

## IGBT

High speed 5 IGBT in TRENCHSTOP™ 5 technology

## IGP40N65H5, IGW40N65H5

650V IGBT high speed switching series fifth generation

Data sheet

Industrial Power Control

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

#### Features and Benefits:

High speed H5 technology offering

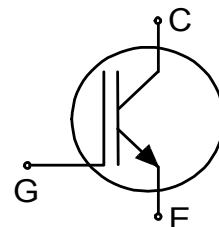
- Best-in-Class efficiency in hard switching and resonant topologies
- Plug and play replacement of previous generation IGBTs
- 650V breakdown voltage
- Low  $Q_g$
- Maximum junction temperature 175°C
- Qualified according to JEDEC for target applications
- Pb-free lead plating; RoHS compliant
- Complete product spectrum and PSpice Models: <http://www.infineon.com/igbt/>

#### Applications:

- Solar converters
- Uninterruptible power supplies
- Welding converters
- Mid to high range switching frequency converters

#### 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    |
|------------|----------|-------|---------------------------------|-------------|---------|------------|
| IGW40N65H5 | 650V     | 40A   | 1.65V                           | 175°C       | G40H655 | PG-TO247-3 |
| IGP40N65H5 | 650V     | 40A   | 1.65V                           | 175°C       | G40H655 | PG-TO220-3 |

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### Maximum ratings

| Parameter                                                                                             | Symbol                        | Value                | Unit             |
|-------------------------------------------------------------------------------------------------------|-------------------------------|----------------------|------------------|
| Collector-emitter voltage                                                                             | $V_{CE}$                      | 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 $T_{vjmax}$                                                | $I_{Cpuls}$                   | 120.0                | A                |
| Turn off safe operating area $V_{CE} \leq 650\text{V}$ , $T_{vj} \leq 175^\circ\text{C}$              | -                             | 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 $T_C = 100^\circ\text{C}$             | $P_{tot}$                     | 255.0<br>120.0       | W                |
| Operating junction temperature                                                                        | $T_{vj}$                      | $-40 \dots +175$     | $^\circ\text{C}$ |
| Storage temperature                                                                                   | $T_{stg}$                     | $-55 \dots +150$     | $^\circ\text{C}$ |
| Soldering temperature,<br>wave soldering 1.6 mm (0.063 in.) from case for 10s                         | PG-TO247-pinGCE<br>PG-TO220-3 | 260<br>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 | $R_{th(j-c)}$ |                               | 0.60       | K/W  |
| Thermal resistance<br>junction - ambient    | $R_{th(j-a)}$ | PG-TO247-pinGCE<br>PG-TO220-3 | 40<br>62   | 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>- | 1.65<br>1.85<br>1.95 | 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>-               | 40.0<br>2000.0 | $\mu A$ |
| 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       |

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 <sub>ies</sub> | V <sub>CE</sub> = 25V, V <sub>GE</sub> = 0V, f = 1MHz                 | -     | 2500 | -    | pF   |
| Output capacitance                                             | C <sub>oes</sub> |                                                                       | -     | 40   | -    |      |
| Reverse transfer capacitance                                   | C <sub>res</sub> |                                                                       | -     | 9    | -    |      |
| Gate charge                                                    | Q <sub>G</sub>   | V <sub>CC</sub> = 520V, I <sub>C</sub> = 40.0A, V <sub>GE</sub> = 15V | -     | 95.0 | -    | nC   |
| Internal emitter inductance measured 5mm (0.197 in.) from case | L <sub>E</sub>   | PG-TO247-pinGCE<br>PG-TO220-3                                         | -     | 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>$r_G = 15.0\Omega, L\sigma = 30\text{nH},$<br>$C\sigma = 30\text{pF}$<br>$L\sigma, C\sigma$ from Fig. E<br>Energy losses include “tail” and<br>diode reverse recovery. | -     | 22   | -    | ns   |
| Rise time                                             | $t_r$               |                                                                                                                                                                                                                                                                                         | -     | 12   | -    | ns   |
| Turn-off delay time                                   | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                         | -     | 165  | -    | ns   |
| Fall time                                             | $t_f$               |                                                                                                                                                                                                                                                                                         | -     | 13   | -    | ns   |
| Turn-on energy                                        | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                         | -     | 0.39 | -    | mJ   |
| Turn-off energy                                       | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                         | -     | 0.12 | -    | mJ   |
| Total switching energy                                | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                         | -     | 0.51 | -    | 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>$r_G = 15.0\Omega, L\sigma = 30\text{nH},$<br>$C\sigma = 30\text{pF}$<br>$L\sigma, C\sigma$ from Fig. E<br>Energy losses include “tail” and<br>diode reverse recovery.  | -     | 19   | -    | ns   |
| Rise time                                             | $t_r$               |                                                                                                                                                                                                                                                                                         | -     | 4    | -    | ns   |
| Turn-off delay time                                   | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                         | -     | 190  | -    | ns   |
| Fall time                                             | $t_f$               |                                                                                                                                                                                                                                                                                         | -     | 24   | -    | ns   |
| Turn-on energy                                        | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                         | -     | 0.09 | -    | mJ   |
| Turn-off energy                                       | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                         | -     | 0.05 | -    | mJ   |
| Total switching energy                                | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                         | -     | 0.14 | -    | 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>$V_{CC} = 400\text{V}, I_C = 20.0\text{A},$<br>$V_{GE} = 0.0/15.0\text{V},$<br>$r_G = 15.0\Omega, L\sigma = 30\text{nH},$<br>$C\sigma = 30\text{pF}$<br>$L\sigma, C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery. | -     | 20   | -    | ns   |
| Rise time                                              | $t_r$               |                                                                                                                                                                                                                                                                                       | -     | 12   | -    | ns   |
| Turn-off delay time                                    | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                       | -     | 195  | -    | ns   |
| Fall time                                              | $t_f$               |                                                                                                                                                                                                                                                                                       | -     | 22   | -    | ns   |
| Turn-on energy                                         | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                       | -     | 0.54 | -    | mJ   |
| Turn-off energy                                        | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                       | -     | 0.20 | -    | mJ   |
| Total switching energy                                 | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                       | -     | 0.74 | -    | 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>$r_G = 15.0\Omega, L\sigma = 30\text{nH},$<br>$C\sigma = 30\text{pF}$<br>$L\sigma, C\sigma$ from Fig. E<br>Energy losses include “tail” and diode reverse recovery.  | -     | 19   | -    | ns   |
| Rise time                                              | $t_r$               |                                                                                                                                                                                                                                                                                       | -     | 5    | -    | ns   |
| Turn-off delay time                                    | $t_{d(\text{off})}$ |                                                                                                                                                                                                                                                                                       | -     | 240  | -    | ns   |
| Fall time                                              | $t_f$               |                                                                                                                                                                                                                                                                                       | -     | 33   | -    | ns   |
| Turn-on energy                                         | $E_{\text{on}}$     |                                                                                                                                                                                                                                                                                       | -     | 0.15 | -    | mJ   |
| Turn-off energy                                        | $E_{\text{off}}$    |                                                                                                                                                                                                                                                                                       | -     | 0.07 | -    | mJ   |
| Total switching energy                                 | $E_{\text{ts}}$     |                                                                                                                                                                                                                                                                                       | -     | 0.22 | -    | mJ   |

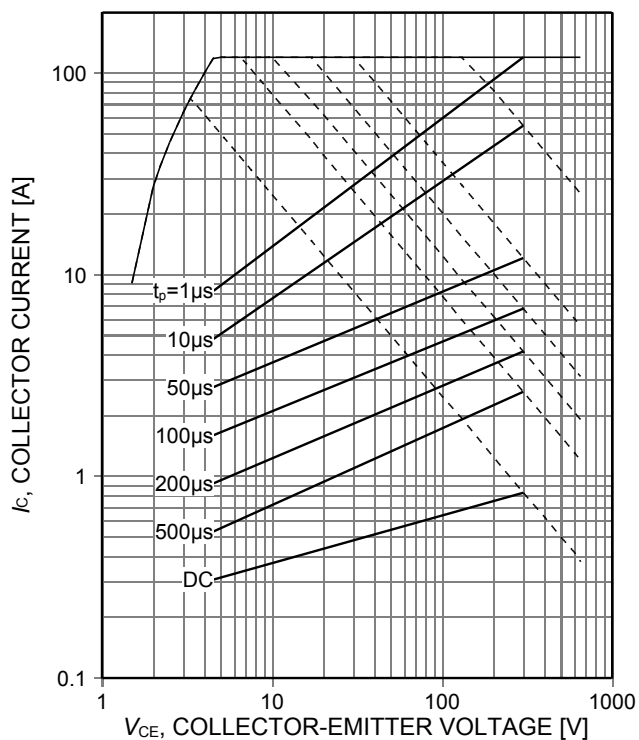


Figure 1. **Forward bias safe operating area**  
( $D=0$ ,  $T_C=25^\circ\text{C}$ ,  $T_{vj}\leq 175^\circ\text{C}$ ;  $V_{GE}=15\text{V}$ .  
Recommended use at  $V_{GE}\geq 7.5\text{V}$ )

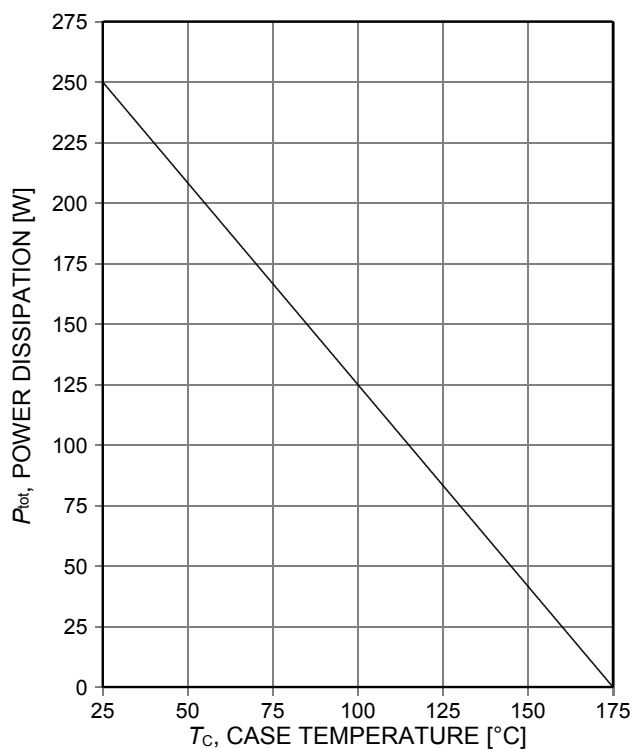


Figure 2. **Power dissipation as a function of case temperature**  
( $T_{vj}\leq 175^\circ\text{C}$ )

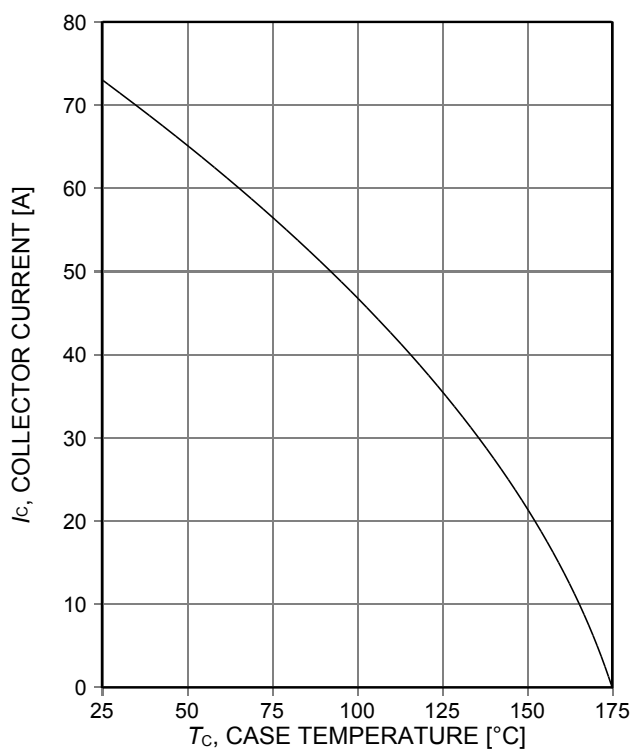


Figure 3. **Collector current as a function of case temperature**  
( $V_{GE}\geq 15\text{V}$ ,  $T_{vj}\leq 175^\circ\text{C}$ )

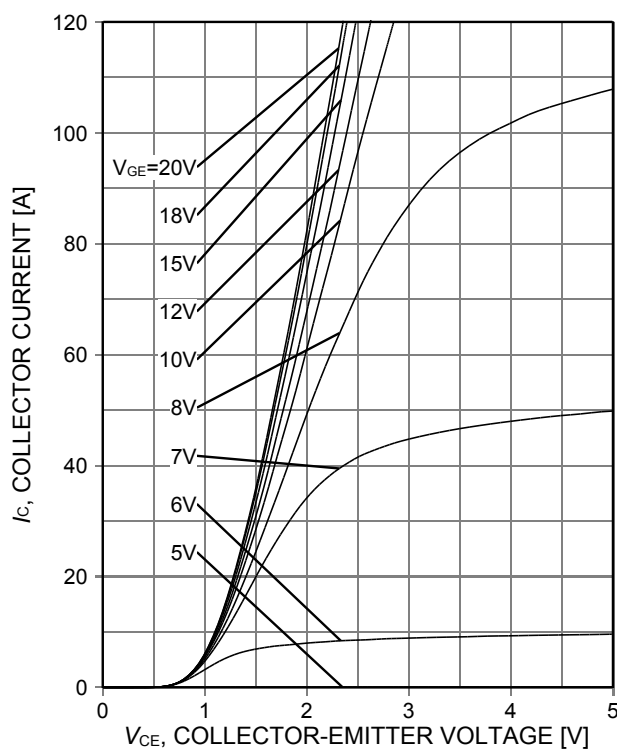


Figure 4. **Typical output characteristic**  
( $T_{vj}=25^\circ\text{C}$ )

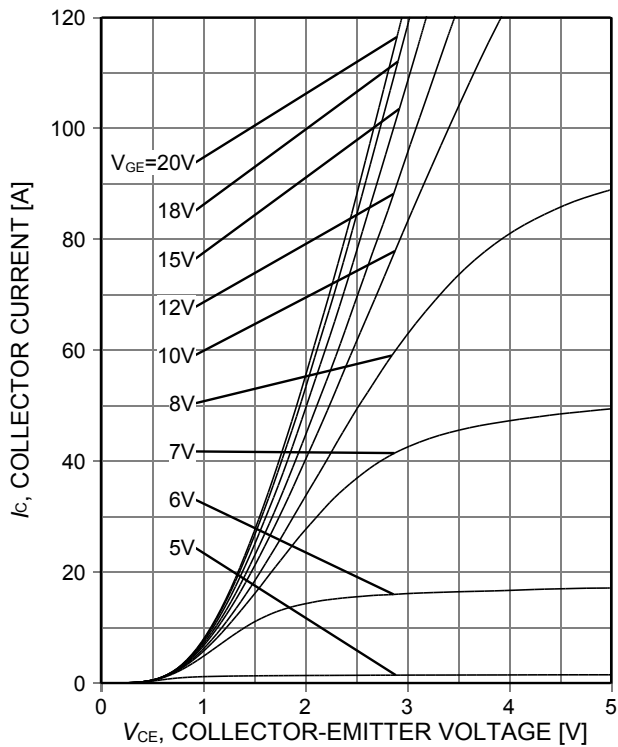


Figure 5. **Typical output characteristic**  
( $T_{vj}=150^{\circ}\text{C}$ )

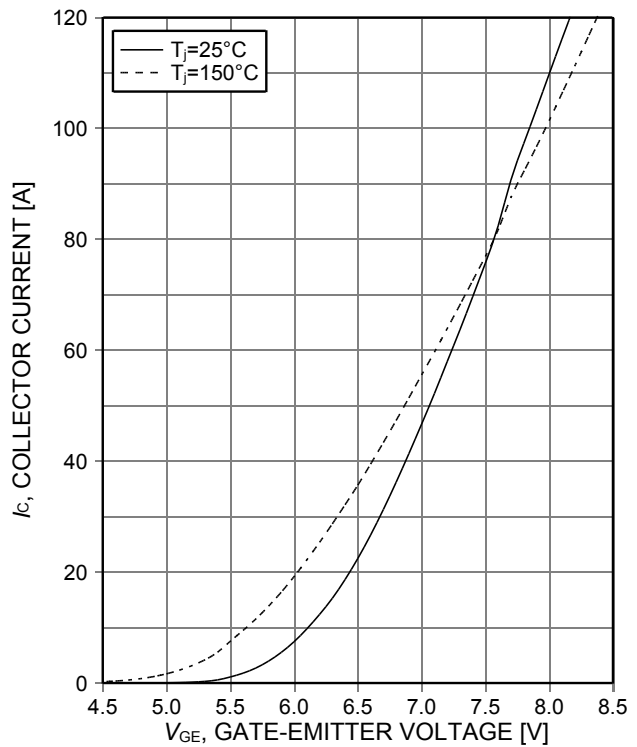


Figure 6. **Typical transfer characteristic**  
( $V_{CE}=20\text{V}$ )

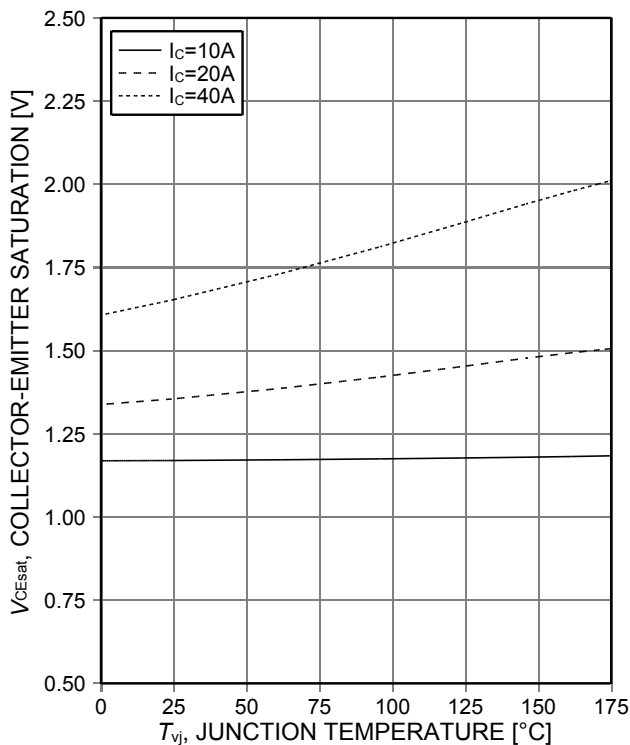


Figure 7. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15\text{V}$ )

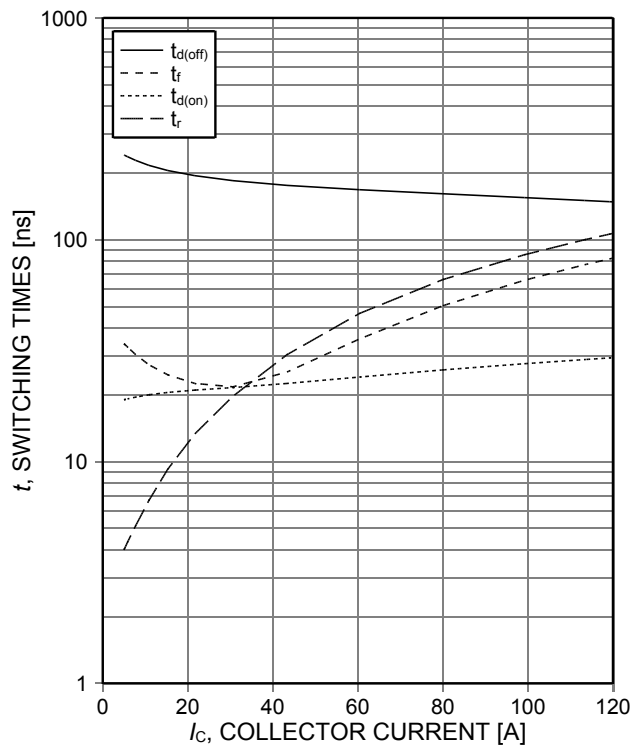


Figure 8. **Typical switching times as a function of collector current**  
(inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

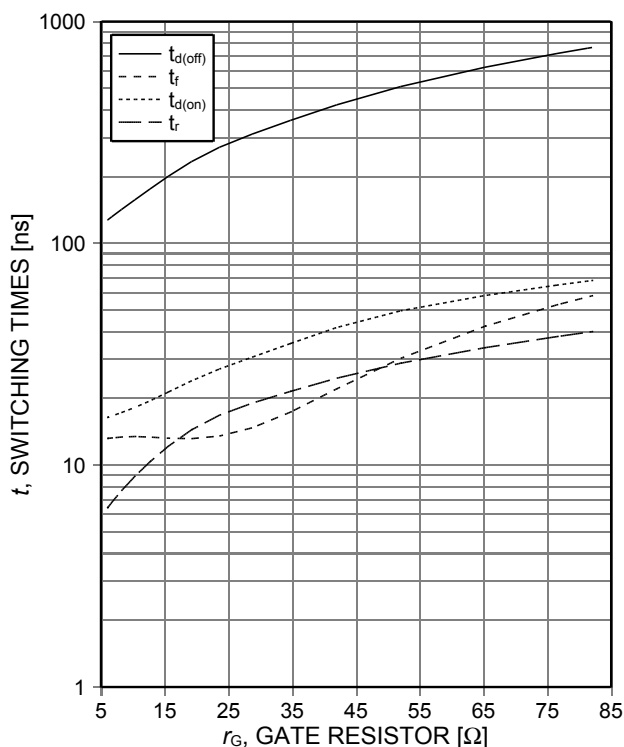


Figure 9. **Typical switching times as a function of gate resistor**  
(inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=20\text{A}$ , Dynamic test circuit in Figure E)

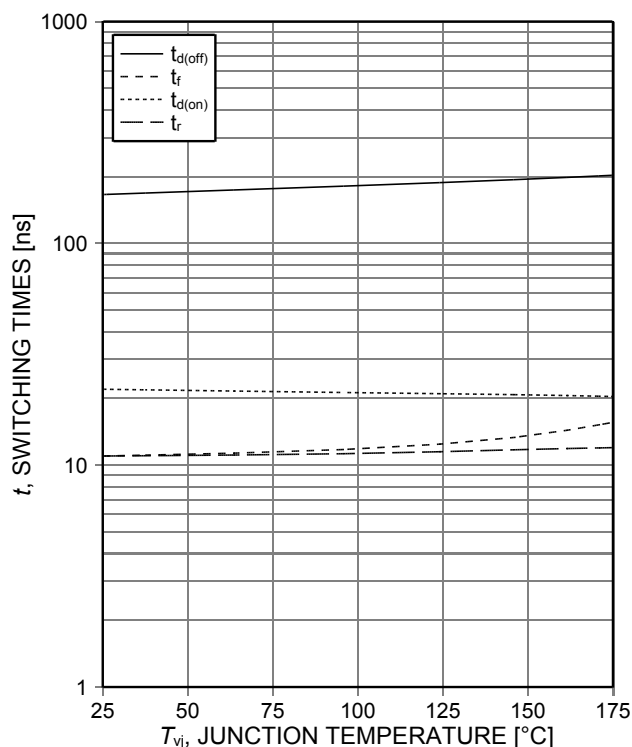


Figure 10. **Typical switching times as a function of junction temperature**  
(inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=20\text{A}$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

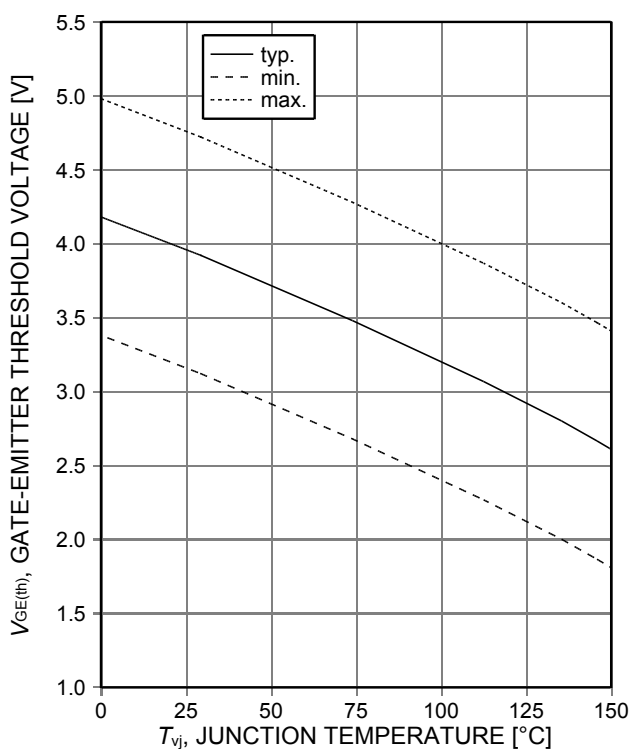


Figure 11. **Gate-emitter threshold voltage as a function of junction temperature**  
( $I_C=0.4\text{mA}$ )

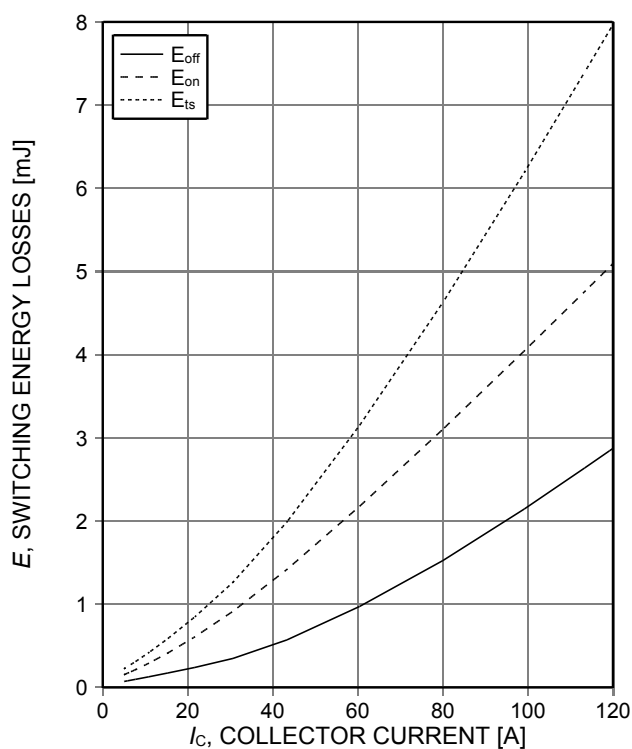


Figure 12. **Typical switching energy losses as a function of collector current**  
(inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

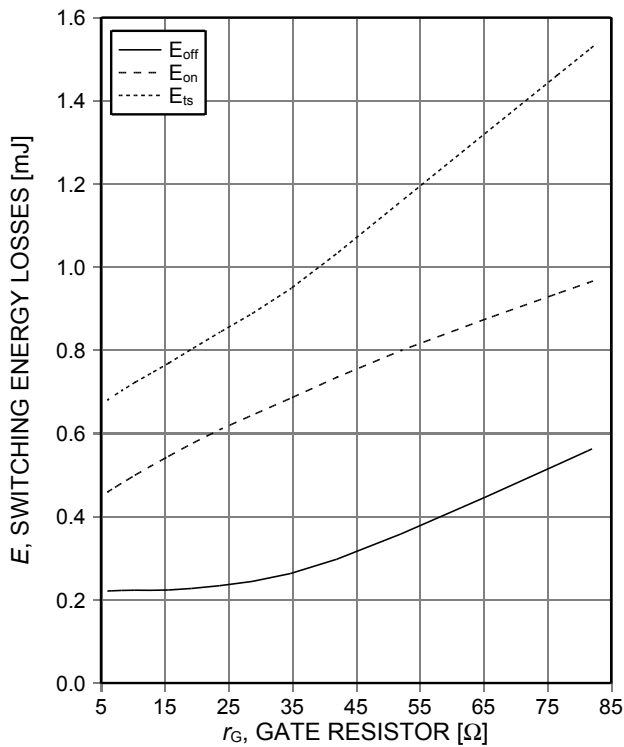


Figure 13. **Typical switching energy losses as a function of gate resistor**  
(inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=20\text{A}$ , Dynamic test circuit in Figure E)

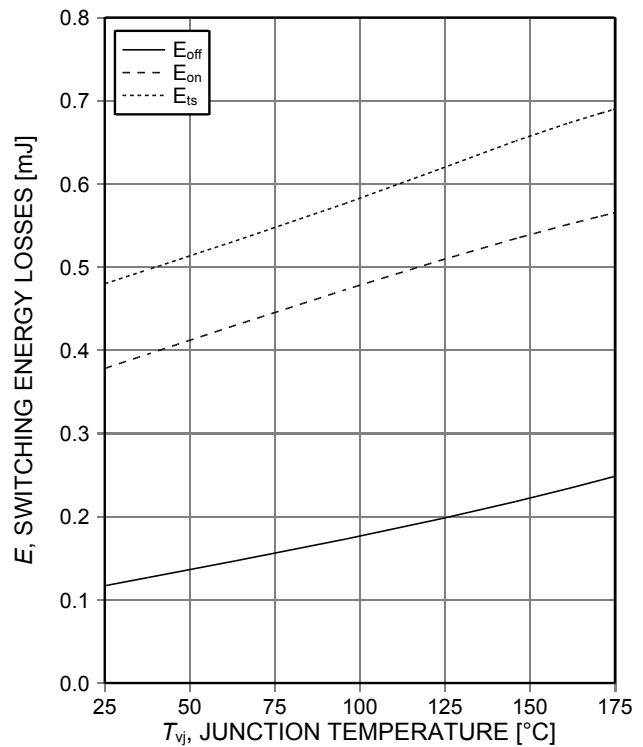


Figure 14. **Typical switching energy losses as a function of junction temperature**  
(inductive load,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=20\text{A}$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

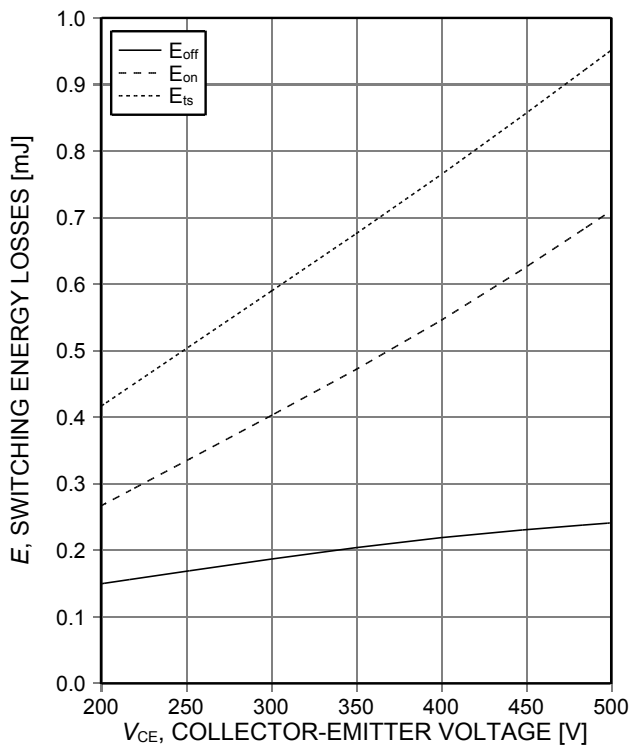


Figure 15. **Typical switching energy losses as a function of collector emitter voltage**  
(inductive load,  $T_{vj}=150^{\circ}\text{C}$ ,  $V_{GE}=15/0\text{V}$ ,  $I_C=20\text{A}$ ,  $r_G=15\Omega$ , Dynamic test circuit in Figure E)

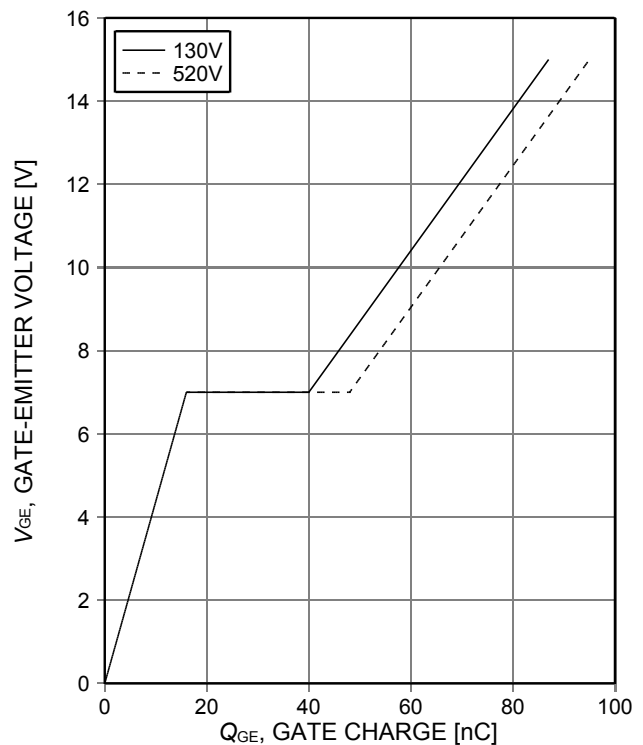


Figure 16. **Typical gate charge**  
( $I_C=40\text{A}$ )

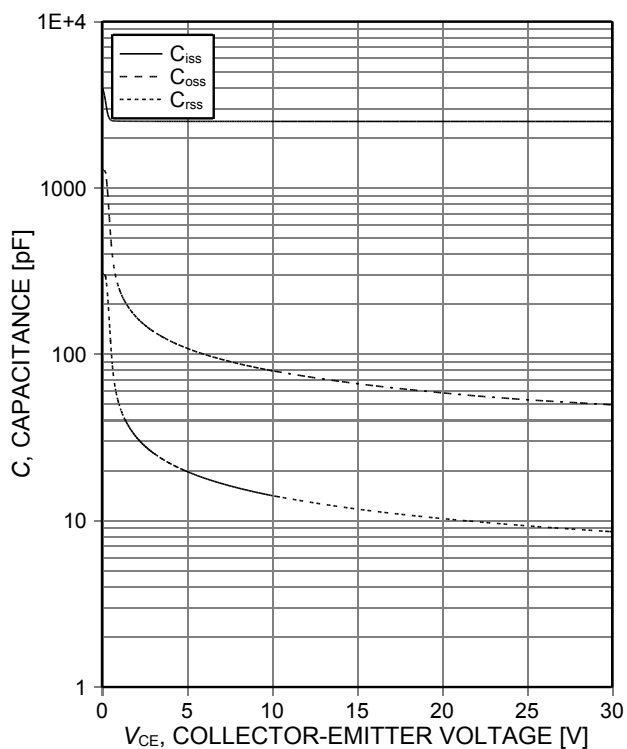


Figure 17. **Typical capacitance as a function of collector-emitter voltage**  
( $V_{GE}=0V$ ,  $f=1MHz$ )

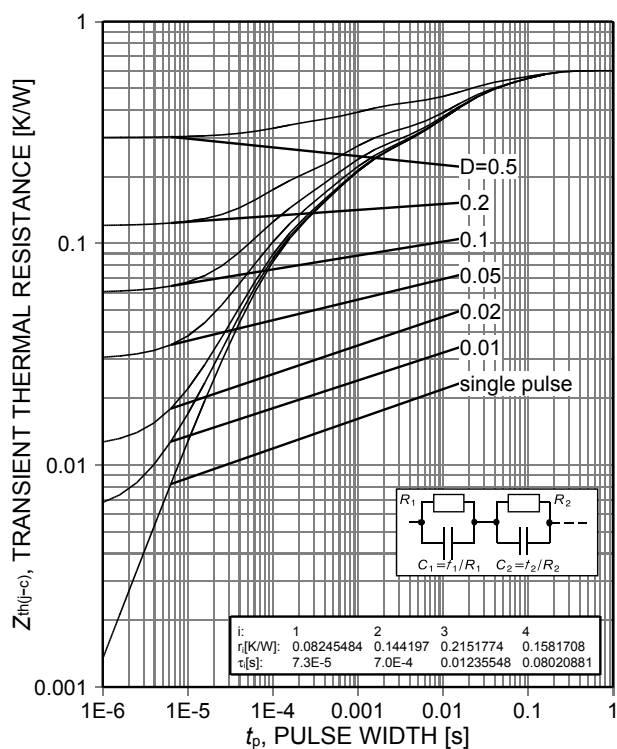
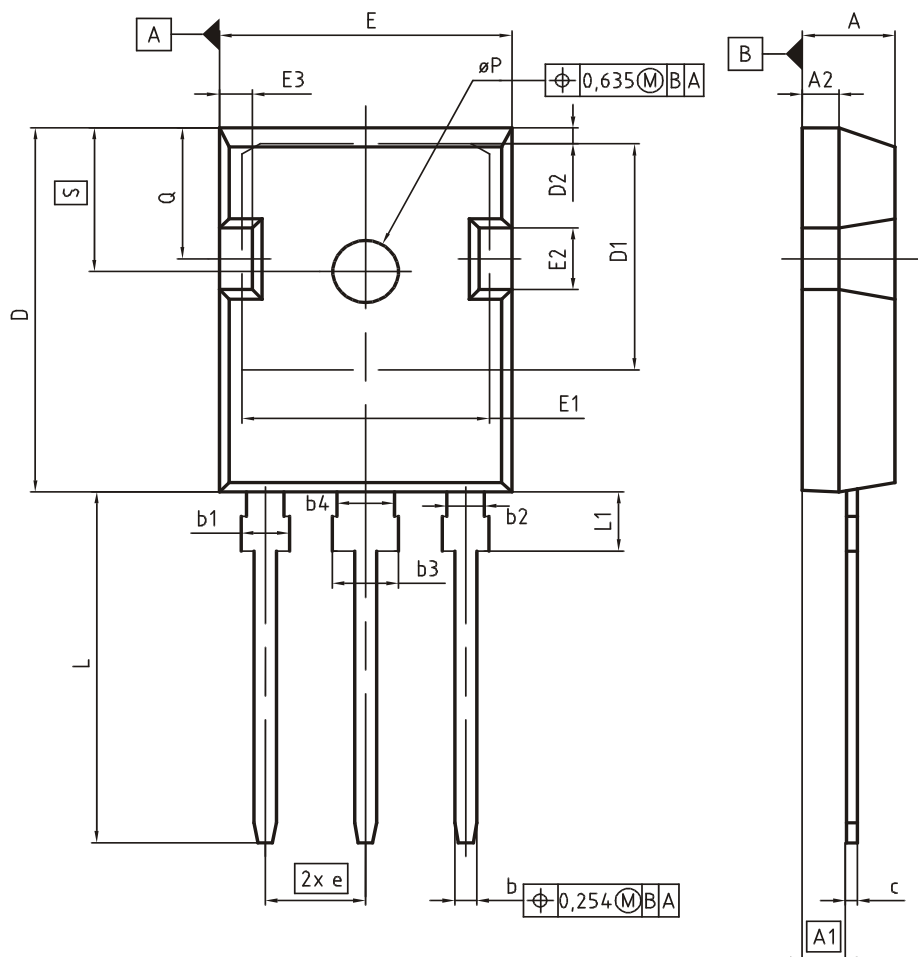
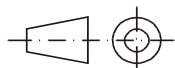


Figure 18. **IGBT transient thermal resistance**  
( $D=t_p/T$ )

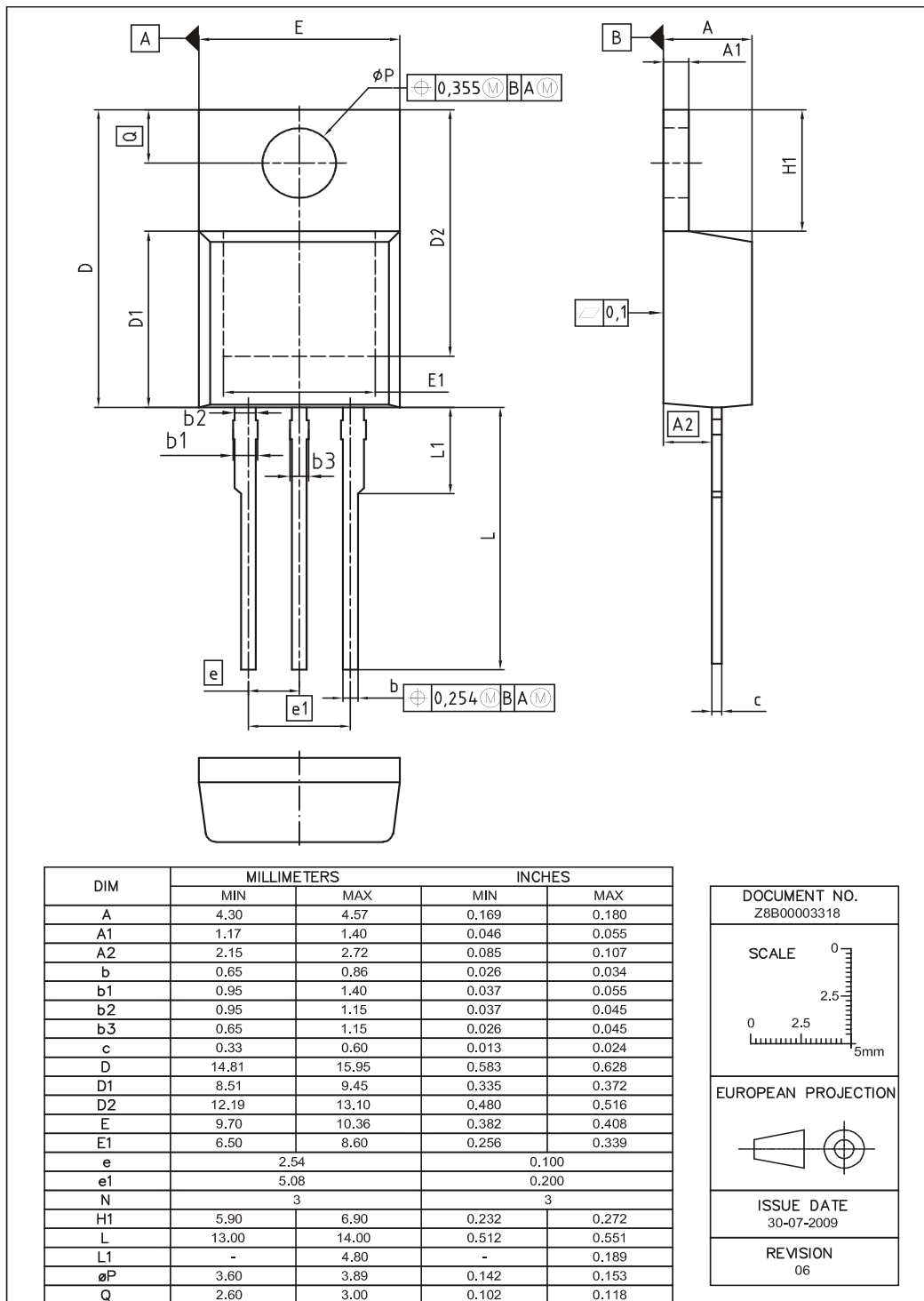
### PG-TO247-3

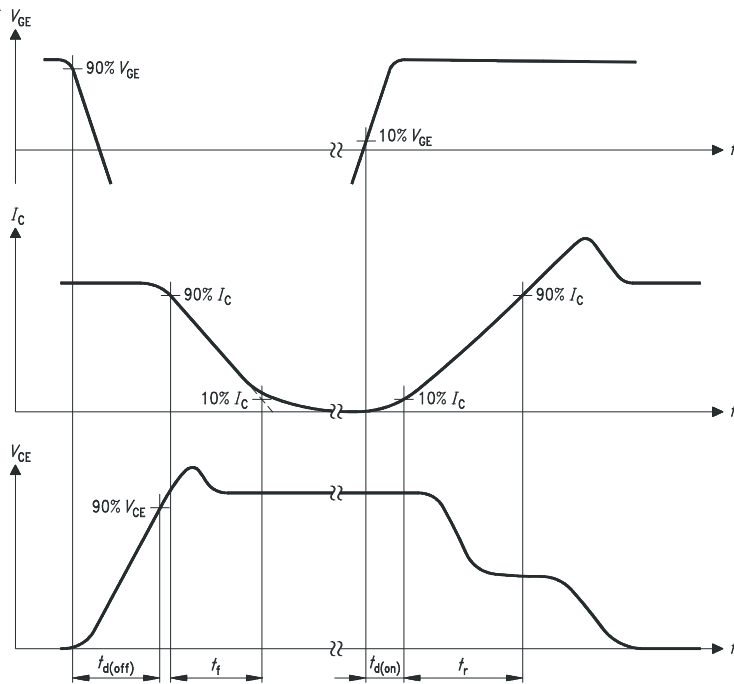


| DIM | MILLIMETERS |       | INCHES      |       |
|-----|-------------|-------|-------------|-------|
|     | MIN         | MAX   | MIN         | MAX   |
| A   | 4.83        | 5.21  | 0.190       | 0.205 |
| A1  | 2.27        | 2.54  | 0.089       | 0.100 |
| A2  | 1.85        | 2.16  | 0.073       | 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 |

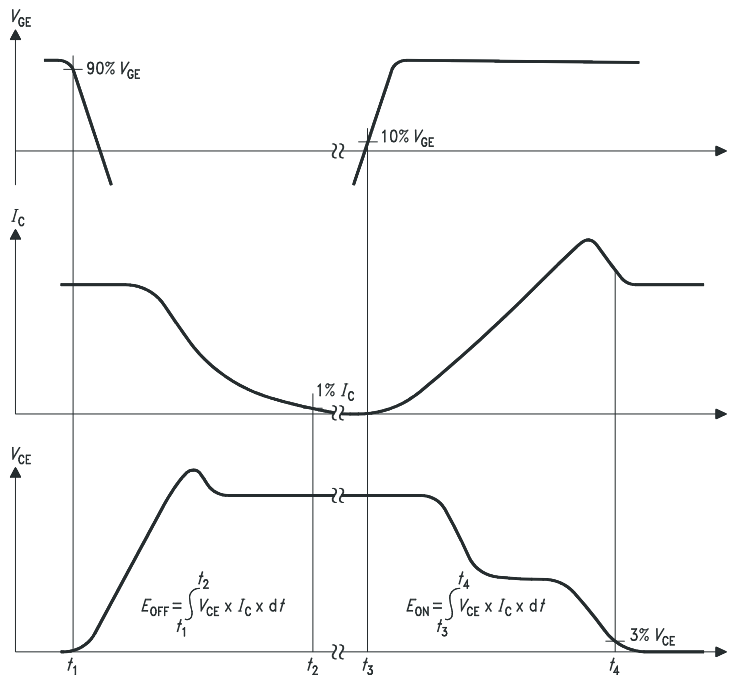
|                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00003327                                                                                  |
| <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                                                                                               |

### PG-TO220-3

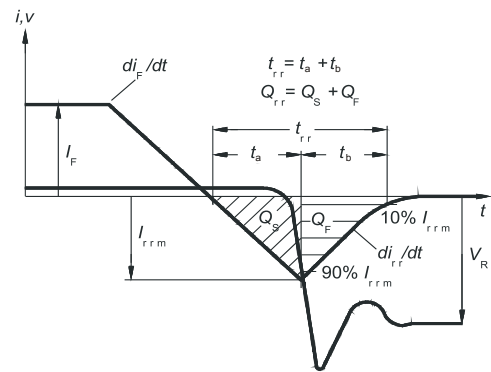




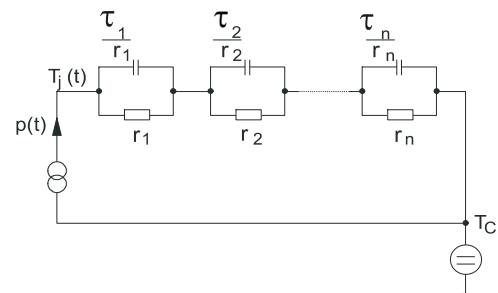
**Figure A. Definition of switching times**



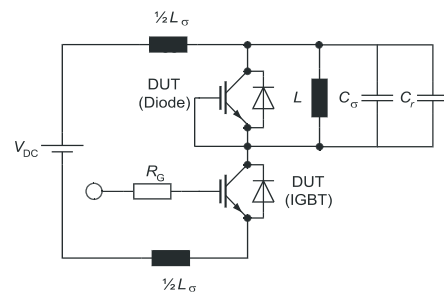
**Figure B. Definition of switching losses**



**Figure C. Definition of diodes 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**

IGW40N65H5, IGP40N65H5

**Revision: 2012-11-09, Rev. 1.1**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 1.1      | 2012-11-09 | Preliminary data sheet                       |

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