}\text{C},$<br>$V_{CC} = 400\text{V}, I_C = 25.0\text{A},$<br>$V_{GE} = 0.0/15.0\text{V},$<br>$R_{G(\text{on})} = 12.0\Omega, R_{G(\text{off})} = 12.0\Omega,$<br>$L\sigma = 30\text{nH}, C\sigma = 30\text{pF}$<br>$L\sigma, C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery. | -     | 21   | -    | ns   |
| Rise time                                             | $t_r$               |                                                                                                                                                                                                                                                                                                                                   | -     | 12   | -    | ns   |
| Turn-off delay time                                   | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                   | -     | 156  | -    | ns   |
| Fall time                                             | $t_f$               |                                                                                                                                                                                                                                                                                                                                   | -     | 6    | -    | ns   |
| Turn-on energy                                        | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                   | -     | 0.49 | -    | mJ   |
| Turn-off energy                                       | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                   | -     | 0.14 | -    | mJ   |
| Total switching energy                                | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                   | -     | 0.63 | -    | mJ   |
|                                                       |                     |                                                                                                                                                                                                                                                                                                                                   |       |      |      |      |
| Turn-on delay time                                    | $t_{d(\text{on})}$  | $T_{vj} = 25^{\circ}\text{C},$<br>$V_{CC} = 400\text{V}, I_C = 6.0\text{A},$<br>$V_{GE} = 0.0/15.0\text{V},$<br>$R_{G(\text{on})} = 12.0\Omega, R_{G(\text{off})} = 12.0\Omega,$<br>$L\sigma = 30\text{nH}, C\sigma = 30\text{pF}$<br>$L\sigma, C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery.  | -     | 19   | -    | ns   |
| Rise time                                             | $t_r$               |                                                                                                                                                                                                                                                                                                                                   | -     | 4    | -    | ns   |
| Turn-off delay time                                   | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                   | -     | 173  | -    | ns   |
| Fall time                                             | $t_f$               |                                                                                                                                                                                                                                                                                                                                   | -     | 10   | -    | ns   |
| Turn-on energy                                        | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                   | -     | 0.10 | -    | mJ   |
| Turn-off energy                                       | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                   | -     | 0.03 | -    | mJ   |
| Total switching energy                                | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                   | -     | 0.13 | -    | mJ   |

**Switching Characteristic, Inductive Load**

| Parameter                                              | Symbol              | Conditions                                                                                                                                                                                                                                                                                                                                         | Value |      |      | Unit |
|--------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|------|------|
|                                                        |                     |                                                                                                                                                                                                                                                                                                                                                    | min.  | typ. | max. |      |
| IGBT Characteristic, at $T_{vj} = 150^{\circ}\text{C}$ |                     |                                                                                                                                                                                                                                                                                                                                                    |       |      |      |      |
| Turn-on delay time                                     | $t_{d(\text{on})}$  | $T_{vj} = 150^{\circ}\text{C}$ ,<br>$V_{CC} = 400\text{V}$ , $I_C = 25.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(\text{on})} = 12.0\Omega$ , $R_{G(\text{off})} = 12.0\Omega$ ,<br>$L\sigma = 30\text{nH}$ , $C\sigma = 30\text{pF}$<br>$L\sigma$ , $C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery. | -     | 21   | -    | ns   |
| Rise time                                              | $t_r$               |                                                                                                                                                                                                                                                                                                                                                    | -     | 14   | -    | ns   |
| Turn-off delay time                                    | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                                    | -     | 191  | -    | ns   |
| Fall time                                              | $t_f$               |                                                                                                                                                                                                                                                                                                                                                    | -     | 5    | -    | ns   |
| Turn-on energy                                         | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                                    | -     | 0.68 | -    | mJ   |
| Turn-off energy                                        | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                                    | -     | 0.25 | -    | mJ   |
| Total switching energy                                 | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                                    | -     | 0.93 | -    | mJ   |
|                                                        |                     |                                                                                                                                                                                                                                                                                                                                                    |       |      |      |      |
| Turn-on delay time                                     | $t_{d(\text{on})}$  | $T_{vj} = 150^{\circ}\text{C}$ ,<br>$V_{CC} = 400\text{V}$ , $I_C = 6.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(\text{on})} = 12.0\Omega$ , $R_{G(\text{off})} = 12.0\Omega$ ,<br>$L\sigma = 30\text{nH}$ , $C\sigma = 30\text{pF}$<br>$L\sigma$ , $C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery.  | -     | 18   | -    | ns   |
| Rise time                                              | $t_r$               |                                                                                                                                                                                                                                                                                                                                                    | -     | 5    | -    | ns   |
| Turn-off delay time                                    | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                                    | -     | 229  | -    | ns   |
| Fall time                                              | $t_f$               |                                                                                                                                                                                                                                                                                                                                                    | -     | 12   | -    | ns   |
| Turn-on energy                                         | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                                    | -     | 0.18 | -    | mJ   |
| Turn-off energy                                        | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                                    | -     | 0.06 | -    | mJ   |
| Total switching energy                                 | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                                    | -     | 0.24 | -    | mJ   |

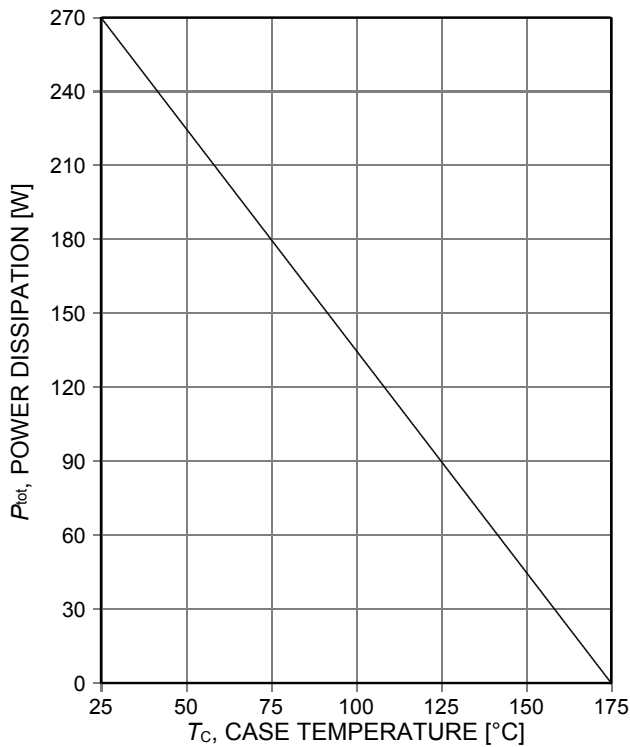


Figure 1. **Power dissipation as a function of case temperature**  
( $T_{vj} \leq 175^\circ\text{C}$ )

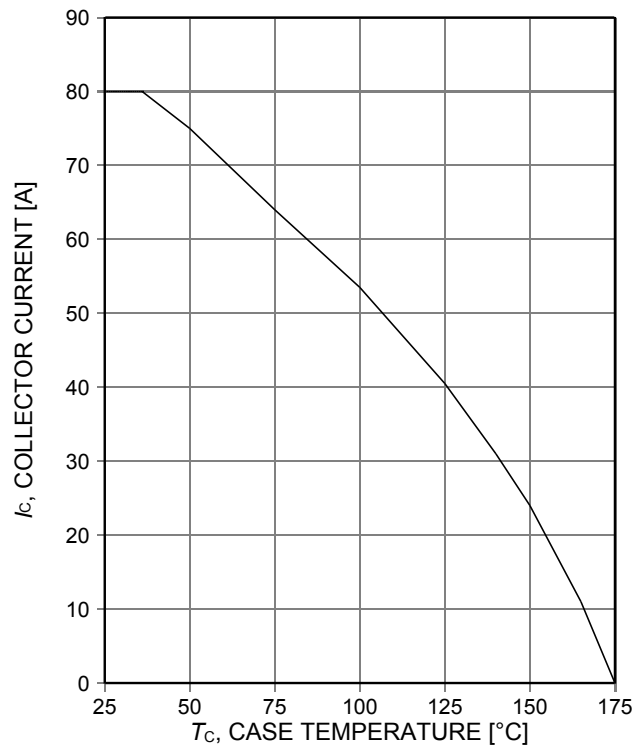


Figure 2. **Collector current as a function of case temperature**  
( $V_{GE} \geq 15\text{V}$ ,  $T_{vj} \leq 175^\circ\text{C}$ )

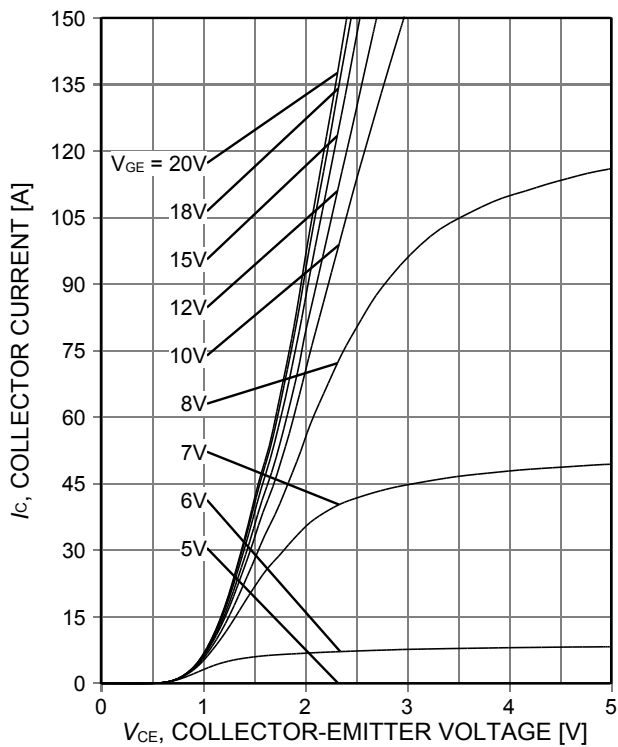


Figure 3. **Typical output characteristic**  
( $T_{vj} = 25^\circ\text{C}$ )

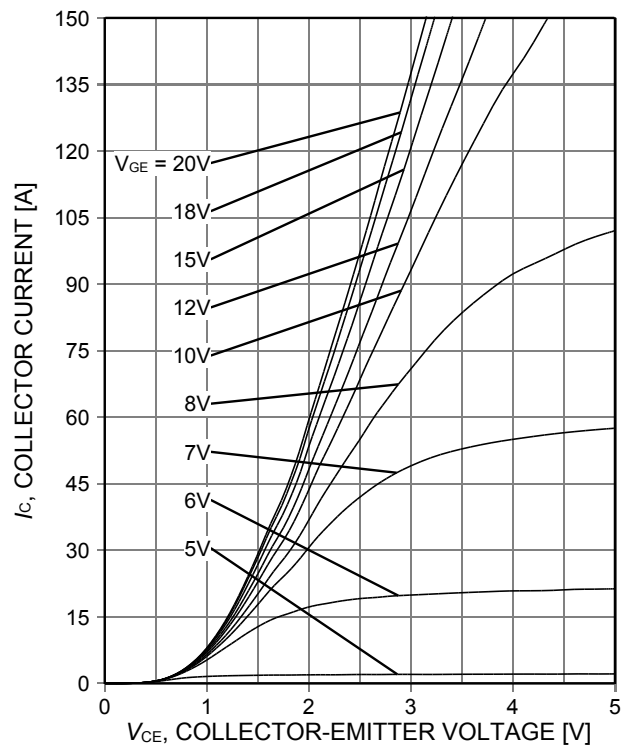


Figure 4. **Typical output characteristic**  
( $T_{vj} = 150^\circ\text{C}$ )

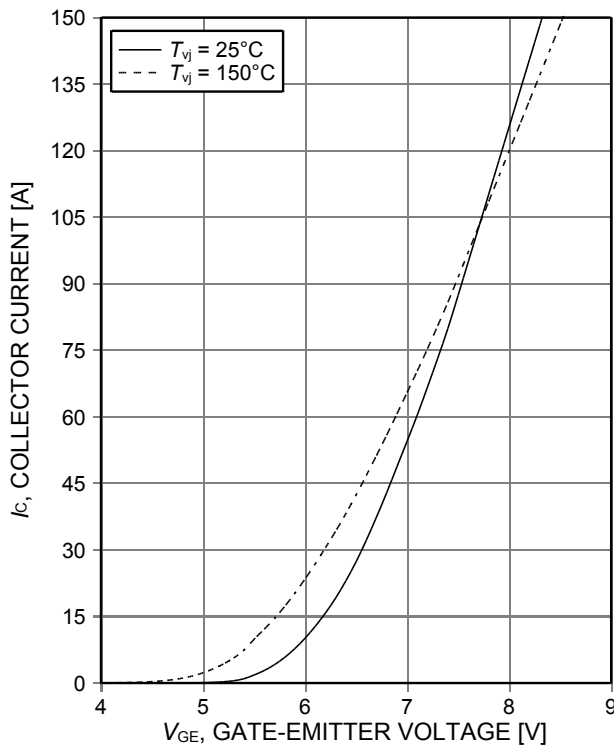


Figure 5. **Typical transfer characteristic**  
( $V_{CE}=20V$ )

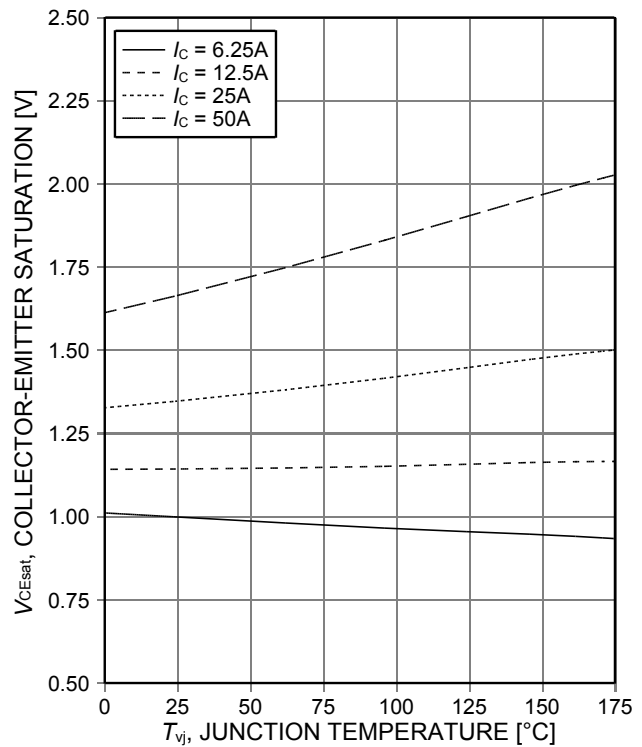


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15V$ )

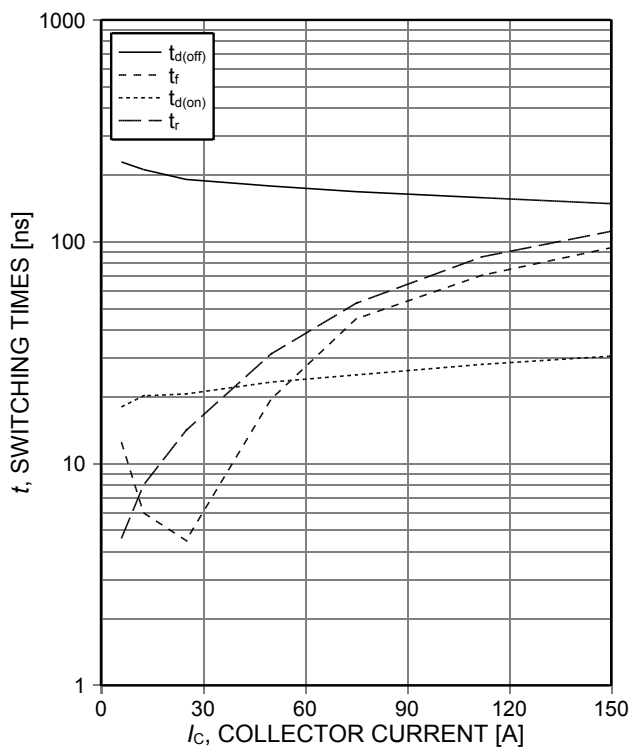


Figure 7. **Typical switching times as a function of collector current**  
(inductive load,  $T_{vj}=150^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $R_{G(on)}=12\Omega$ ,  $R_{G(off)}=12\Omega$ , dynamic test circuit in Figure E)

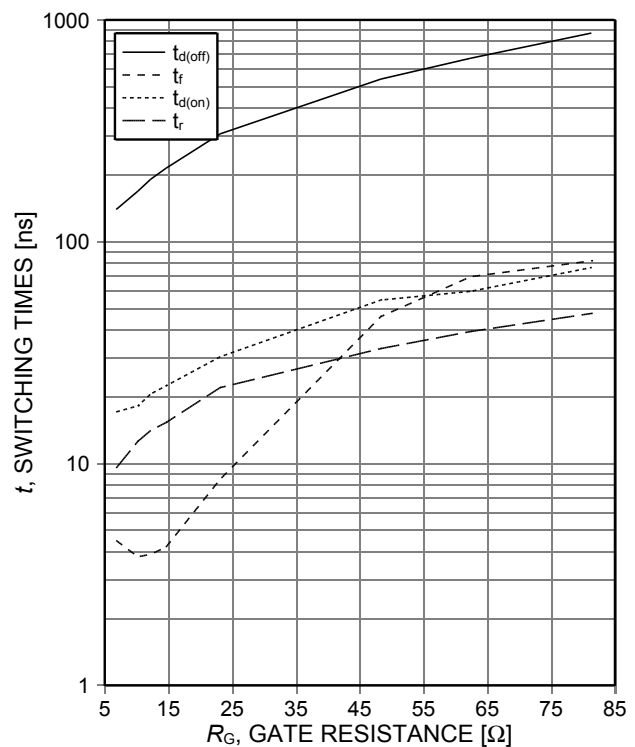


Figure 8. **Typical switching times as a function of gate resistance**  
(inductive load,  $T_{vj}=150^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $I_C=25A$ , dynamic test circuit in Figure E)



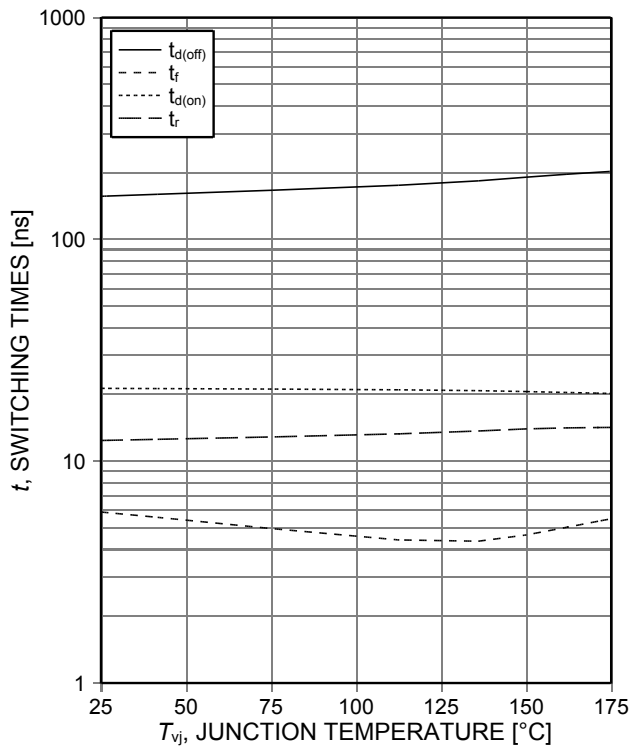


Figure 9. **Typical switching times as a function of junction temperature**  
(inductive load,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $I_C=25A$ ,  $R_{G(on)}=12\Omega$ ,  $R_{G(off)}=12\Omega$ , dynamic test circuit in Figure E)

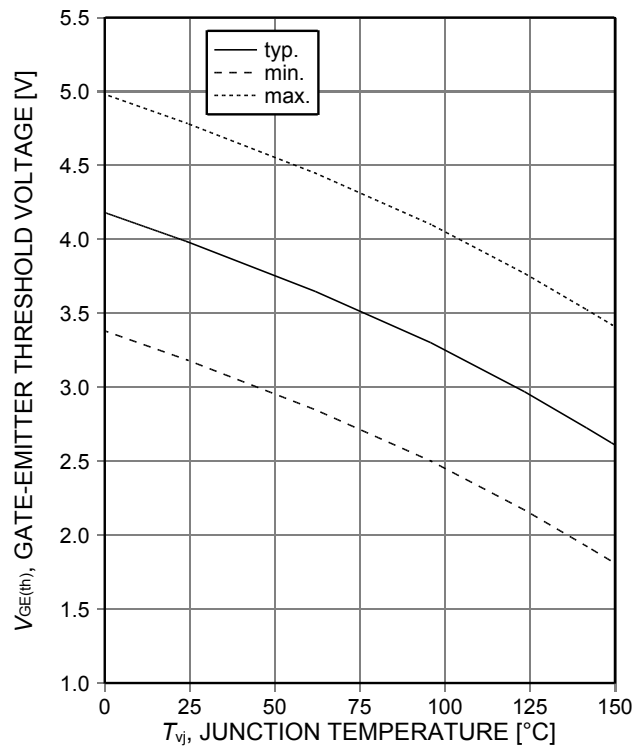


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**  
( $I_C=0.4mA$ )

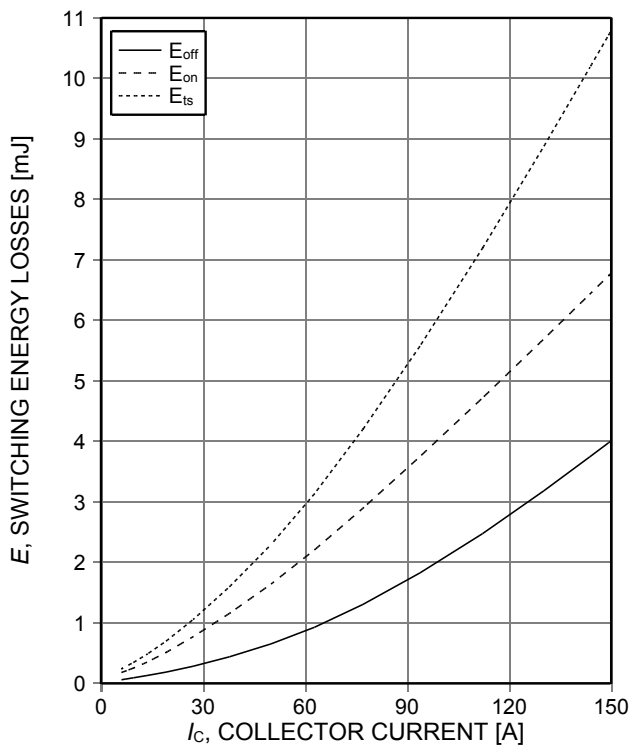


Figure 11. **Typical switching energy losses as a function of collector current**  
(inductive load,  $T_{vj}=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $R_{G(on)}=12\Omega$ ,  $R_{G(off)}=12\Omega$ , dynamic test circuit in Figure E)

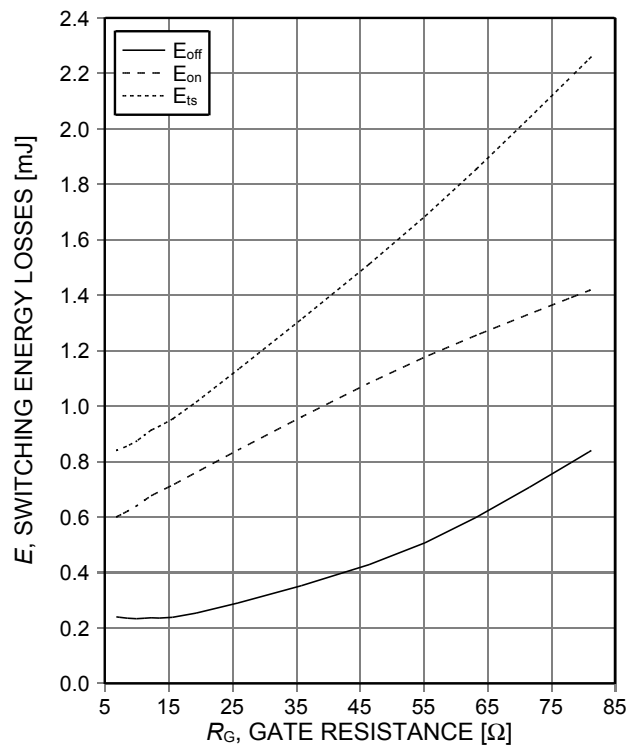


Figure 12. **Typical switching energy losses as a function of gate resistance**  
(inductive load,  $T_{vj}=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $I_C=25A$ , dynamic test circuit in Figure E)

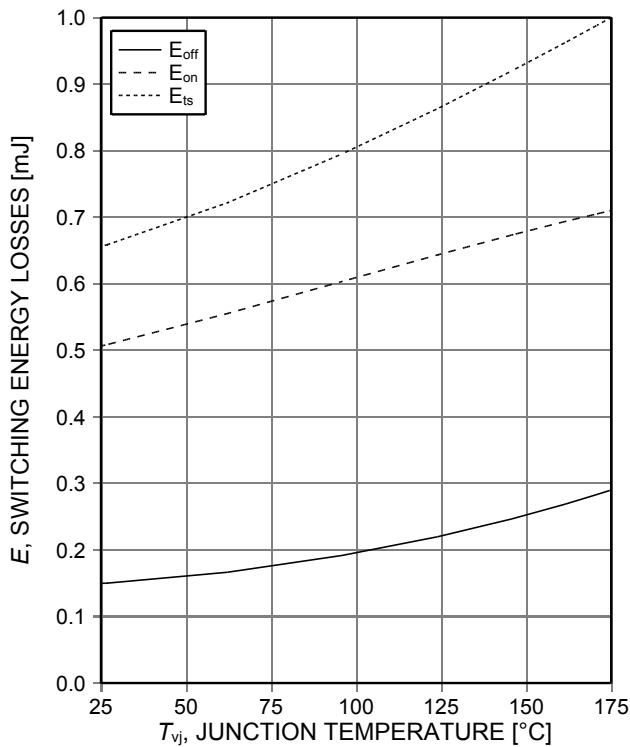


Figure 13. **Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $I_C=25A$ ,  $R_{G(on)}=12\Omega$ ,  $R_{G(off)}=12\Omega$ , dynamic test circuit in Figure E)

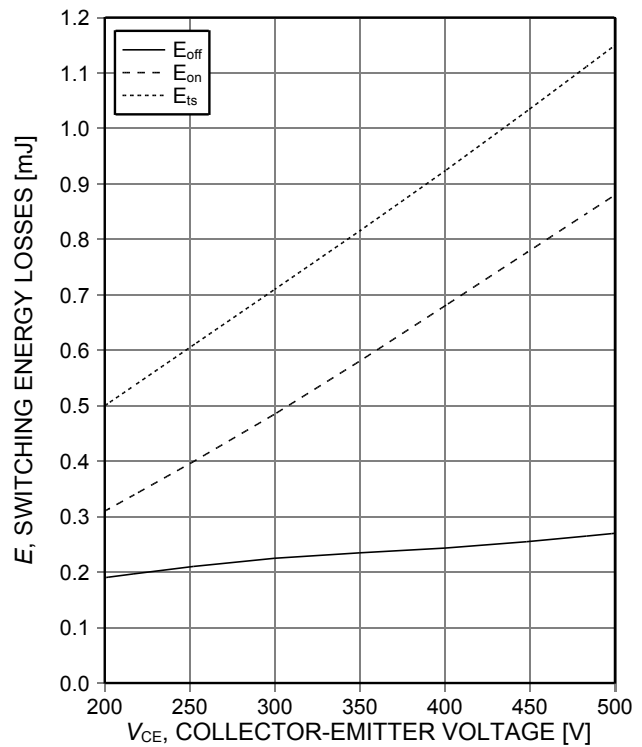


Figure 14. **Typical switching energy losses as a function of collector-emitter voltage**  
(inductive load,  $T_{vj}=150^\circ C$ ,  $V_{GE}=0/15V$ ,  $I_C=25A$ ,  $R_{G(on)}=12\Omega$ ,  $R_{G(off)}=12\Omega$ , dynamic test circuit in Figure E)

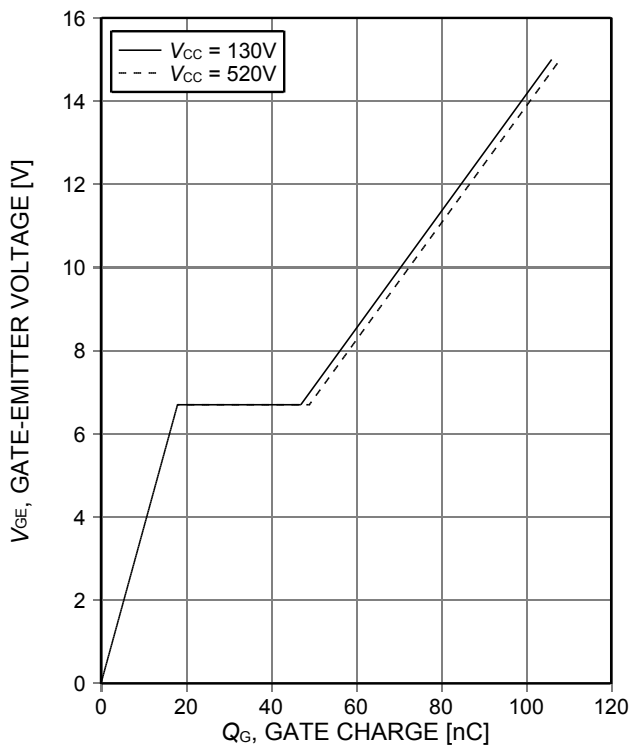


Figure 15. **Typical gate charge**  
( $I_C=50A$ )

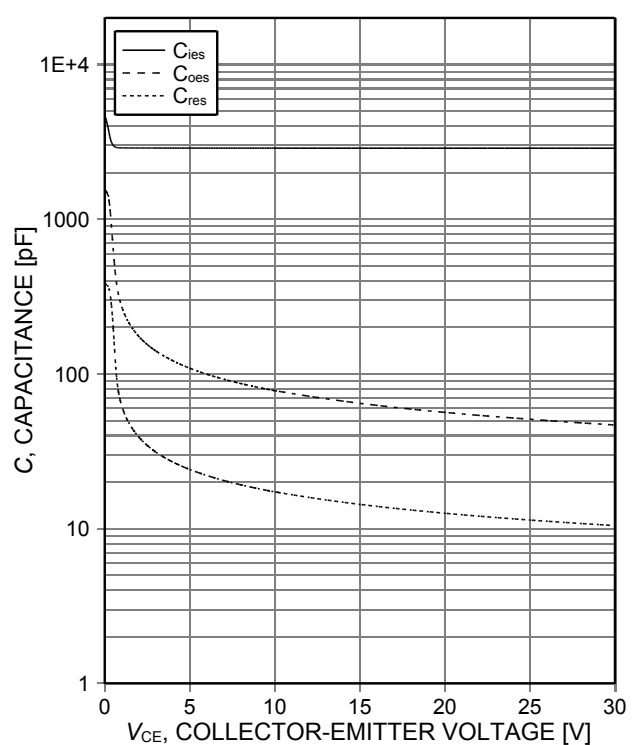


Figure 16. **Typical capacitance as a function of collector-emitter voltage**  
( $V_{GE}=0V$ ,  $f=1MHz$ )

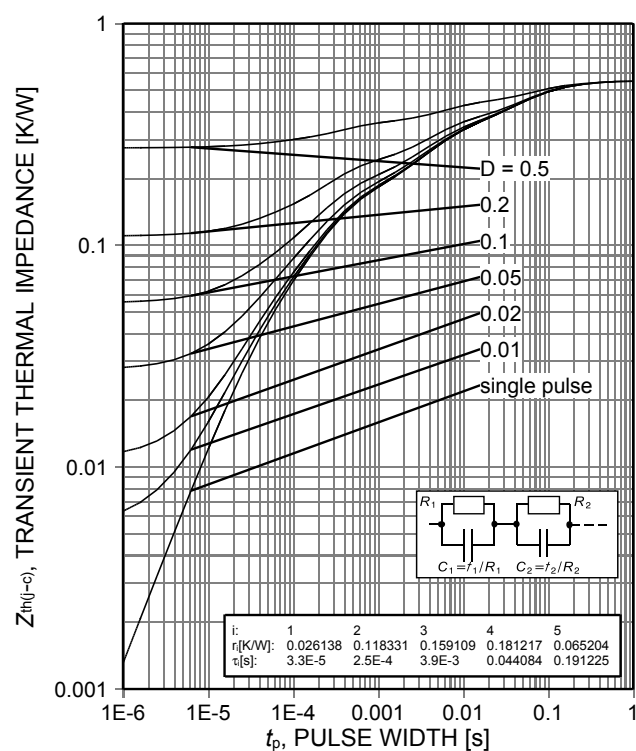
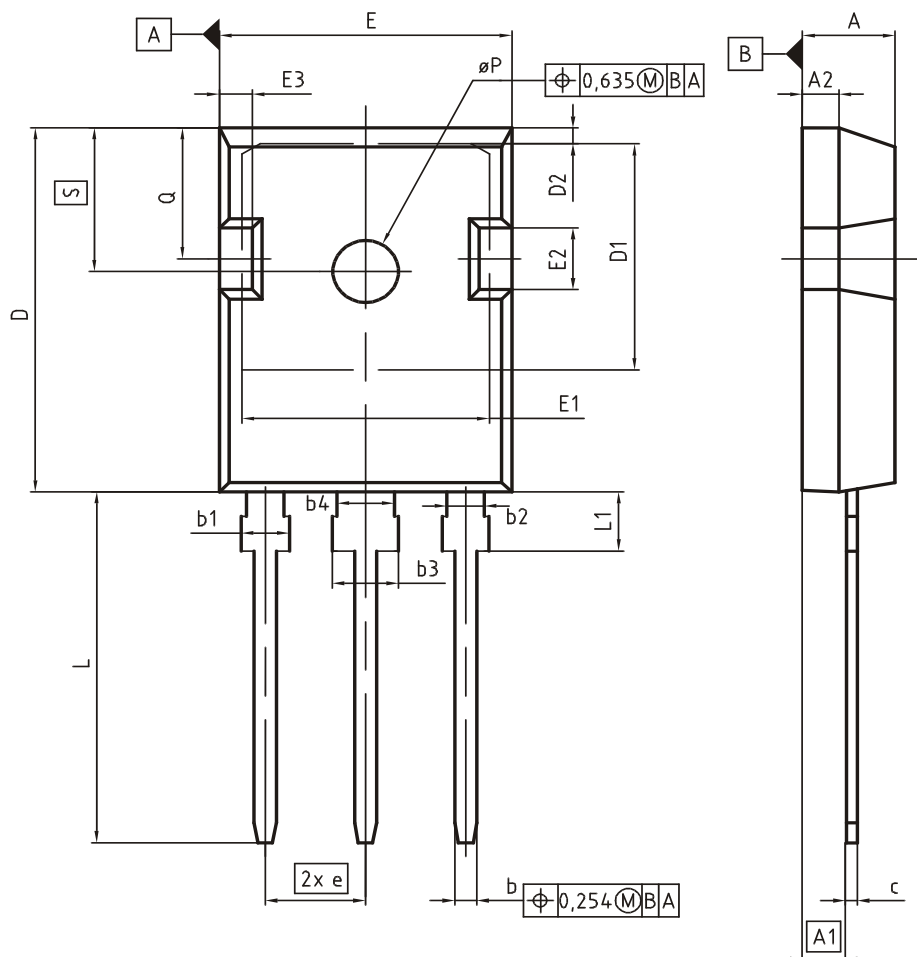
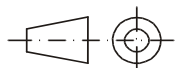


Figure 17. IGBT transient thermal impedance  
( $D=t_p/T$ )

## 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 |

|                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00003327                                                                                  |
| <b>SCALE</b><br>0 5 7.5mm                                                                                           |
| <b>EUROPEAN PROJECTION</b><br> |
| <b>ISSUE DATE</b><br>09-07-2010                                                                                     |
| <b>REVISION</b><br>05                                                                                               |

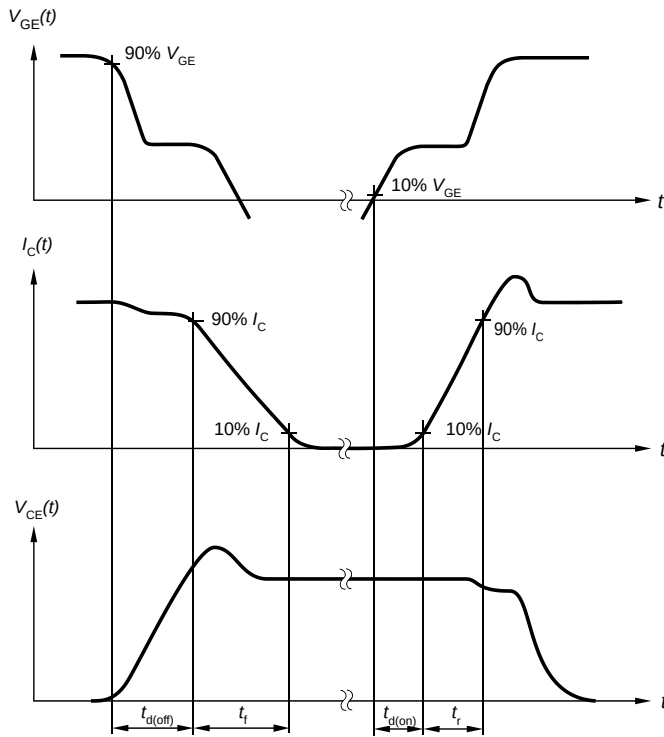


Figure A. Definition of switching times

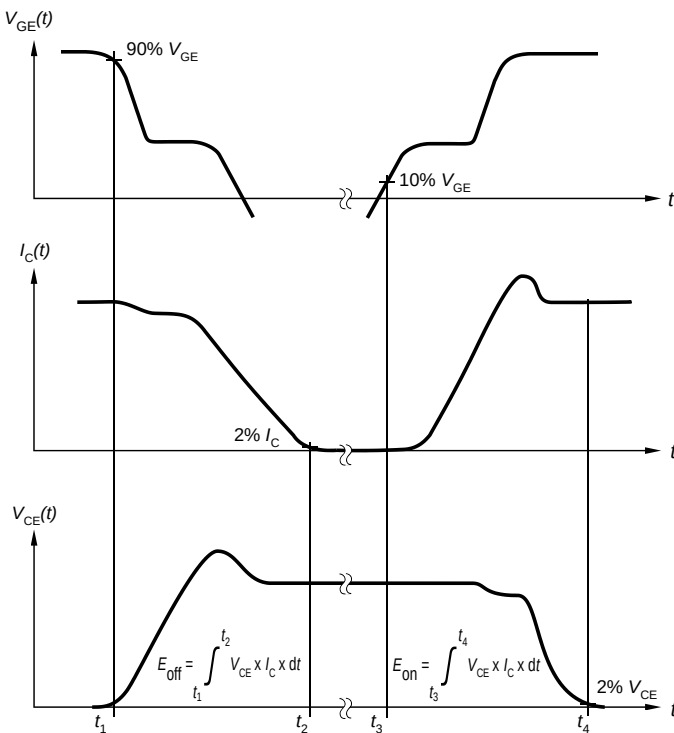


Figure B. Definition of switching losses

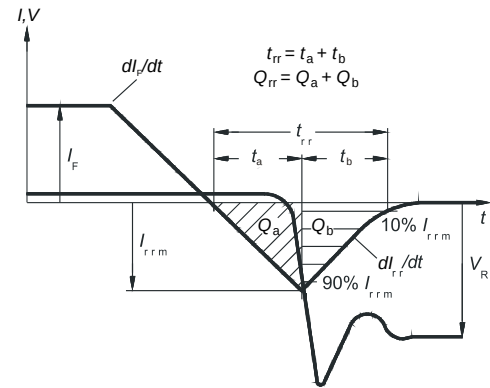


Figure C. Definition of diode switching characteristics

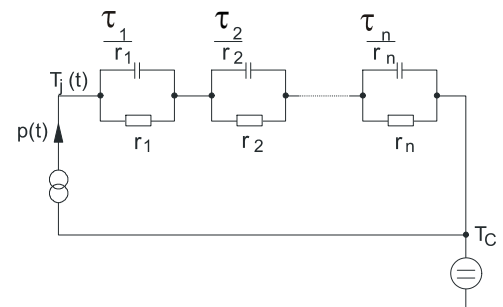


Figure D. Thermal equivalent circuit

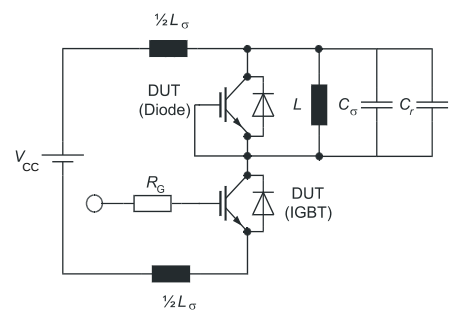


Figure E. **Dynamic test circuit**  
Parasitic inductance  $L_{\sigma}$ ,  
parasitic capacitor  $C_{\sigma}$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)

## Revision History

IGW50N65F5A

Revision: 2015-01-15, Rev. 2.1

## Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.1      | 2015-01-15 | Final data sheet                             |

## We Listen to Your Comments

Any information within this document that you feel is wrong, unclear or missing at all?

Your feedback will help us to continuously improve the quality of this document.

Please send your proposal (including a reference to this document) to: [erratum@infineon.com](mailto:erratum@infineon.com)

## Published by

Infineon Technologies AG

81726 Munich, Germany

81726 München, Germany

© 2015 Infineon Technologies AG

All Rights Reserved.

## Legal Disclaimer

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics.

With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation, warranties of non-infringement of intellectual property rights of any third party.

## Information

For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office ([www.infineon.com](http://www.infineon.com)).

## Warnings

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.

The Infineon Technologies component described in this Data Sheet may be used in life-support devices or systems and/or automotive, aviation and aerospace applications or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support, automotive, aviation and aerospace device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.