



# STGW20NC60VD

30 A, 600 V, very fast IGBT

## Features

- High current capability
- High frequency operation up to 50 KHz
- Very soft ultra fast recovery antiparallel diode

## Description

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

## Applications

- High frequency inverters, UPS
- Motor drive
- SMPS and PFC in both hard switch and resonant topologies

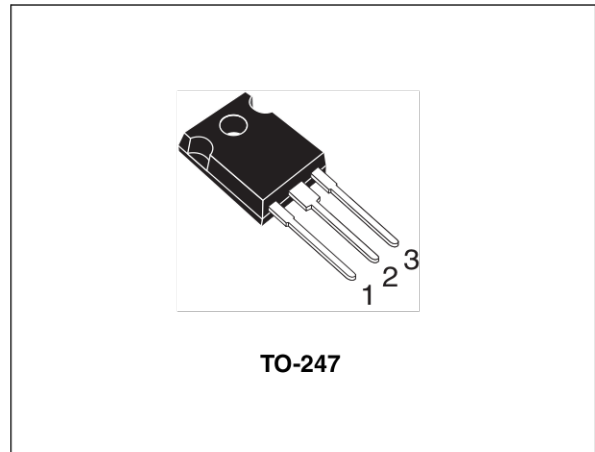


Figure 1. Internal schematic diagram

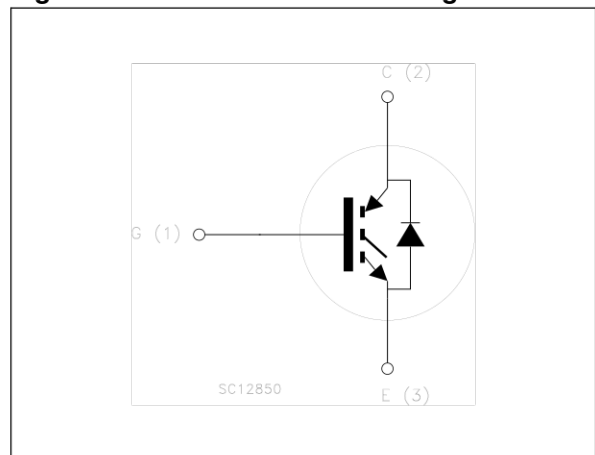


Table 1. Device summary

| Order code   | Marking    | Package | Packaging |
|--------------|------------|---------|-----------|
| STGW20NC60VD | GW20NC60VD | 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                |
| $I_C^{(1)}$    | Continuous collector current at $T_C = 25^\circ\text{C}$         | 60          | A                |
| $I_C^{(1)}$    | Continuous collector current at $T_C = 100^\circ\text{C}$        | 30          | A                |
| $I_{CP}^{(2)}$ | Pulsed collector current   | 150         | A                |
| $I_{CL}^{(3)}$ | Turn-off latching current  | 100         | A                |
| $V_{GE}$       | Gate-emitter voltage   | $\pm 20$    | V                |
| $I_F$          | Diode RMS forward current at $T_C = 25^\circ\text{C}$            | 30          | A                |
| $I_{FSM}$      | Surge not repetitive forward current<br>$t_p = 10$ ms sinusoidal | 120         | A                |
| $P_{TOT}$      | Total dissipation at $T_C = 25^\circ\text{C}$                    | 200         | W                |
| $T_j$          | Operating junction temperature                                   | - 55 to 150 | $^\circ\text{C}$ |
| $T_{stg}$      | Storage temperature  |             |                  |

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

- Pulse width limited by maximum junction temperature and turn-off within RBSOA.
- $V_{clamp} = 80\% V_{CES}$ ,  $T_J = 150^\circ\text{C}$ ,  $R_G = 10\ \Omega$ ,  $V_{GE} = 15\text{ V}$ .

**Table 3. Thermal data**

| Symbol         | Parameter                              | Value | Unit               |
|----------------|--|-------|--------------------|
| $R_{thj-case}$ | Thermal resistance junction-case IGBT  | 0.63  | $^\circ\text{C/W}$ |
|                | Thermal resistance junction-case diode | 1.5   | $^\circ\text{C/W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient    | 50    | $^\circ\text{C/W}$ |

## 2 Electrical characteristics

( $T_j = 25^\circ\text{C}$  unless otherwise specified)

**Table 4. Static**

| Symbol        | Parameter  | Test conditions   | Min. | Typ.       | Max.      | Unit                |
|---------------|--|---|------|------------|-----------|---------------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage ( $V_{GE} = 0$ ) | $I_C = 1 \text{ mA}$  | 600  |            |           | V                   |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage                 | $V_{GE}=15 \text{ V}, I_C=20 \text{ A}$<br>$V_{GE}=15 \text{ V}, I_C=20 \text{ A}, T_j=125^\circ\text{C}$ |      | 1.8<br>1.7 | 2.5       | V<br>V              |
| $V_{GE(th)}$  | Gate threshold voltage                               | $V_{CE} = V_{GE}, I_C = 250 \mu\text{A}$  | 3.75 |            | 5.75      | V                   |
| $I_{CES}$     | Collector-cut-off current ( $V_{GE} = 0$ )           | $V_{CE} = 600 \text{ V}$<br>$V_{CE}=600 \text{ V}, T_j = 125^\circ\text{C}$                               |      |            | 250<br>1  | $\mu\text{A}$<br>mA |
| $I_{GES}$     | Gate-emitter leakage current ( $V_{CE} = 0$ )        | $V_{GE} = \pm 20\text{V}$   |      |            | $\pm 100$ | nA                  |
| $g_{fs}$      | Forward transconductance                             | $V_{CE} = 15 \text{ V}, I_C = 20 \text{ A}$   |      | 15         |           | S                   |

**Table 5. Dynamic**

| Symbol    | Parameter                    | Test conditions   | Min. | Typ. | Max | Unit |
|-----------|------------------------------|---|------|------|-----|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{V}, f = 1 \text{ MHz}, V_{GE} = 0$  | -    | 2200 |     | pF   |
| $C_{oes}$ | Output capacitance           |   |      | 225  |     | pF   |
| $C_{res}$ | Reverse transfer capacitance |   |      | 50   |     | pF   |
| $Q_g$     | Total gate charge            | $V_{CE} = 390\text{V}, I_C = 20\text{A},$<br>$V_{GE} = 15\text{V},$<br><i>(see Figure 18)</i> | -    | 100  | 140 | nC   |
| $Q_{ge}$  | Gate-emitter charge          |   |      | 16   |     | nC   |
| $Q_{gc}$  | Gate-collector charge        |   |      | 45   |     | nC   |

**Table 6. Switching on/off (inductive load)**

| Symbol          | Parameter             | Test conditions                             | Min. | Typ. | Max. | Unit             |
|-----------------|-----------------------|---|------|------|------|------------------|
| $t_{d(on)}$     | Turn-on delay time    | $V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ , |      | 31   |      | ns               |
| $t_r$           | Current rise time     | $R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$    | -    | 11   | -    | ns               |
| $(di/dt)_{onf}$ | Turn-on current slope | (see Figure 17)                             |      | 1600 |      | A/ $\mu\text{s}$ |
| $t_{d(on)}$     | Turn-on delay time    | $V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ , |      | 31   |      | ns               |
| $t_r$           | Current rise time     | $R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$    | -    | 11.5 | -    | ns               |
| $(di/dt)_{on}$  | Turn-on current slope | $T_j=125^\circ\text{C}$ (see Figure 17)     |      | 1500 |      | A/ $\mu\text{s}$ |
| $t_{r(Voff)}$   | Off voltage rise time | $V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ , |      | 28   |      | ns               |
| $t_{d(off)}$    | Turn-off delay time   | $R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$    | -    | 100  | -    | ns               |
| $t_f$           | Current fall time     | (see Figure 17)                             |      | 75   |      | ns               |
| $t_{r(Voff)}$   | Off voltage rise time | $V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ , |      | 66   |      | ns               |
| $t_{d(off)}$    | Turn-off delay time   | $R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$    | -    | 150  | -    | ns               |
| $t_f$           | Current fall time     | $T_j=125^\circ\text{C}$ (see Figure 17)     |      | 130  |      | ns               |

**Table 7. Switching energy (inductive load)**

| Symbol         | Parameter                 | Test conditions                             | Min | Typ. | Max | Unit          |
|----------------|---------------------------|---|-----|------|-----|---------------|
| $E_{on}^{(1)}$ | Turn-on switching losses  | $V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ , |     | 220  | 300 | $\mu\text{J}$ |
| $E_{off}$      | Turn-off switching losses | $R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$ ,  | -   | 330  | 450 | $\mu\text{J}$ |
| $E_{ts}$       | Total switching losses    | (see Figure 19)                             |     | 550  | 750 | $\mu\text{J}$ |
| $E_{on}^{(1)}$ | Turn-on switching losses  | $V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ , |     | 450  |     | $\mu\text{J}$ |
| $E_{off}$      | Turn-off switching losses | $R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$ ,  | -   | 770  |     | $\mu\text{J}$ |
| $E_{ts}$       | Total switching losses    | $T_j=125^\circ\text{C}$<br>(see Figure 19)  |     | 1220 |     | $\mu\text{J}$ |

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in Figure 19.  $E_{on}$  include diode recovery energy. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs & Diode are at the same temperature ( $25^\circ\text{C}$  and  $125^\circ\text{C}$ ).

**Table 8. Collector-emitter diode**

| Symbol                            | Parameter  | Test conditions   | Min | Typ.             | Max | Unit          |
|-----------------------------------|--|---|-----|------------------|-----|---------------|
| $V_F$                             | Forward on-voltage   | $I_F = 20\text{ A}$<br>$I_F = 20\text{ A}, T_j = 125^\circ\text{C}$   | -   | 2<br>1.6         | -   | V<br>V        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{rrm}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_F = 20\text{ A}, V_R = 40\text{ V},$<br>$T_j = 25^\circ\text{C}, di/dt = 100\text{ A}/\mu\text{s}$<br>(see Figure 20)      | -   | 44<br>66<br>3    | -   | ns<br>nC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{rrm}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_F = 2\text{ A}, V_R = 40\text{ V},$<br>$T_j = 125^\circ\text{C},$<br>$di/dt = 100\text{ A}/\mu\text{s}$<br>(see Figure 20) | -   | 88<br>237<br>5.4 | -   | ns<br>nC<br>A |

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

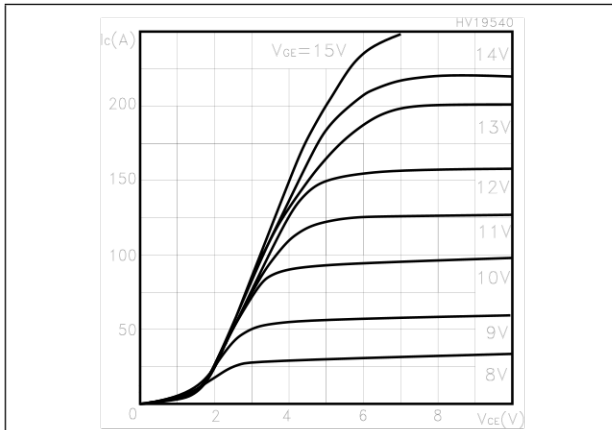


Figure 3. Transfer characteristics

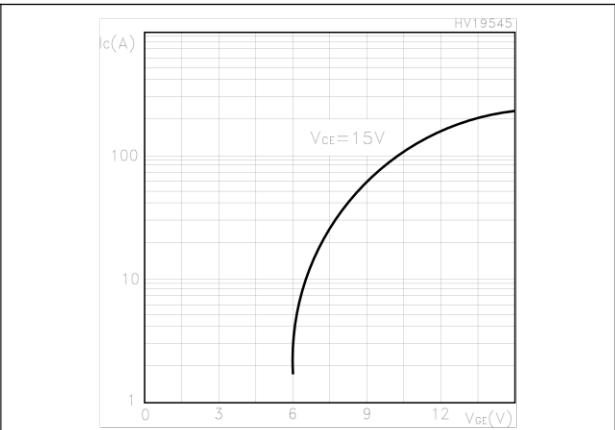


Figure 4. Transconductance

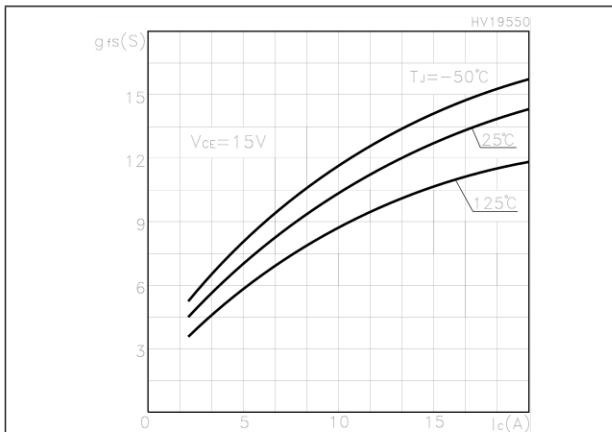


Figure 5. Collector-emitter on voltage vs temperature

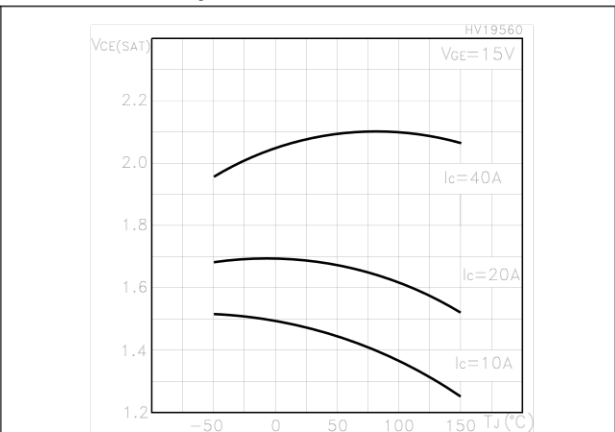


Figure 6. Collector-emitter on voltage vs collector current

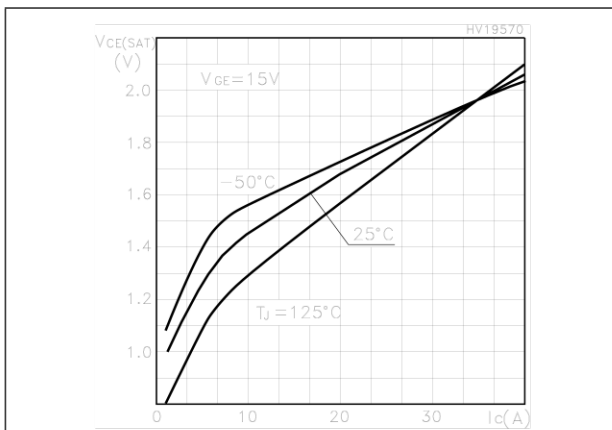
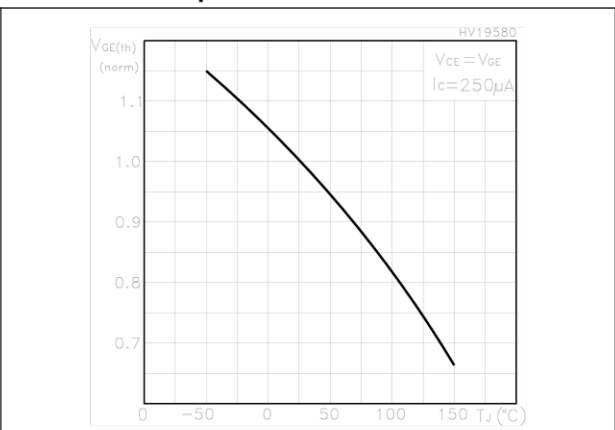
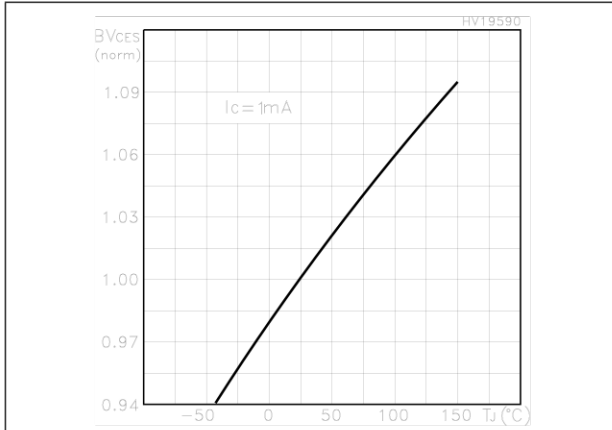


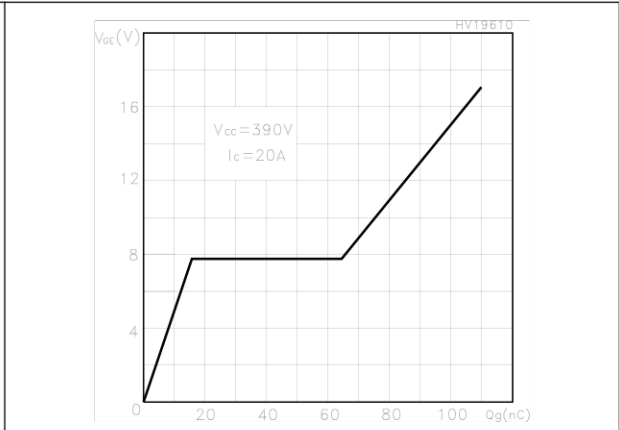
Figure 7. Normalized gate threshold vs temperature



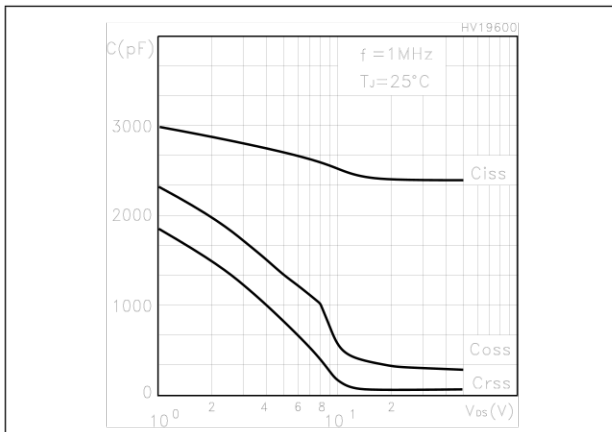
**Figure 8. Normalized breakdown voltage vs temperature**



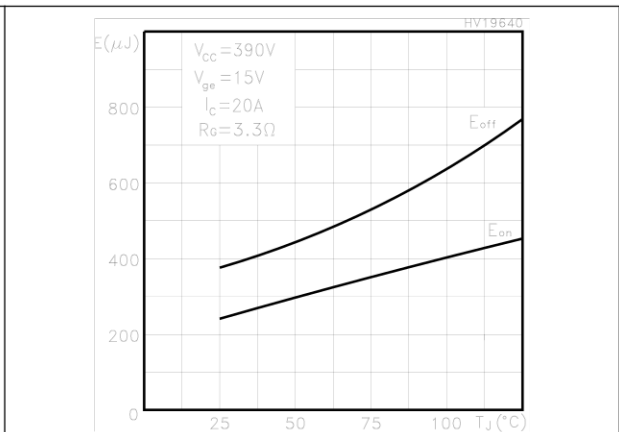
**Figure 9. Gate charge vs gate-emitter voltage**



**Figure 10. Capacitance variations**



**Figure 11. Switching losses vs temperature**



**Figure 12. Switching losses vs gate resistance** **Figure 13. Switching losses vs collector current**

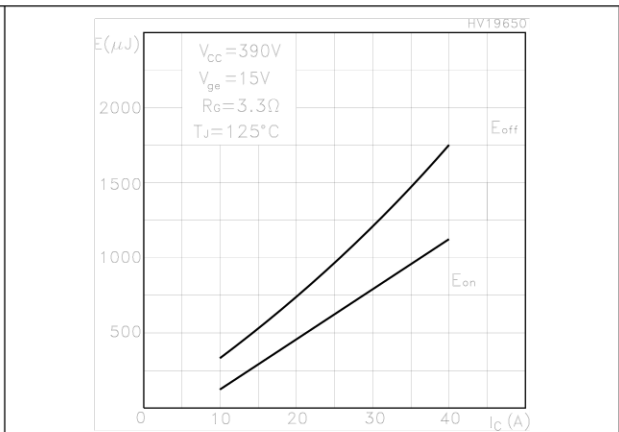
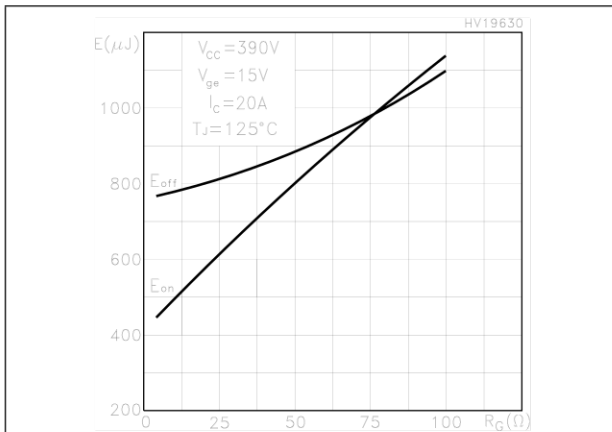




Figure 14. Thermal impedance

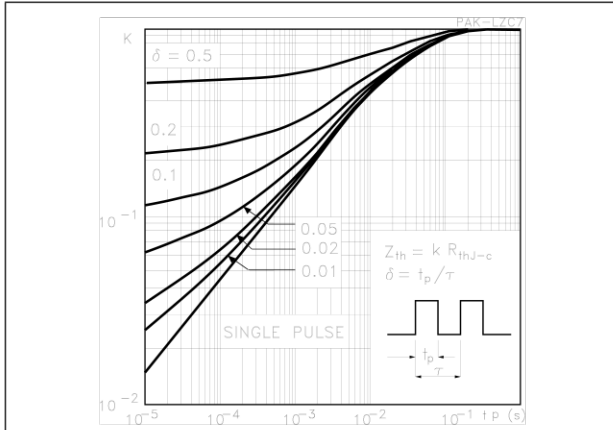


Figure 15. Turn-off SOA

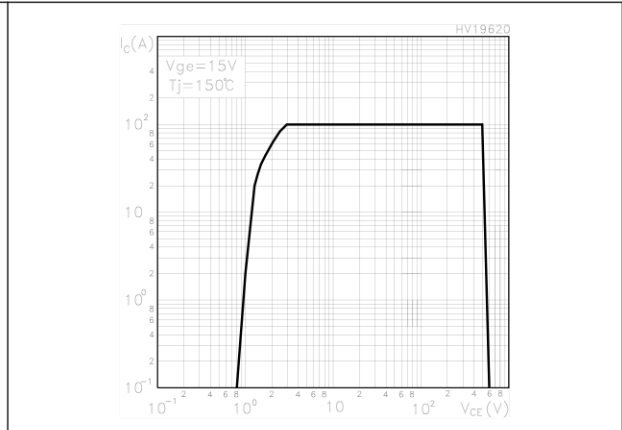
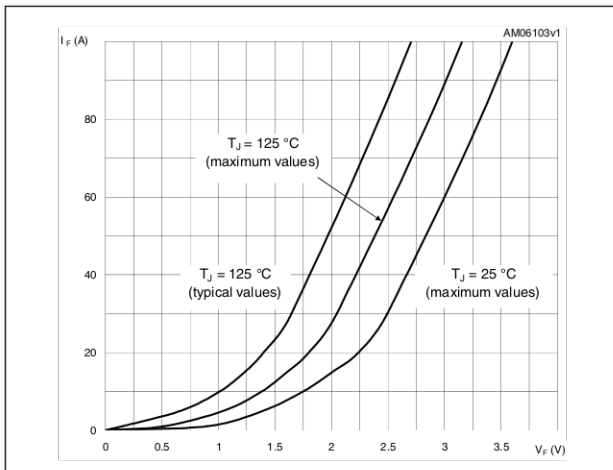


Figure 16. Emitter-collector diode characteristics



### 3 Test circuits

Figure 17. Test circuit for inductive load switching

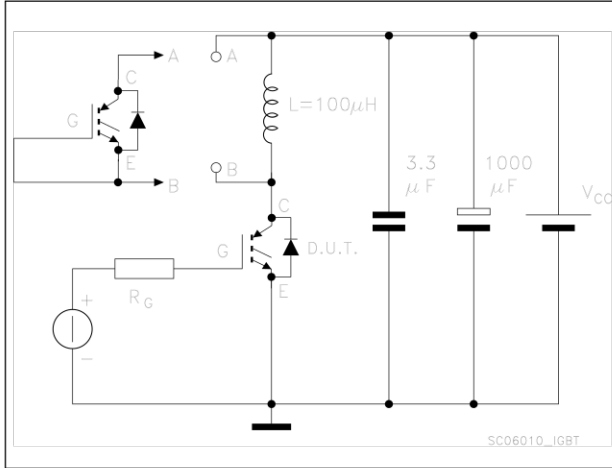


Figure 18. Gate charge test circuit

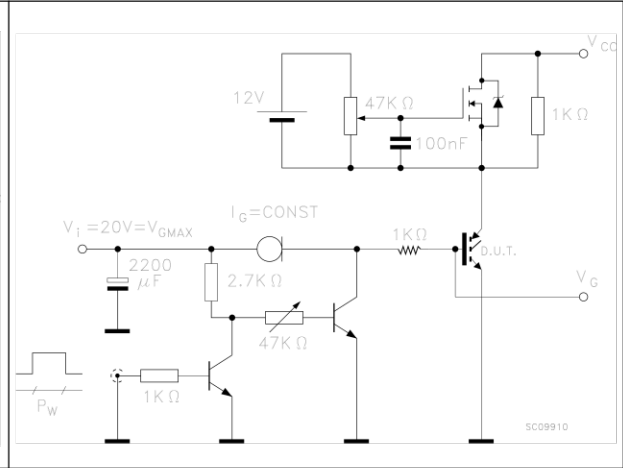


Figure 19. Switching waveforms

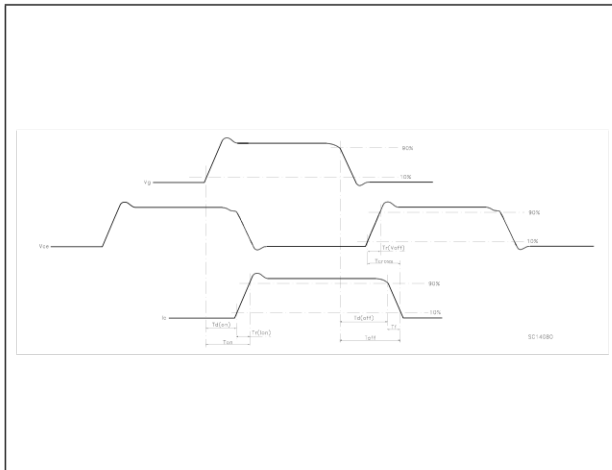
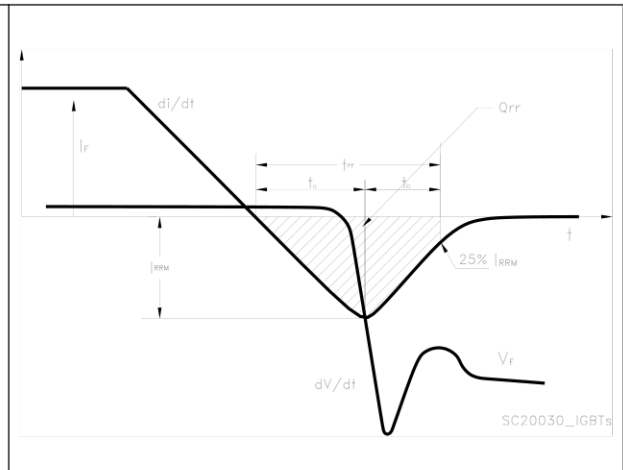


Figure 20. Diode recovery times waveform

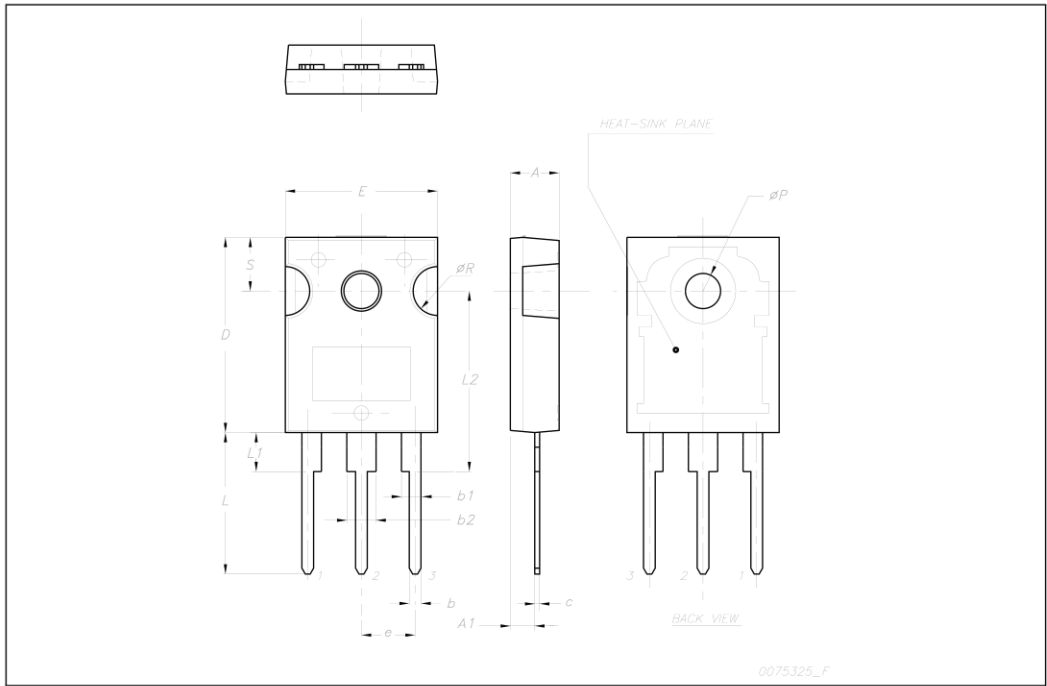


## 4 Package mechanical data

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

**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    |       | 5.45  |       |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| øP   | 3.55  |       | 3.65  |
| øR   | 4.50  |       | 5.50  |
| S    |       | 5.50  |       |



## 5 Revision history

Table 9. Revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 12-Jul-2004 | 4        | Stylesheet updated.<br>Added switching losses maximum values in <i>Table 7: Switching energy (inductive load)</i> .<br>Inserted <i>Figure 20: Diode recovery times waveform</i> .  |
| 09-Mar-2010 | 5        | Inserted $I_{FSM}$ parameter on <i>Table 2: Absolute maximum ratings</i> .<br>Updated <i>Figure 16: Emitter-collector diode characteristics</i> and package mechanical data.<br>Minor text changes to improve readability. |

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