

### Features

- Low on-voltage drop ( $V_{CE(sat)}$ )
- Low  $C_{res} / C_{ies}$  ratio (no cross conduction susceptibility)
- Short-circuit withstand time 10  $\mu$ s
- IGBT co-packaged with ultra fast free-wheeling diode

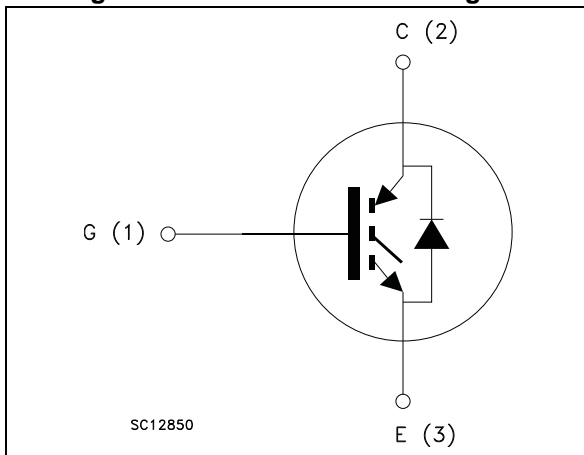
### Applications

- High frequency inverters
- Motor drivers

### Description

This IGBT utilizes the advanced PowerMESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

| Order code   | Marking    | Package | Packaging |
|--------------|------------|---------|-----------|
| STGW40NC60KD | GW40NC60KD | TO-247  | Tube      |

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter   | Value       | Unit               |
|----------------|---|-------------|--------------------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0$ )  | 600         | V                  |
| $I_C^{(1)}$    | Collector current (continuous) at $T_C = 25\text{ °C}$  | 70          | A                  |
| $I_C^{(1)}$    | Collector current (continuous) at $T_C = 100\text{ °C}$   | 38          | A                  |
| $I_{CL}^{(2)}$ | Turn-off latching current   | 220         | A                  |
| $I_{CP}^{(3)}$ | Pulsed collector current  | 220         | A                  |
| $V_{GE}$       | Gate-emitter voltage  | $\pm 20$    | V                  |
| $I_F$          | Diode RMS forward current at $T_C = 25\text{ °C}$   | 30          | A                  |
| $I_{FSM}$      | Surge non repetitive forward current $t_p = 10\text{ ms}$ sinusoidal  | 120         | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$   | 250         | W                  |
| $t_{scw}$      | Short circuit withstand time, $V_{CE} = 0.5 V_{(BR)CES}$<br>$T_j = 125\text{ °C}$ , $R_G = 10\ \Omega$ , $V_{GE} = 12\text{ V}$ | 10          | $\mu\text{s}$      |
| $T_j$          | Operating junction temperature  | - 55 to 150 | $^{\circ}\text{C}$ |

1. Calculated according to the iterative formula:

$$I_c(T_c) = \frac{T_{J(MAX)} - T_c}{R_{thj-c} \times V_{CE(sat)(MAX)} \cdot (T_c \cdot I_c)}$$

2.  $V_{clamp} = 80\% \cdot (V_{CES})$ ,  $T_j = 150\text{ °C}$ ,  $R_G = 10\ \Omega$ ,  $V_{GE} = 15\text{ V}$   
 3. Pulse width limited by max. junction temperature allowed

**Table 3. Thermal resistance**

| Symbol         | Parameter                                   | Value | Unit                 |
|----------------|---|-------|----------------------|
| $R_{thj-case}$ | Thermal resistance junction-case IGBT max.  | 0.5   | $^{\circ}\text{C/W}$ |
|                | Thermal resistance junction-case diode max. | 1.5   | $^{\circ}\text{C/W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max     | 50    | $^{\circ}\text{C/W}$ |

## 2 Electrical characteristics

T<sub>CASE</sub>=25°C unless otherwise specified.

**Table 4. Static**

| Symbol                         | Parameter   | Test conditions  | Min. | Typ. | Max. | Unit |
|--------------------------------|---|--|------|------|------|------|
| V <sub>(BR)CES</sub>           | Collector-emitter breakdown voltage (V <sub>GE</sub> = 0) | I <sub>C</sub> = 1 mA  | 600  |      |      | V    |
| V <sub>CE(sat)</sub>           | Collector-emitter saturation voltage                      | V <sub>GE</sub> = 15 V, I <sub>C</sub> = 30 A                          |      | 2.1  | 2.7  | V    |
|                                |   | V <sub>GE</sub> = 15 V, I <sub>C</sub> = 30 A, T <sub>C</sub> = 125 °C |      | 1.9  |      | V    |
| I <sub>CES</sub>               | Collector cut-off current (V <sub>GE</sub> = 0)           | V <sub>CE</sub> = 600 V  |      |      | 500  | μA   |
|                                |   | V <sub>CE</sub> = 600 V, T <sub>C</sub> = 125 °C                       |      |      | 5    | mA   |
| V <sub>GE(th)</sub>            | Gate threshold voltage                                    | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250 μA            | 4.5  |      | 6.5  | V    |
| I <sub>GES</sub>               | Gate-emitter cut-off current (V <sub>CE</sub> = 0)        | V <sub>GE</sub> = ±20 V  |      |      | ±100 | nA   |
| g <sub>fs</sub> <sup>(1)</sup> | Forward transconductance                                  | V <sub>CE</sub> = 15 V, I <sub>C</sub> = 30 A                          |      | 20   |      | S    |

1. Pulsed: Pulse duration = 300 μs, duty cycle 1.5%

**Table 5. Dynamic**

| Symbol           | Parameter                    | Test conditions  | Min. | Typ. | Max. | Unit |
|------------------|------------------------------|--|------|------|------|------|
| C <sub>ies</sub> | Input capacitance            | V <sub>CE</sub> = 25 V, f = 1 MHz, V <sub>GE</sub> = 0 | -    | 2870 | -    | pF   |
| C <sub>oes</sub> | Output capacitance           |  |      | 295  |      | pF   |
| C <sub>res</sub> | Reverse transfer capacitance |  |      | 69   |      | pF   |
| Q <sub>g</sub>   | Total gate charge            | V <sub>CE</sub> = 480 V, I <sub>C</sub> = 30 A,        | -    | 135  | -    | nC   |
| Q <sub>ge</sub>  | Gate-emitter charge          | V <sub>GE</sub> = 15 V                                 |      | 27   |      | nC   |
| Q <sub>gc</sub>  | Gate-collector charge        | (see Figure 18)  |      | 69.5 |      | nC   |

Table 6. Switching on/off (inductive load)

| Symbol                                 | Parameter   | Test conditions  | Min. | Typ.               | Max. | Unit                   |
|--|---|--|------|--------------------|------|------------------------|
| $t_{d(on)}$<br>$t_r$<br>$(di/dt)_{on}$ | Turn-on delay time<br>Current rise time<br>Turn-on current slope  | $V_{CC} = 480\text{ V}$ , $I_C = 30\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>(see Figure 17)                                      | -    | 46<br>18.5<br>1530 | -    | ns<br>ns<br>A/ $\mu$ s |
| $t_{d(on)}$<br>$t_r$<br>$(di/dt)_{on}$ | Turn-on delay time<br>Current rise time<br>Turn-on current slope  | $V_{CC} = 480\text{ V}$ , $I_C = 30\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125\text{ }^\circ\text{C}$ (see Figure 17)    | -    | 45<br>19<br>1400   | -    | ns<br>ns<br>A/ $\mu$ s |
| $t_{r(Voff)}$<br>$t_{d(off)}$<br>$t_f$ | Off voltage rise time<br>Turn-off delay time<br>Current fall time | $V_{CC} = 480\text{ V}$ , $I_C = 30\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>(see Figure 17)                                      | -    | 38<br>164<br>87    | -    | ns<br>ns<br>ns         |
| $t_{r(Voff)}$<br>$t_{d(off)}$<br>$t_f$ | Off voltage rise time<br>Turn-off delay time<br>Current fall time | $V_{CC} = 480\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>$T_C = 125\text{ }^\circ\text{C}$<br>(see Figure 17) | -    | 70<br>208<br>130   | -    | ns<br>ns<br>ns         |

Table 7. Switching energy (inductive load)

| Symbol                                  | Parameter   | Test conditions  | Min. | Typ.                | Max. | Unit                          |
|---|---|--|------|---------------------|------|-------------------------------|
| $E_{on}$<br>$E_{off}^{(1)}$<br>$E_{ts}$ | Turn-on switching losses<br>Turn-off switching losses<br>Total switching losses | $V_{CC} = 480\text{ V}$ , $I_C = 30\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>(see Figure 17)                                      | -    | 595<br>716<br>1311  | -    | $\mu$ J<br>$\mu$ J<br>$\mu$ J |
| $E_{on}$<br>$E_{off}^{(1)}$<br>$E_{ts}$ | Turn-on switching losses<br>Turn-off switching losses<br>Total switching losses | $V_{CC} = 480\text{ V}$ , $I_C = 30\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125\text{ }^\circ\text{C}$<br>(see Figure 17) | -    | 808<br>1200<br>2008 | -    | $\mu$ J<br>$\mu$ J<br>$\mu$ J |

1. Turn-off losses include also the tail of the collector current.

Table 8. Collector-emitter diode

| Symbol                            | Parameter  | Test conditions  | Min. | Typ.              | Max. | Unit          |
|-----------------------------------|--|--|------|-------------------|------|---------------|
| $V_F$                             | Forward on-voltage   | $I_F = 30\text{ A}$<br>$I_F = 30\text{ A}$ , $T_C = 125\text{ }^\circ\text{C}$   | -    | 2.4<br>1.8        | -    | V<br>V        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{rrm}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_F = 30\text{ A}$ , $V_R = 50\text{ V}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$<br>(see Figure 20)                                     | -    | 45<br>56<br>2.55  | -    | ns<br>nC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{rrm}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_F = 30\text{ A}$ , $V_R = 50\text{ V}$ ,<br>$T_C = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>(see Figure 20) | -    | 100<br>290<br>5.8 | -    | ns<br>nC<br>A |

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

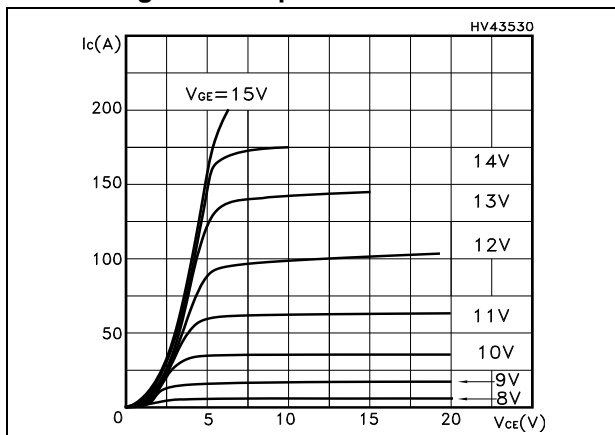


Figure 3. Transfer characteristics

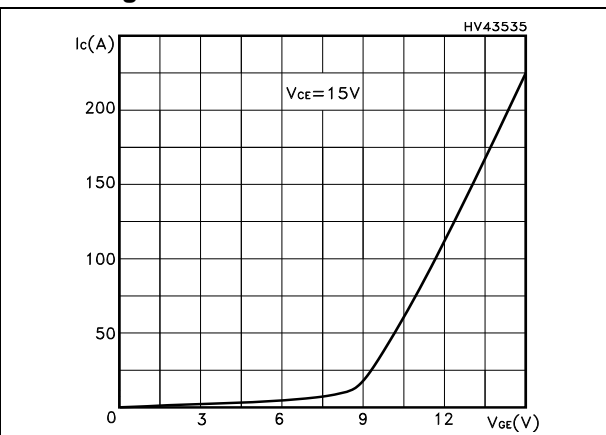


Figure 4. Transconductance

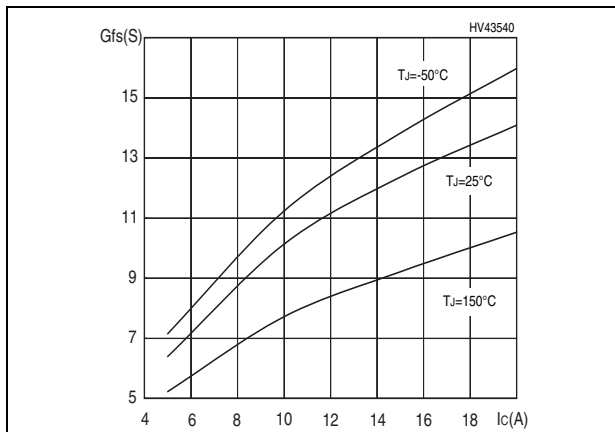


Figure 5. Collector-emitter on voltage vs. temperature

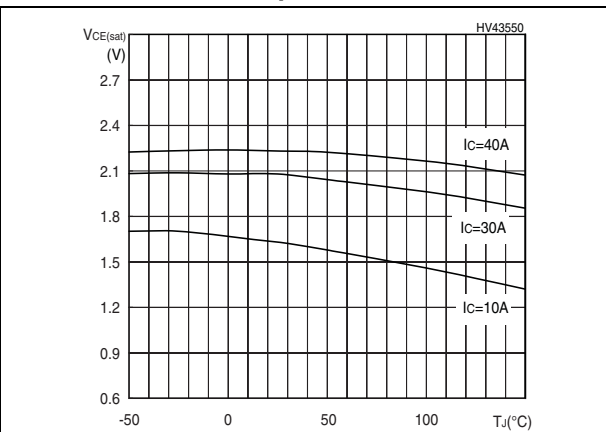


Figure 6. Gate charge vs. gate-source voltage

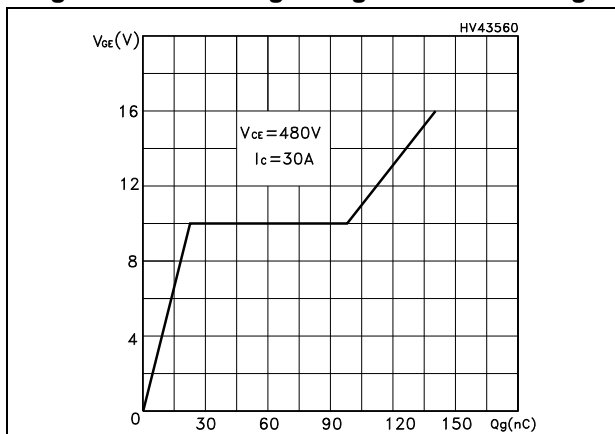


Figure 7. Capacitance variations

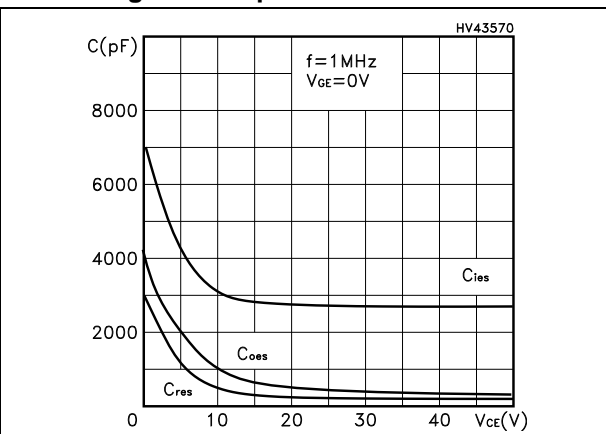


Figure 8. Normalized gate threshold voltage vs. temperature

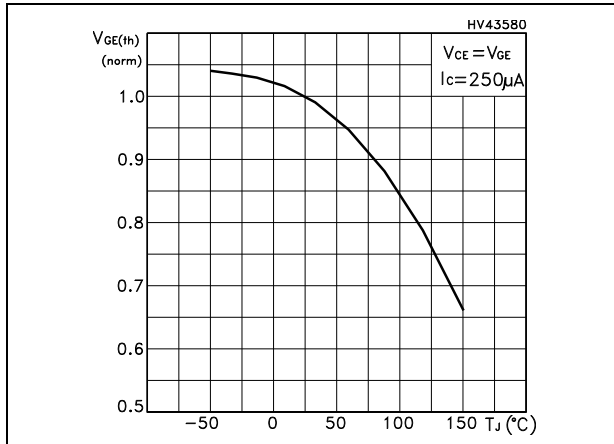


Figure 9. Collector-emitter on voltage vs. collector current

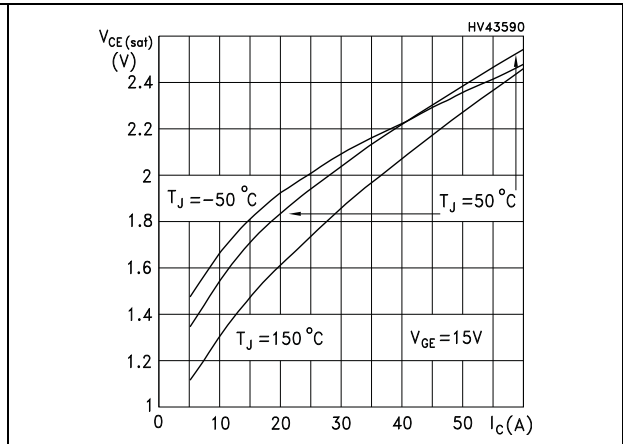


Figure 10. Normalized breakdown voltage vs. temperature

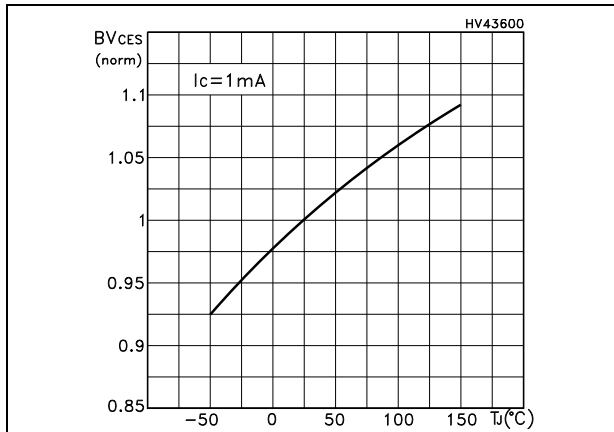


Figure 11. Switching losses vs. temperature

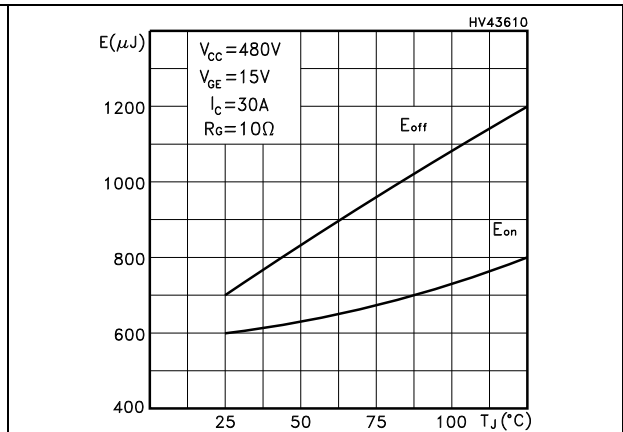


Figure 12. Switching losses vs. gate resistance

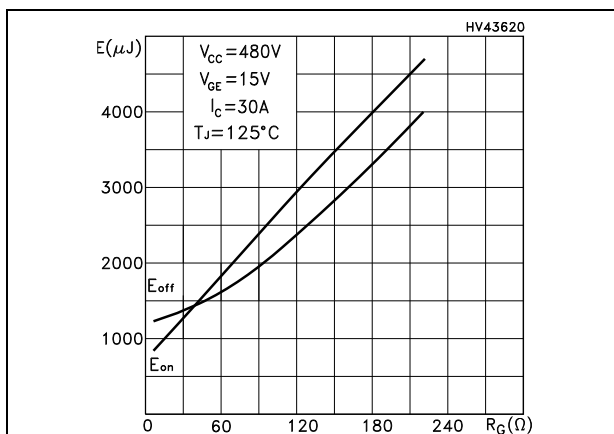


Figure 13. Switching losses vs. collector current

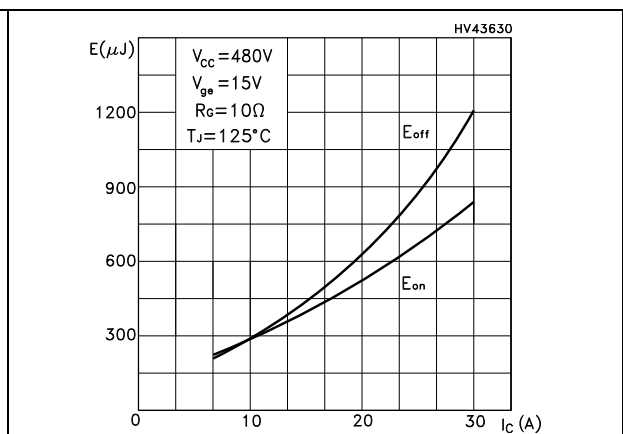


Figure 14. Thermal Impedance

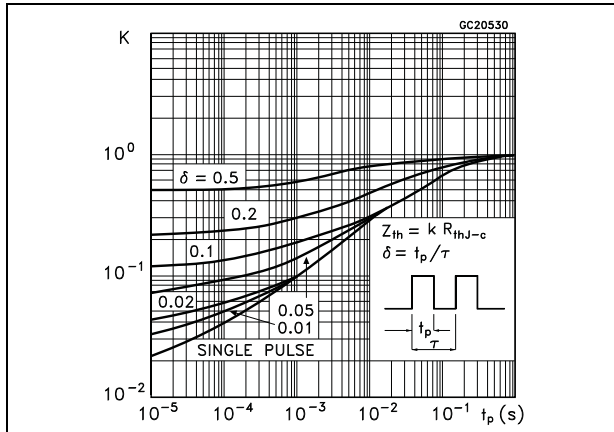


Figure 15. Turn-off SOA

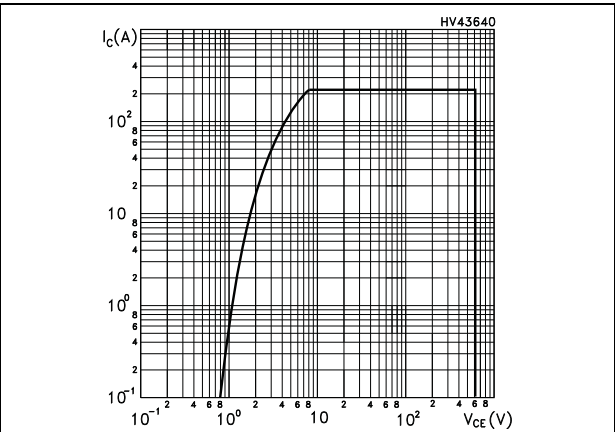
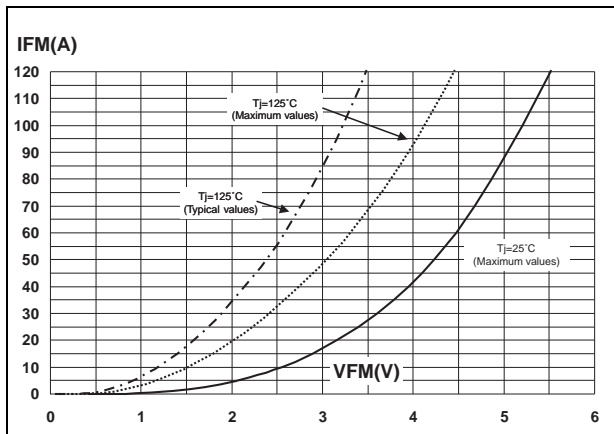


Figure 16. Forward voltage drop vs. forward current





### 3 Test circuits

Figure 17. Test circuit for inductive load switching

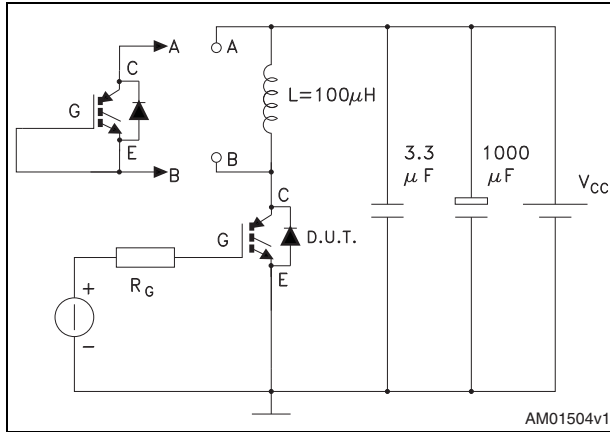


Figure 18. Gate charge test circuit

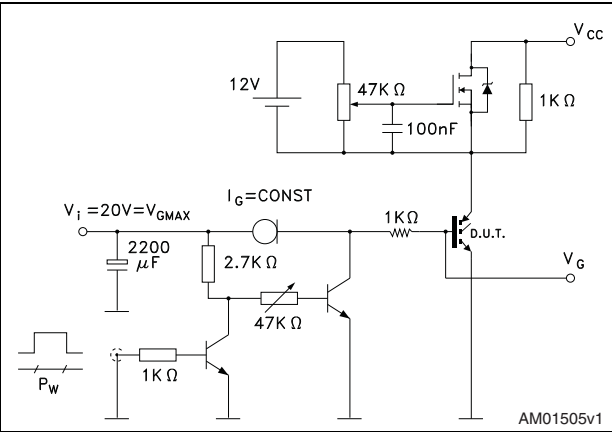


Figure 19. Switching waveform

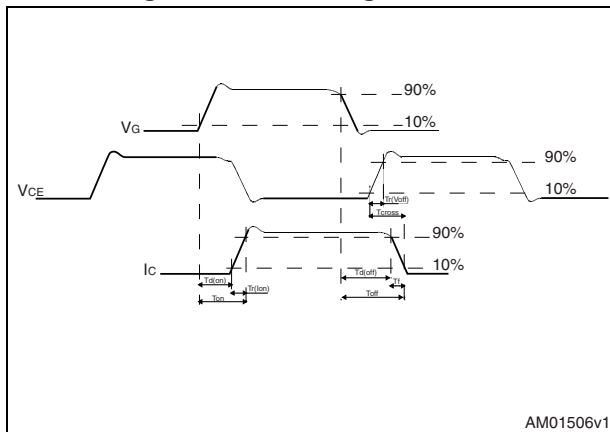
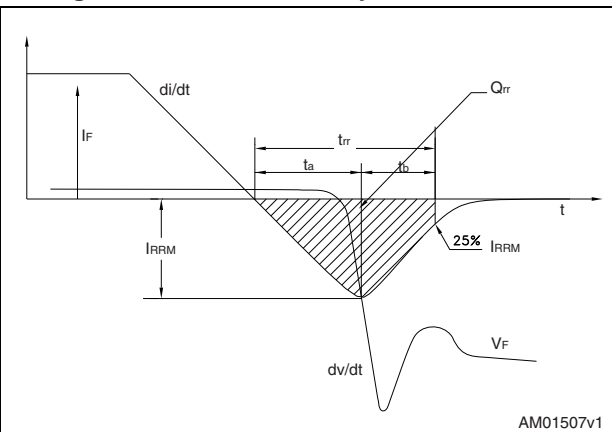


Figure 20. Diode recovery time waveform



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

Figure 21. TO-247 drawing

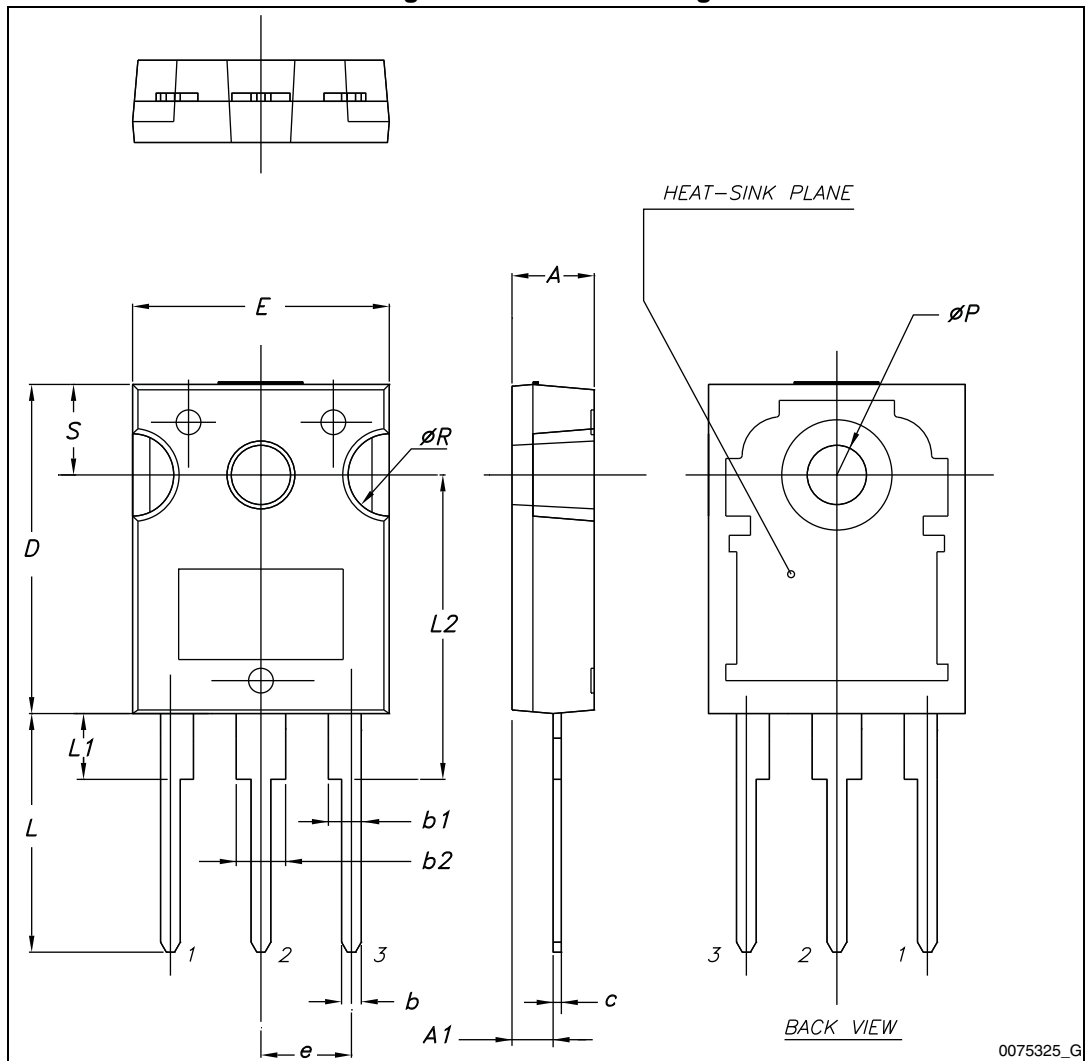


Table 9. TO-247 mechanical data

| Dim. | mm.   |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.85  |       | 5.15  |
| A1   | 2.20  |       | 2.60  |
| b    | 1.0   |       | 1.40  |
| b1   | 2.0   |       | 2.40  |
| b2   | 3.0   |       | 3.40  |
| c    | 0.40  |       | 0.80  |
| D    | 19.85 |       | 20.15 |
| E    | 15.45 |       | 15.75 |
| e    | 5.30  | 5.45  | 5.60  |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| ØP   | 3.55  |       | 3.65  |
| ØR   | 4.50  |       | 5.50  |
| S    | 5.30  | 5.50  | 5.70  |

## 5 Revision history

Table 10. Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 11-Jun-2008 | 1        | Initial release  |
| 12-Mar-2014 | 2        | Modified total switching losses typical value in <a href="#">Table 7: Switching energy (inductive load)</a> .<br>Minor text changes. |

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