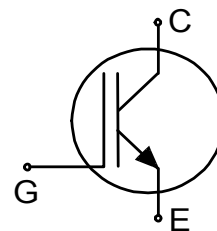


High speed switching series fifth generation

## High speed 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
  - Dynamically stress tested
  - Qualified according to AEC-Q101
  - Green package (RoHS compliant)
  - Complete product spectrum and PSpice Models:  
<http://www.infineon.com/igbt/>



### Applications:

- Off-board charger
- On-board charger
- DC/DC converter
- Power-factor correction

### 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    |
|-------------|----------|-------|---------------------------------|-------------|---------|------------|
| AIGW40N65F5 | 650V     | 40A   | 1.6V                            | 175°C       | AG40EF5 | PG-TO247-3 |

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## High speed switching series fifth generation

## Maximum Ratings

| 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>$T_C = 25^{\circ}\text{C}$<br>$T_C = 100^{\circ}\text{C}$                 | $I_C$       | 74.0<br>46.0         | A                  |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}^{1)}$                                                               | $I_{Cpuls}$ | 120.0                | A                  |
| Turn off safe operating area<br>$V_{CE} \leq 650\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p = 1\mu\text{s}^{1)}$ | -           | 120.0                | 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 $T_C = 100^{\circ}\text{C}$                             | $P_{tot}$   | 250.0<br>125.0       | 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 | Value |      |      | Unit |
|---------------------------------------------|----------------------|------------|-------|------|------|------|
|                                             |                      |            | min.  | typ. | max. |      |
| R <sub>th</sub> Characteristics             |                      |            |       |      |      |      |
| IGBT thermal resistance,<br>junction - case | R <sub>th(j-C)</sub> |            | -     | -    | 0.60 | K/W  |
| Thermal resistance<br>junction - ambient    | R <sub>th(j-a)</sub> |            | -     | -    | 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 | $V_{CEsat}$   | $V_{GE} = 15.0V, I_C = 40.0A$<br>$T_{vj} = 25^{\circ}C$<br>$T_{vj} = 125^{\circ}C$<br>$T_{vj} = 175^{\circ}C$ | -<br>-<br>- | 1.60<br>1.80<br>1.90 | 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>1000            | 40<br>-        | $\mu A$ |
| Gate-emitter leakage current         | $I_{GES}$     | $V_{CE} = 0V, V_{GE} = 20V$                                                                                   | -           | -                    | 100            | nA      |
| Transconductance                     | $g_{fs}$      | $V_{CE} = 20V, I_C = 40.0A$                                                                                   | -           | 50.0                 | -              | S       |

<sup>1)</sup> Defined by design. Not subject to production test.<sup>2)</sup> Package not recommended for surface mount applications

## High speed switching series fifth generation

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

| Parameter                                                      | Symbol    | Conditions                                 | Value |      |      | Unit |
|----------------------------------------------------------------|-----------|--------------------------------------------|-------|------|------|------|
|                                                                |           |                                            | min.  | typ. | max. |      |
| Dynamic Characteristic                                         |           |                                            |       |      |      |      |
| Input capacitance                                              | $C_{ies}$ | $V_{CE} = 25V, V_{GE} = 0V, f = 1MHz$      | -     | 2500 | -    | pF   |
| Output capacitance                                             | $C_{oes}$ |                                            | -     | 50   | -    |      |
| Reverse transfer capacitance                                   | $C_{res}$ |                                            | -     | 9    | -    |      |
| Gate charge                                                    | $Q_G$     | $V_{CC} = 520V, I_C = 40.0A, V_{GE} = 15V$ | -     | 95.0 | -    | nC   |
| Internal emitter inductance measured 5mm (0.197 in.) from 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>$V_{CC} = 400\text{V}, I_C = 20.0\text{A},$<br>$V_{GE} = 0.0/15.0\text{V},$<br>$R_{G(\text{on})} = 15.0\Omega, R_{G(\text{off})} = 15.0\Omega,$<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                                             | $t_r$               |                                                                                                                                                                                                                                                                                                                                   | -     | 11   | -    | ns   |
| Turn-off delay time                                   | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                   | -     | 165  | -    | ns   |
| Fall time                                             | $t_f$               |                                                                                                                                                                                                                                                                                                                                   | -     | 13   | -    | ns   |
| Turn-on energy                                        | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                   | -     | 0.35 | -    | mJ   |
| Turn-off energy                                       | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                   | -     | 0.10 | -    | mJ   |
| Total switching energy                                | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                   | -     | 0.45 | -    | mJ   |
|                                                       |                     |                                                                                                                                                                                                                                                                                                                                   |       |      |      |      |
| Turn-on delay time                                    | $t_{d(\text{on})}$  | $T_{vj} = 25^{\circ}\text{C},$<br>$V_{CC} = 400\text{V}, I_C = 5.0\text{A},$<br>$V_{GE} = 0.0/15.0\text{V},$<br>$R_{G(\text{on})} = 15.0\Omega, R_{G(\text{off})} = 15.0\Omega,$<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                                             | $t_r$               |                                                                                                                                                                                                                                                                                                                                   | -     | 4    | -    | ns   |
| Turn-off delay time                                   | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                   | -     | 175  | -    | ns   |
| Fall time                                             | $t_f$               |                                                                                                                                                                                                                                                                                                                                   | -     | 12   | -    | ns   |
| Turn-on energy                                        | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                   | -     | 0.07 | -    | mJ   |
| Turn-off energy                                       | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                   | -     | 0.03 | -    | mJ   |
| Total switching energy                                | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                   | -     | 0.10 | -    | mJ   |

## High speed switching series fifth generation

## 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>$V_{CC} = 400\text{V}$ , $I_C = 20.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(\text{on})} = 15.0\Omega$ , $R_{G(\text{off})} = 15.0\Omega$ ,<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<br>diode reverse recovery. | -     | 18   | -    | ns   |
| Rise time                                              | $t_r$               |                                                                                                                                                                                                                                                                                                                                                       | -     | 12   | -    | ns   |
| Turn-off delay time                                    | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                                       | -     | 195  | -    | ns   |
| Fall time                                              | $t_f$               |                                                                                                                                                                                                                                                                                                                                                       | -     | 5    | -    | ns   |
| Turn-on energy                                         | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                                       | -     | 0.46 | -    | mJ   |
| Turn-off energy                                        | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                                       | -     | 0.16 | -    | mJ   |
| Total switching energy                                 | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                                       | -     | 0.62 | -    | mJ   |
|                                                        |                     |                                                                                                                                                                                                                                                                                                                                                       |       |      |      |      |
| Turn-on delay time                                     | $t_{d(\text{on})}$  | $T_{vj} = 150^{\circ}\text{C}$ ,<br>$V_{CC} = 400\text{V}$ , $I_C = 5.0\text{A}$ ,<br>$V_{GE} = 0.0/15.0\text{V}$ ,<br>$R_{G(\text{on})} = 15.0\Omega$ , $R_{G(\text{off})} = 15.0\Omega$ ,<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<br>diode reverse recovery.  | -     | 16   | -    | ns   |
| Rise time                                              | $t_r$               |                                                                                                                                                                                                                                                                                                                                                       | -     | 5    | -    | ns   |
| Turn-off delay time                                    | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                                                                                       | -     | 225  | -    | ns   |
| Fall time                                              | $t_f$               |                                                                                                                                                                                                                                                                                                                                                       | -     | 13   | -    | ns   |
| Turn-on energy                                         | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                                                                                       | -     | 0.14 | -    | mJ   |
| Turn-off energy                                        | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                                                                                       | -     | 0.05 | -    | mJ   |
| Total switching energy                                 | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                                                                                       | -     | 0.19 | -    | mJ   |

High speed switching series fifth generation

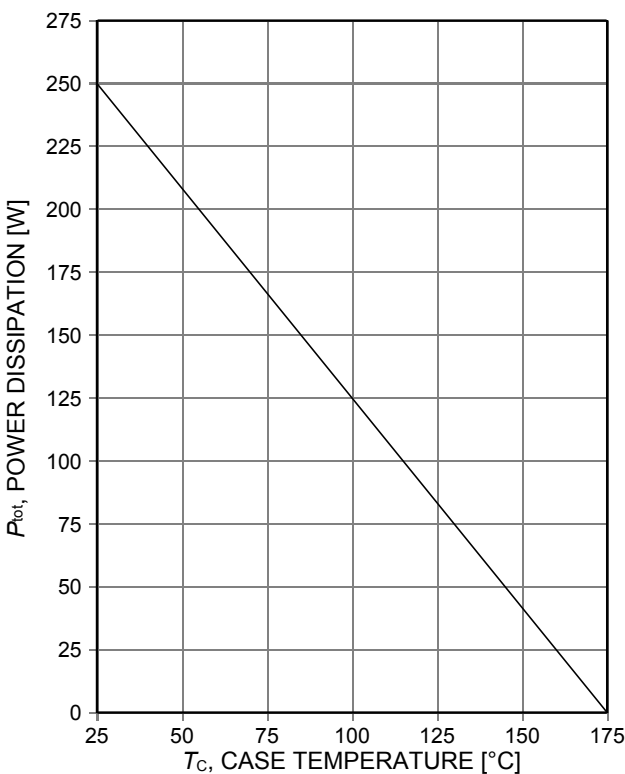


Figure 1. **Power dissipation as a function of case temperature**  
( $T_{vj} \leq 175^\circ\text{C}$ )

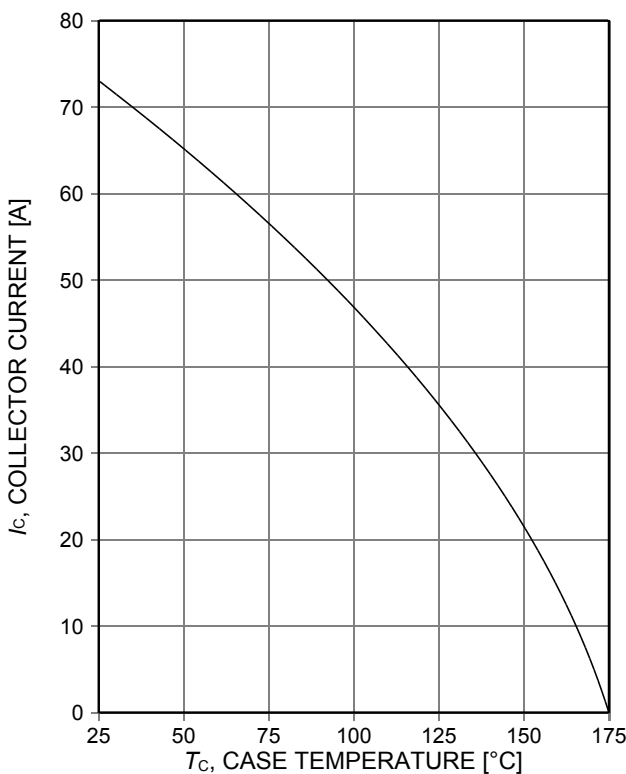


Figure 2. **Collector current as a function of case temperature**  
( $V_{GE} \geq 15\text{V}$ ,  $T_{vj} \leq 175^\circ\text{C}$ )

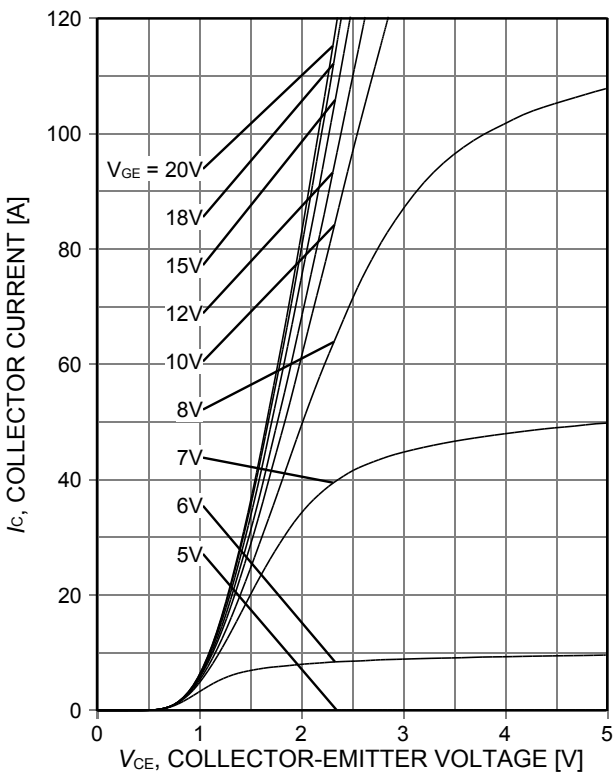


Figure 3. **Typical output characteristic**  
( $T_{vj} = 25^\circ\text{C}$ )

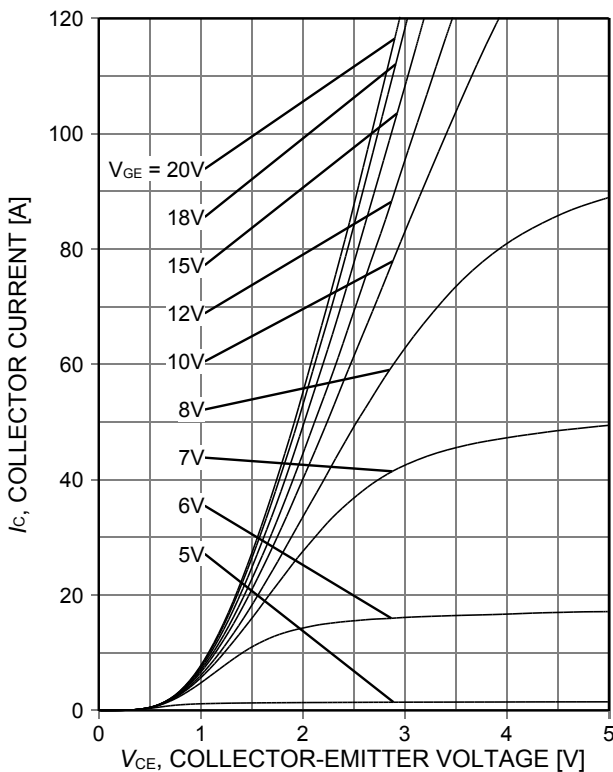


Figure 4. **Typical output characteristic**  
( $T_{vj} = 150^\circ\text{C}$ )

## High speed switching series fifth generation

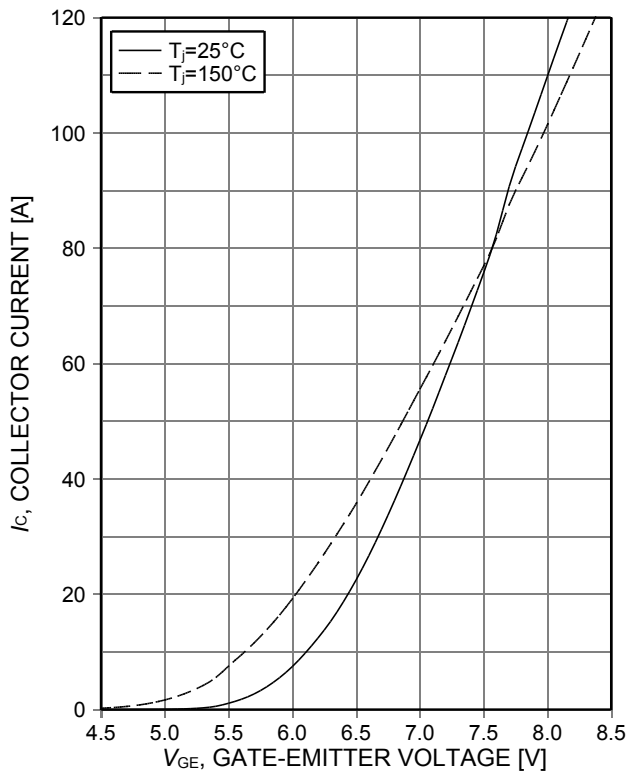


Figure 5. **Typical transfer characteristic**  
( $V_{CE}=20V$ )

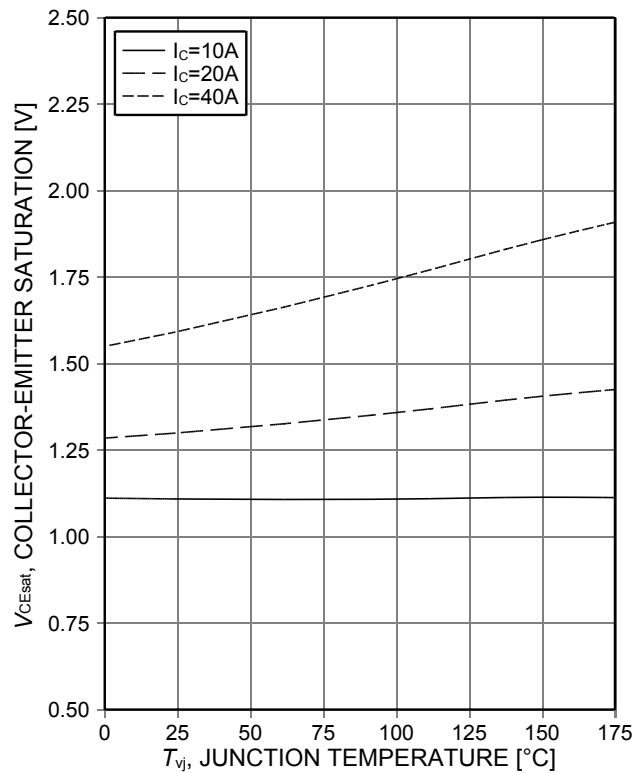


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15V$ )

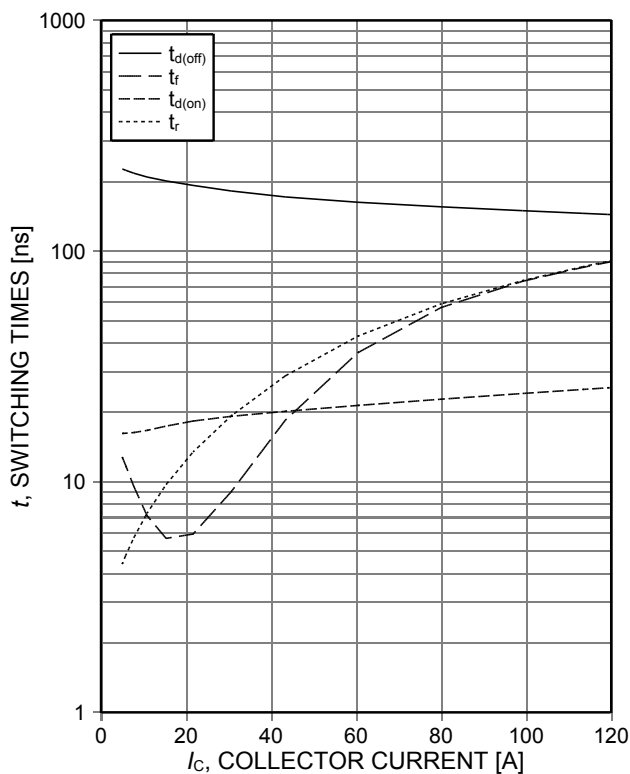


Figure 7. **Typical switching times as a function of collector current**  
(inductive load,  $T_{vj}=150^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

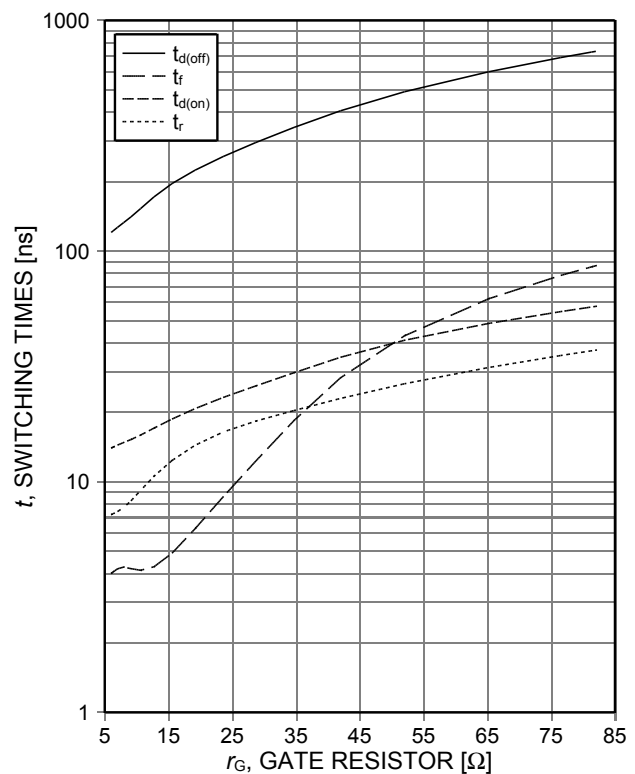


Figure 8. **Typical switching times as a function of gate resistor**  
(inductive load,  $T_{vj}=150^{\circ}C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ , Dynamic test circuit in Figure E)

## High speed switching series fifth generation

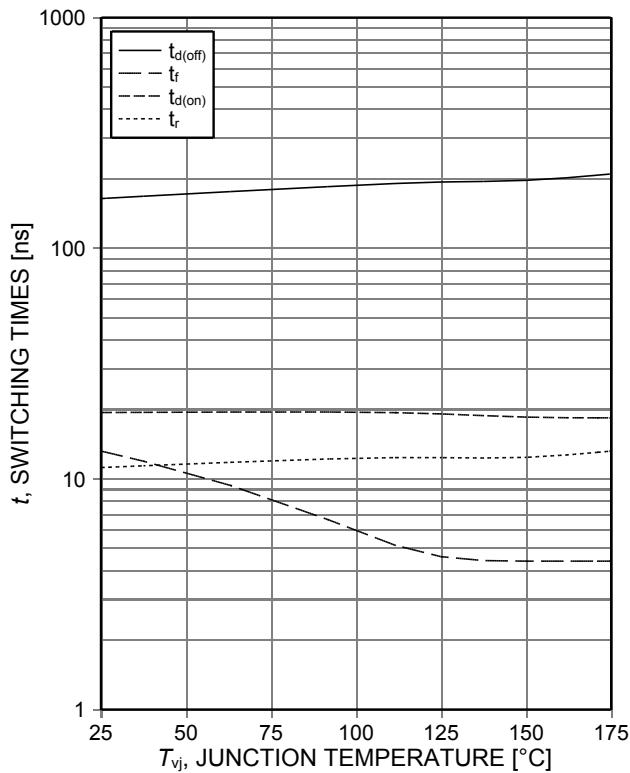


Figure 9. **Typical switching times as a function of junction temperature**  
(inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

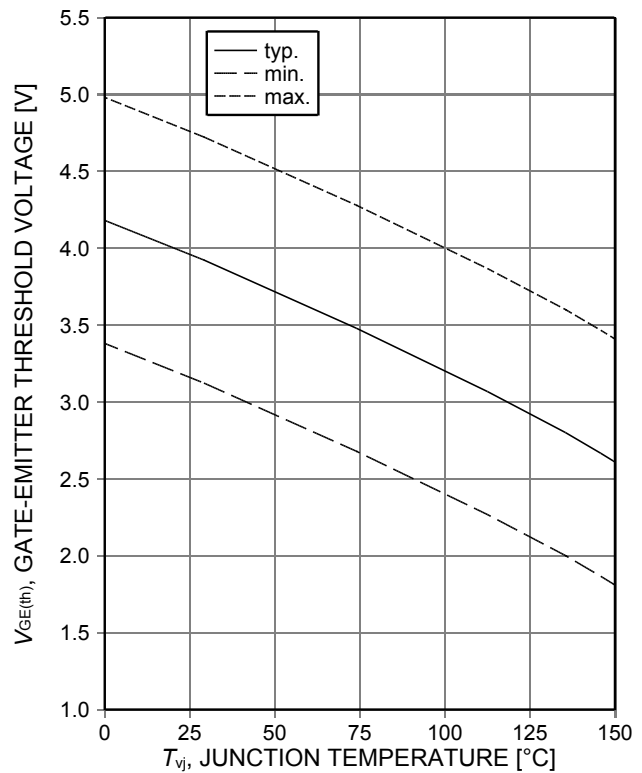


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**  
( $I_C=0.4mA$ )

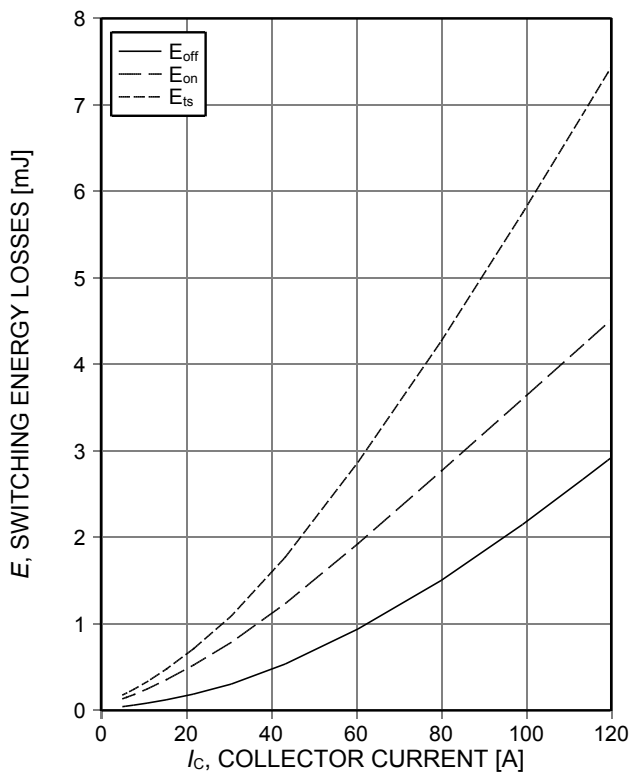


Figure 11. **Typical switching energy losses as a function of collector current**  
(inductive load,  $T_{vj}=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

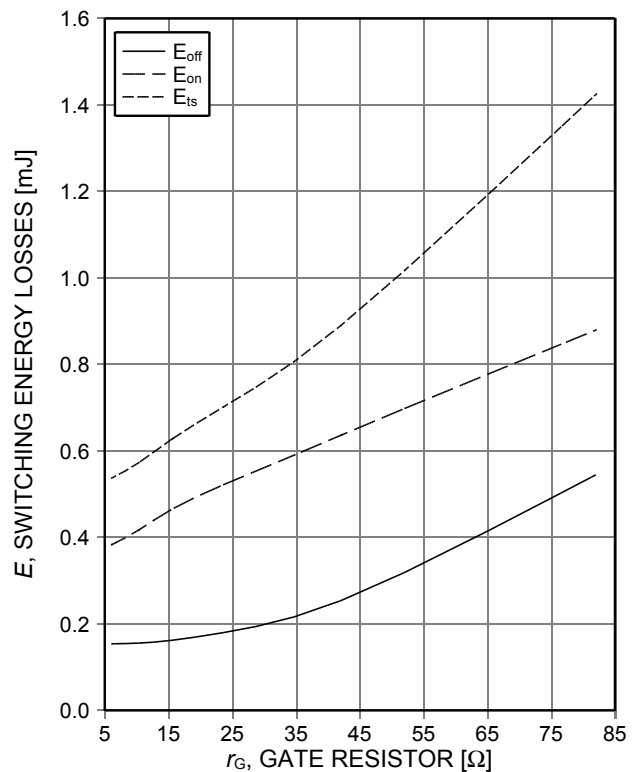


Figure 12. **Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_{vj}=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ , Dynamic test circuit in Figure E)

## High speed switching series fifth generation

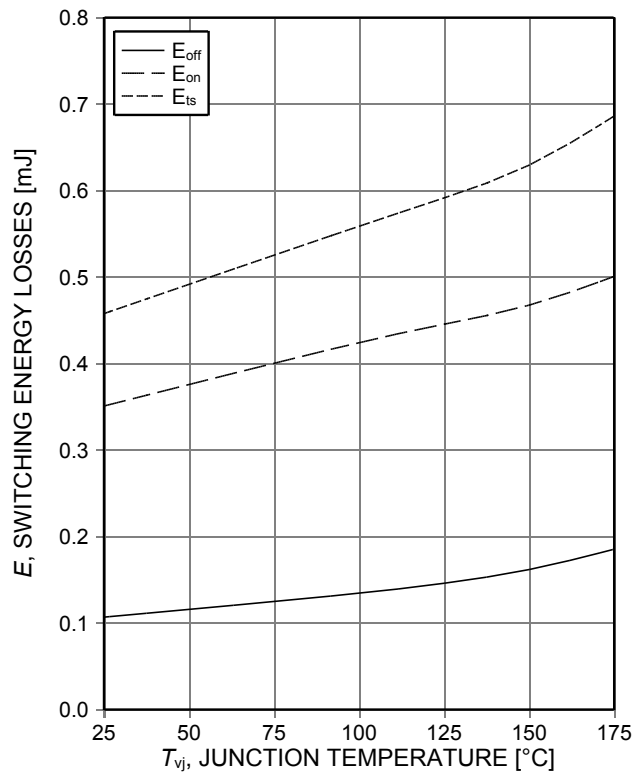


Figure 13. **Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

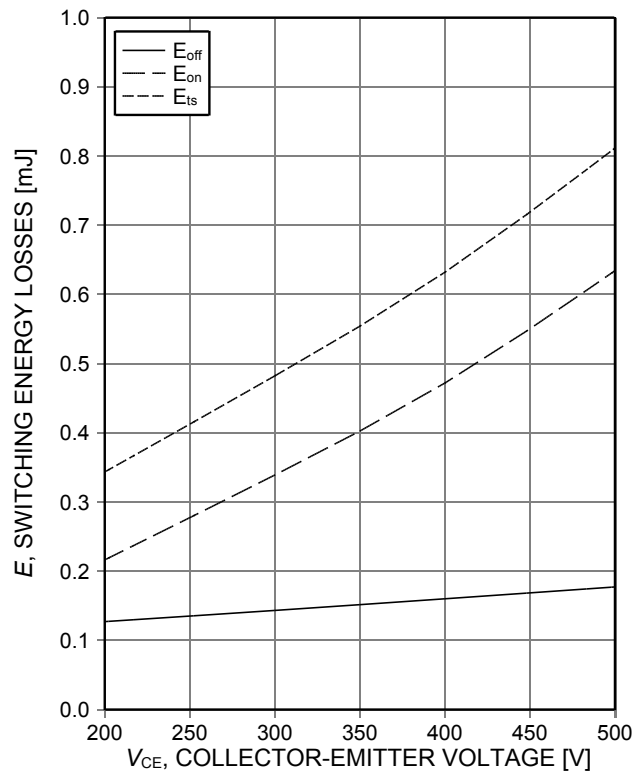


Figure 14. **Typical switching energy losses as a function of collector emitter voltage**  
(inductive load,  $T_{vj}=150^\circ C$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

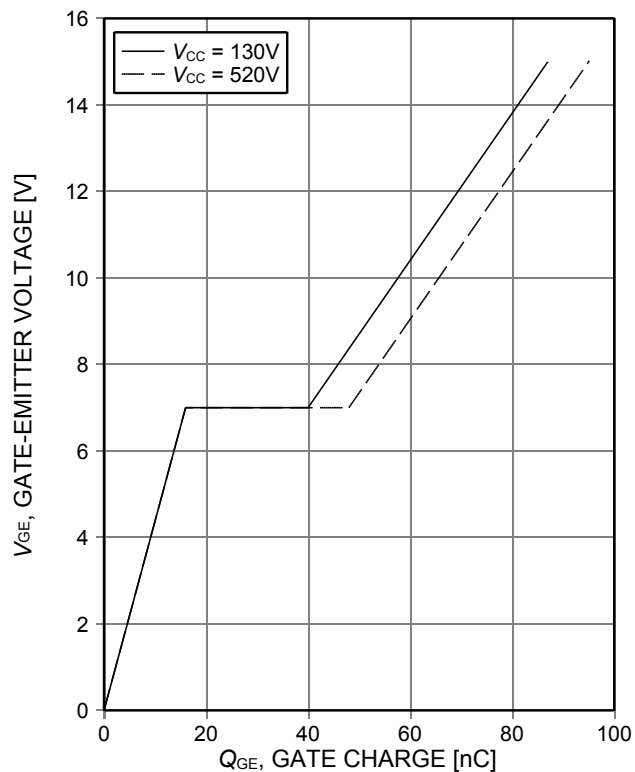


Figure 15. **Typical gate charge**  
( $I_C=40A$ )

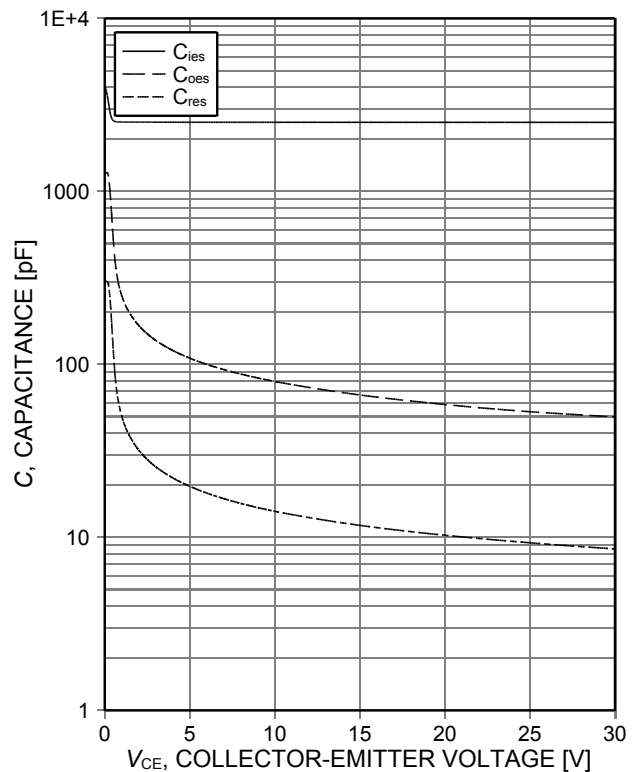


Figure 16. **Typical capacitance as a function of collector-emitter voltage**  
( $V_{GE}=0V$ ,  $f=1MHz$ )

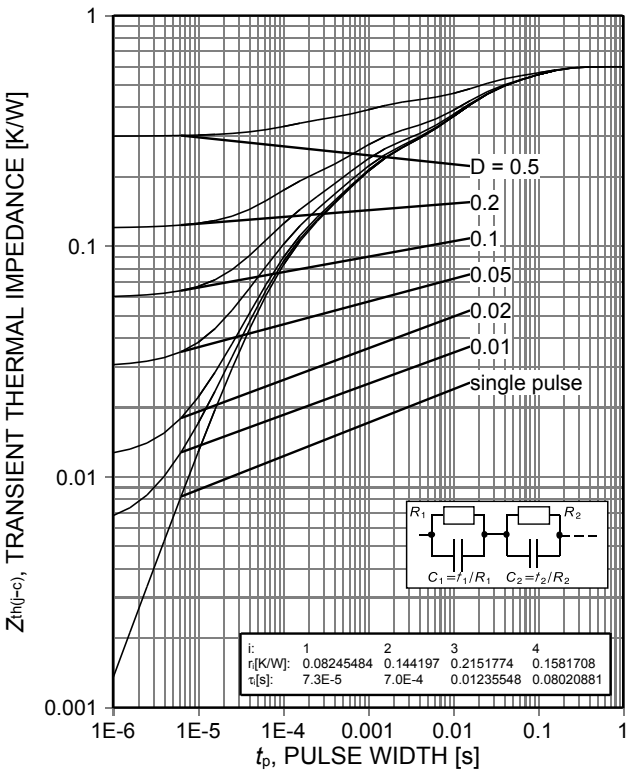
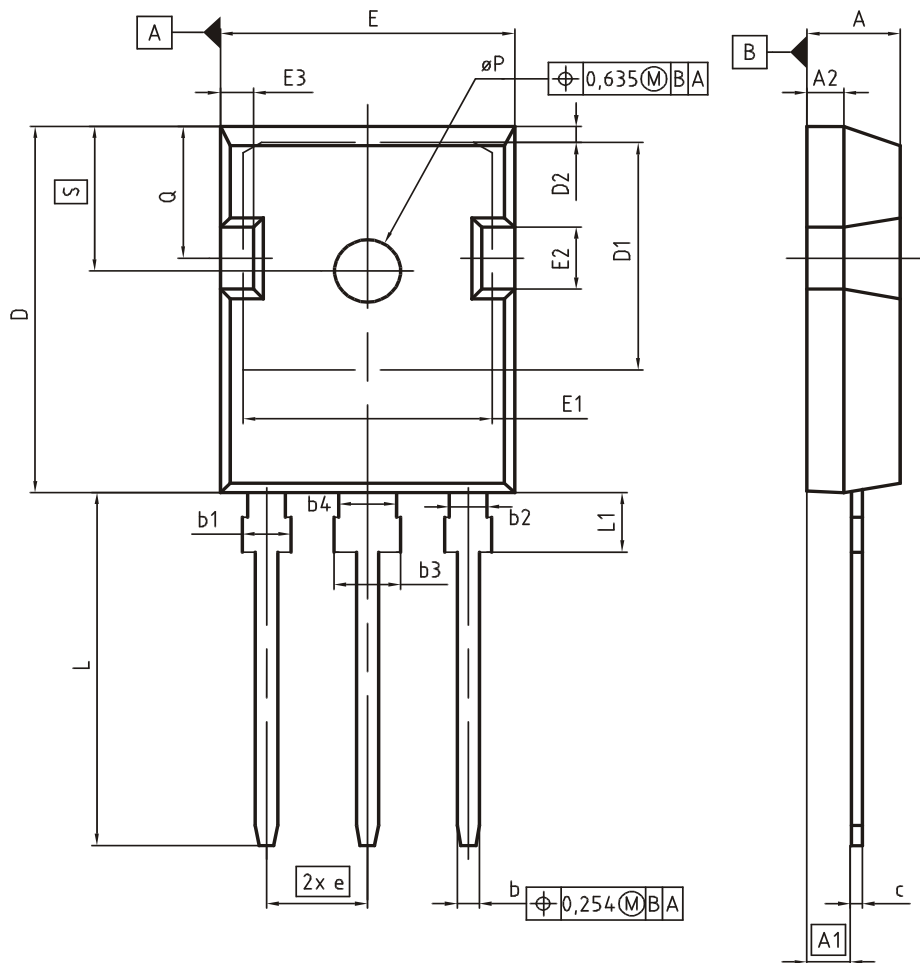
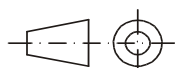


Figure 17. IGBT transient thermal impedance  
( $D=t_p/T$ )

## 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 |

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

## Testing Conditions

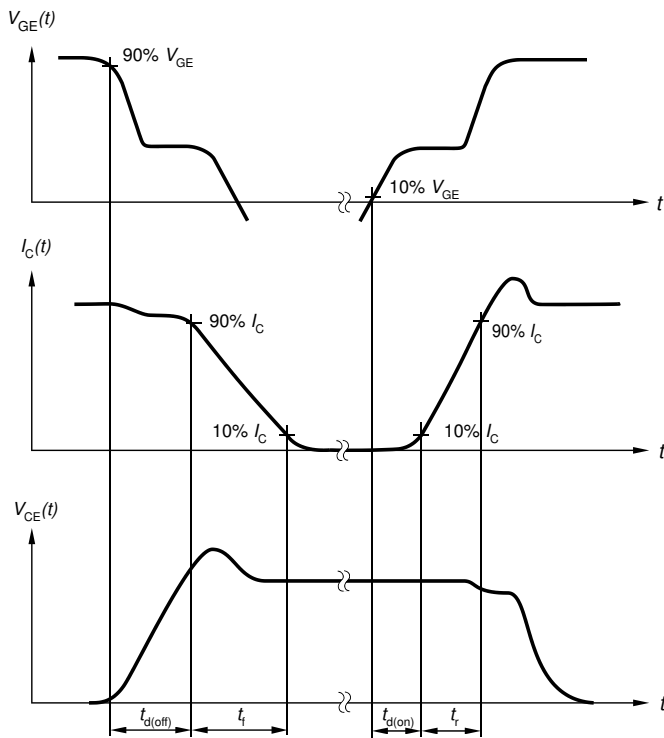


Figure A. Definition of switching times

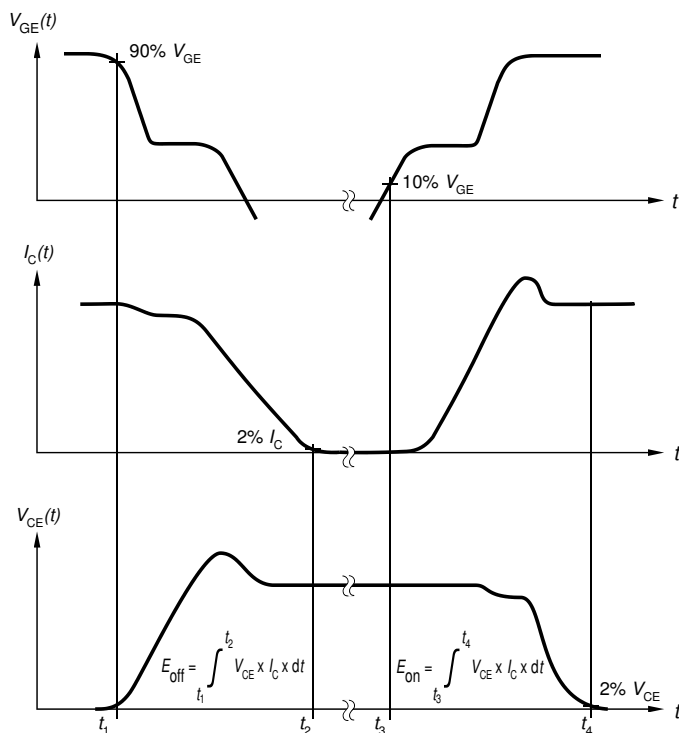


Figure B. Definition of switching losses

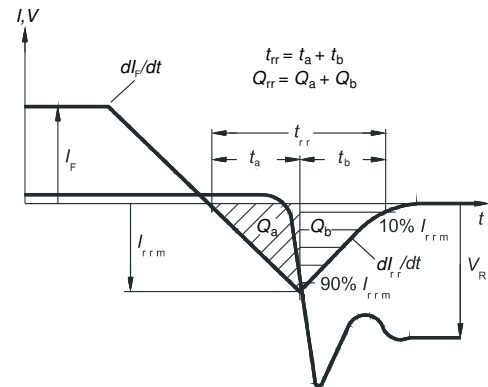


Figure C. Definition of diode switching characteristics

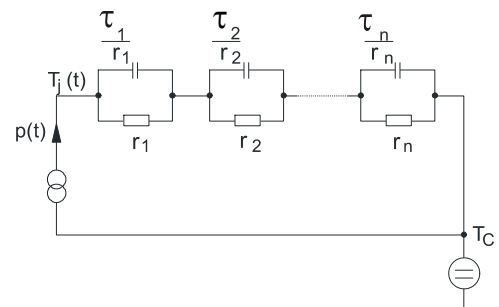


Figure D. Thermal equivalent circuit

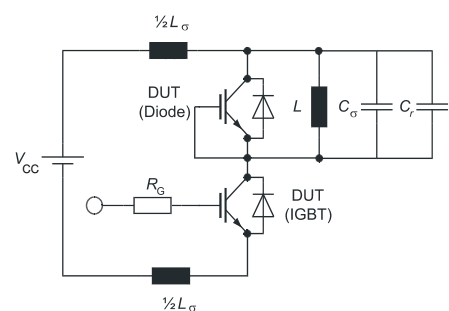


Figure E. **Dynamic test circuit**  
 Parasitic inductance  $L_{\sigma}$ ,  
 parasitic capacitor  $C_{\sigma}$ ,  
 relief capacitor  $C_r$ ,  
 (only for ZVT switching)

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High speed switching series fifth generation

#### Revision History

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AIGW40N65F5

**Revision: 2017-06-27, Rev. 2.1**

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Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.1      | 2017-06-27 | Data sheet created                           |

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