



# STGY40NC60VD

N-channel 600V - 50A - Max247  
Very fast PowerMESH™ IGBT

## Features

| Type         | V <sub>CES</sub> | V <sub>CE(sat)</sub><br>(max)@25°C | I <sub>c</sub><br>@100°C |
|--------------|------------------|------------------------------------|--------------------------|
| STGY40NC60VD | 600V             | < 2.5V                             | 50A                      |

- High current capability
- High frequency operation up to 50kHz
- Low C<sub>RES</sub> / C<sub>IES</sub> ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode

## Description

Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix “V” identifies a family optimized for very high frequency applications.

## Applications

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

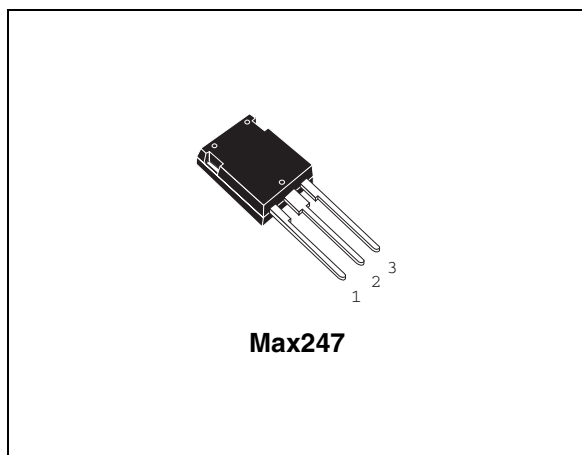


Figure 1. Internal schematic diagram

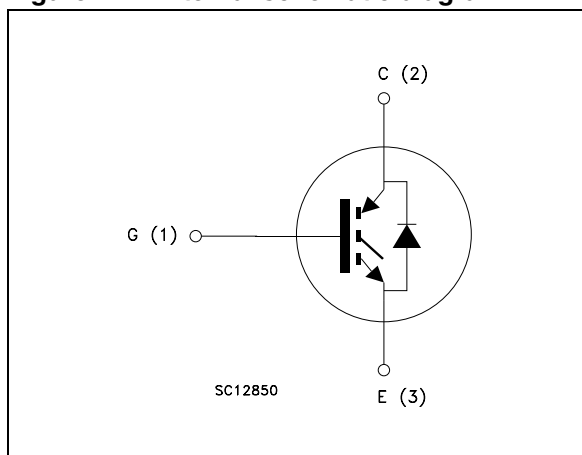


Table 1. Device summary

| Order code   | Marking    | Package | Packaging |
|--------------|------------|---------|-----------|
| STGY40NC60VD | GY40NC60VD | Max247  | Tube      |

# Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                         | Parameter  | Value      | Unit |
|--------------------------------|--|------------|------|
| V <sub>CES</sub>               | Collector-emitter voltage (V <sub>GS</sub> = 0)          | 600        | V    |
| I <sub>C</sub> <sup>(1)</sup>  | Collector current (continuous) at T <sub>C</sub> = 25°C  | 80         | A    |
| I <sub>C</sub> <sup>(1)</sup>  | Collector current (continuous) at T <sub>C</sub> = 100°C | 50         | A    |
| I <sub>CL</sub> <sup>(2)</sup> | Turn-off SOA minimum current                             | 200        | A    |
| I <sub>F</sub>                 | Diode RMS forward current at T <sub>C</sub> = 25°C       | 30         | A    |
| V <sub>GE</sub>                | Gate-emitter voltage                                     | ±20        | V    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25°C               | 260        | W    |
| T <sub>j</sub>                 | Operating junction temperature                           | -55 to 150 | °C   |

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C, I_C)}$$

2. Pulse width limited by max junction temperature

**Table 2. Thermal resistance**

| Symbol                | Parameter   | Value | Unit |
|-----------------------|---|-------|------|
| R <sub>thj-case</sub> | Thermal resistance junction-case max IGBT   | 0.48  | °C/W |
| R <sub>thj-case</sub> | Thermal resistance junction-case max diode  | 1.5   | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max   | 50    | °C/W |
| T <sub>L</sub>        | Maximum lead temperature for soldering purpose (1.6mm from case, for 10 sec) typ. | 300   | °C   |

## 2 Electrical characteristics

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

**Table 3. Static**

| Symbol        | Parameter                                     | Test conditions   | Min. | Typ.       | Max.      | Unit                |
|---------------|---|---|------|------------|-----------|---------------------|
| $V_{BR(CES)}$ | Collector-emitter breakdown voltage           | $I_C = 1\text{mA}, V_{GE} = 0$  | 600  |            |           | V                   |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage          | $V_{GE} = 15\text{V}, I_C = 40\text{A}$<br>$V_{GE} = 15\text{V}, I_C = 40\text{A}, T_C = 125^{\circ}\text{C}$     |      | 1.9<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 ( $V_{GE} = 0$ )    | $V_{CE} = \text{Max rating}, T_C = 25^{\circ}\text{C}$<br>$V_{CE} = \text{Max rating}, T_C = 125^{\circ}\text{C}$ |      |            | 10<br>1   | $\mu\text{A}$<br>mA |
| $I_{GES}$     | Gate-emitter leakage current ( $V_{CE} = 0$ ) | $V_{GE} = \pm 20\text{V}, V_{CE} = 0$   |      |            | $\pm 100$ | nA                  |
| $g_{fs}$      | Forward transconductance                      | $V_{CE} = 15\text{V}, I_C = 20\text{A}$   |      | 20         |           | S                   |

**Table 4. Dynamic**

| Symbol    | Parameter                    | Test conditions   | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{V}, f = 1\text{MHz},$<br>$V_{GE} = 0$ |      | 4550 |      | pF   |
| $C_{oes}$ | Output capacitance           |   |      | 350  |      | pF   |
| $C_{res}$ | Reverse transfer capacitance |   |      | 105  |      | pF   |
| $Q_g$     | Total gate charge            | $V_{CE} = 390\text{V}, I_C = 40\text{A},$               |      | 214  |      | nC   |
| $Q_{ge}$  | Gate-emitter charge          | $V_{GE} = 15\text{V},$                                  |      | 30   |      | nC   |
| $Q_{gc}$  | Gate-collector charge        | <a href="#">Figure 17</a>                               |      | 96   |      | nC   |

**Table 5. 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  | $V_{CC} = 390V, I_C = 40A$<br>$R_G = 3.3\Omega, V_{GE} = 15V,$<br><i>Figure 18, Figure 16</i>                        |      | 43<br>17<br>2060 |      | 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  | $V_{CC} = 390V, I_C = 40A$<br>$R_G = 3.3\Omega, V_{GE} = 15V,$<br>$T_J = 125^\circ C$<br><i>Figure 18, Figure 16</i> |      | 42<br>19<br>1900 |      | ns<br>ns<br>A/ $\mu$ s |
| $t_{r(Voff)}$<br>$t_{d(Voff)}$<br>$t_f$ | Off voltage rise time<br>Turn-off delay time<br>Current fall time | $V_{CC} = 390V, I_C = 40A$<br>$R_G = 3.3\Omega, V_{GE} = 15V,$<br><i>Figure 18, Figure 16</i>                        |      | 25<br>140<br>45  |      | ns<br>ns<br>ns         |
| $t_{r(Voff)}$<br>$t_{d(Voff)}$<br>$t_f$ | Off voltage rise time<br>Turn-off delay time<br>Current fall time | $V_{CC} = 390V, I_C = 40A$<br>$R_G = 3.3\Omega, V_{GE} = 15V,$<br>$T_J = 125^\circ C$<br><i>Figure 18, Figure 16</i> |      | 60<br>170<br>77  |      | ns<br>ns<br>ns         |

**Table 6. 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 | $V_{CC} = 390V, I_C = 40A$<br>$R_G = 3.3\Omega, V_{GE} = 15V,$<br><i>Figure 16</i>                        |      | 330<br>720<br>1050  | 450<br>970<br>1420 | $\mu$ 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 | $V_{CC} = 390V, I_C = 40A$<br>$R_G = 3.3\Omega, V_{GE} = 15V,$<br>$T_J = 125^\circ C$<br><i>Figure 16</i> |      | 640<br>1400<br>2040 |                    | $\mu$ J<br>$\mu$ J<br>$\mu$ J |

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

Table 7. Collector-emitter diode

| Symbol    | Parameter                | Test conditions  | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|--|------|------|------|------|
| $V_f$     | Forward on-voltage       | $I_f = 20A$  |      | 1.5  | 2.2  | V    |
|           |                          | $I_f = 20A, T_j = 125^\circ C$                                     |      | 1    |      | V    |
| $t_{rr}$  | Reverse recovery time    | $I_f = 20A, V_R = 40V,$<br>$T_j = 25^\circ C, di/dt = 100 A/\mu s$ |      | 44   |      | ns   |
| $Q_{rr}$  | Reverse recovery charge  | $T_j = 25^\circ C, di/dt = 100 A/\mu s$                            |      | 66   |      | nC   |
| $I_{rrm}$ | Reverse recovery current | <i>Figure 19</i>   |      | 3    |      | A    |
| $t_{rr}$  | Reverse recovery time    | $I_f = 40A, V_R = 50V,$<br>$T_j = 125^\circ C, di/dt = 100A/\mu s$ |      | 88   |      | ns   |
| $Q_{rr}$  | Reverse recovery charge  | $T_j = 125^\circ C, di/dt = 100A/\mu s$                            |      | 237  |      | nC   |
| $I_{rrm}$ | Reverse recovery current | <i>Figure 19</i>   |      | 5.4  |      | A    |

## 2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

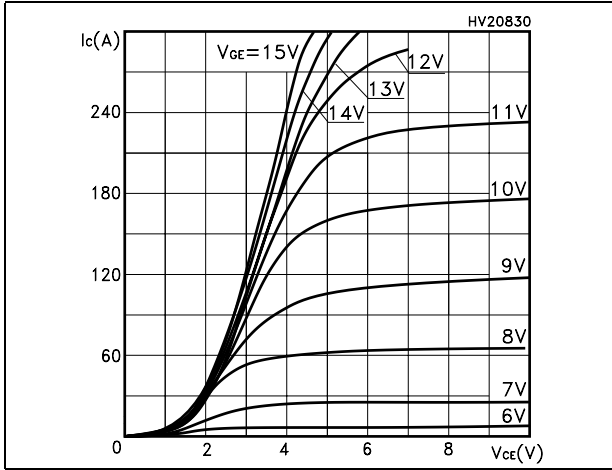


Figure 2. Transfer characteristics

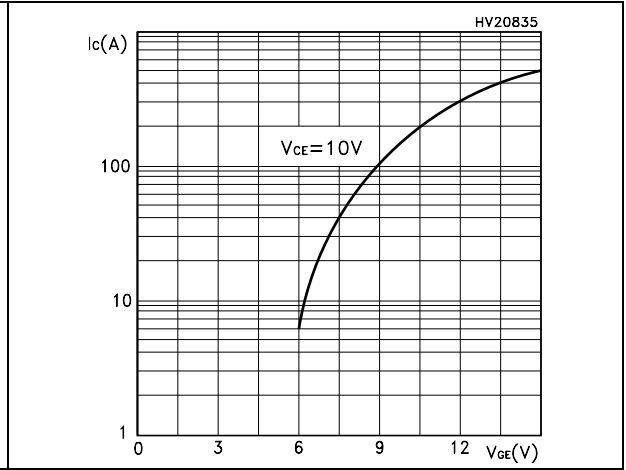


Figure 3. Transconductance

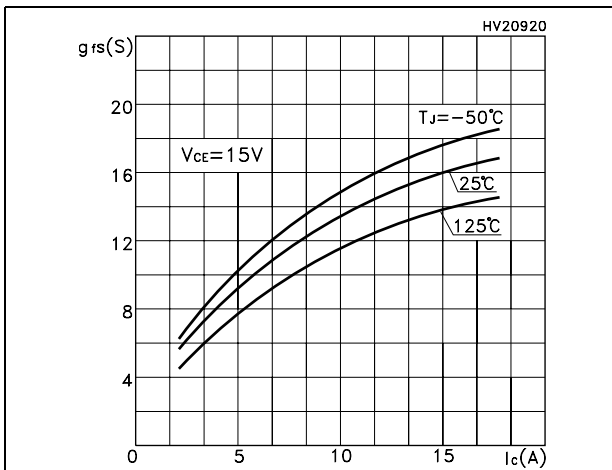


Figure 4. Collector-emitter on voltage vs temperature

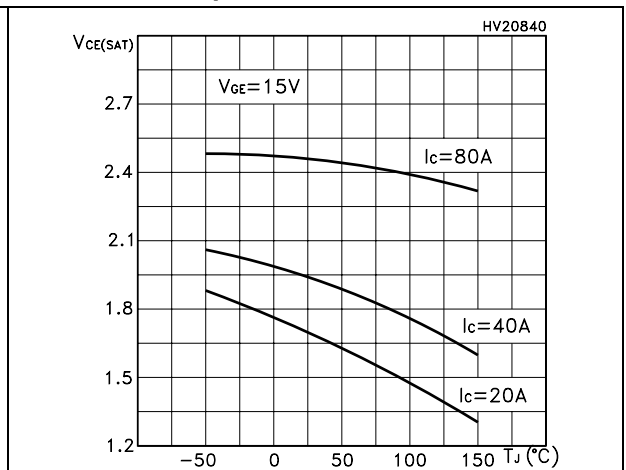


Figure 5. Gate charge vs gate-source voltage Figure 6. Capacitance variations

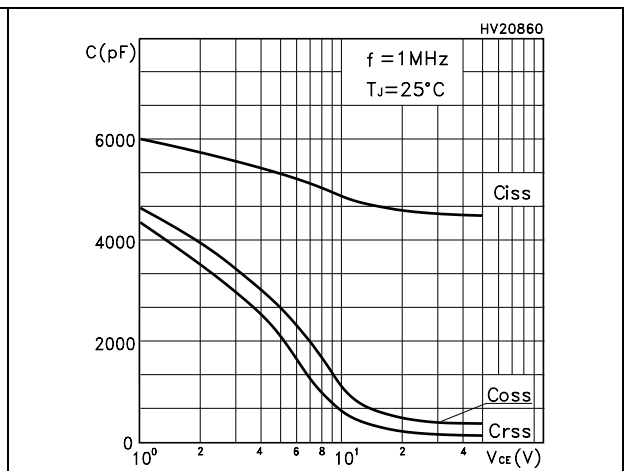
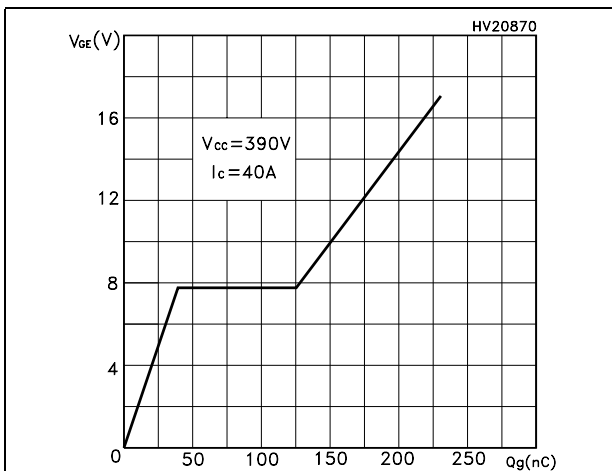


Figure 7. Normalized gate threshold voltage vs temperature

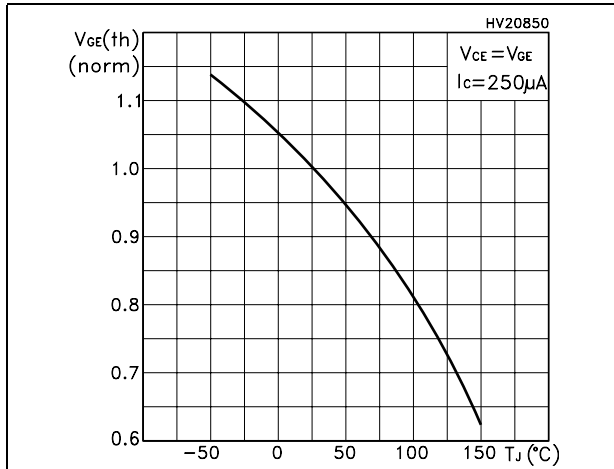


Figure 8. Collector-emitter on voltage vs collector current

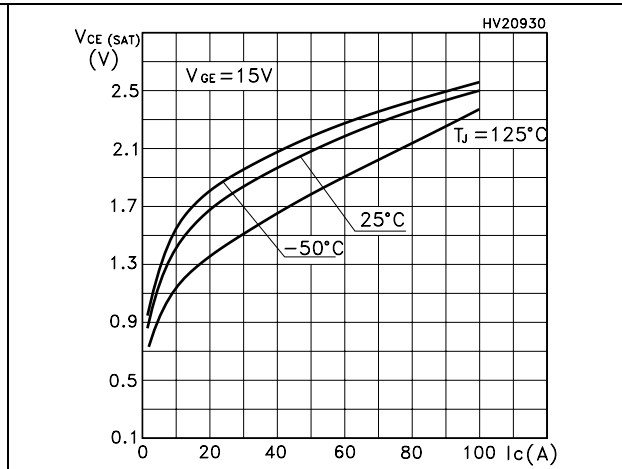


Figure 9. Normalized breakdown voltage vs temperature

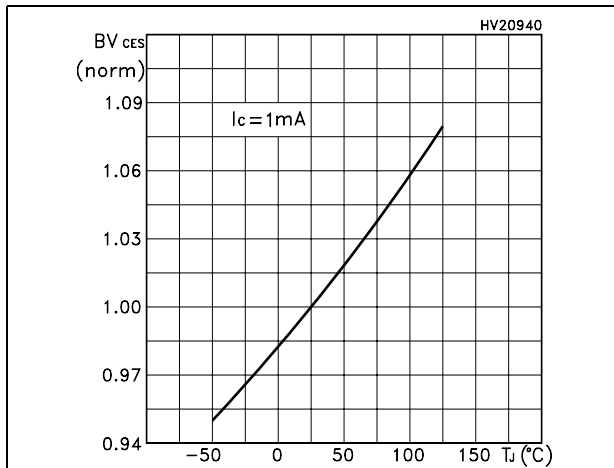


Figure 10. Switching losses vs temperature

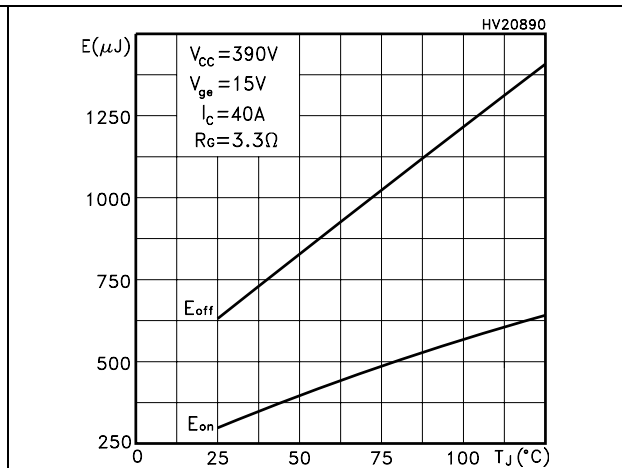


Figure 11. Switching losses vs gate resistance

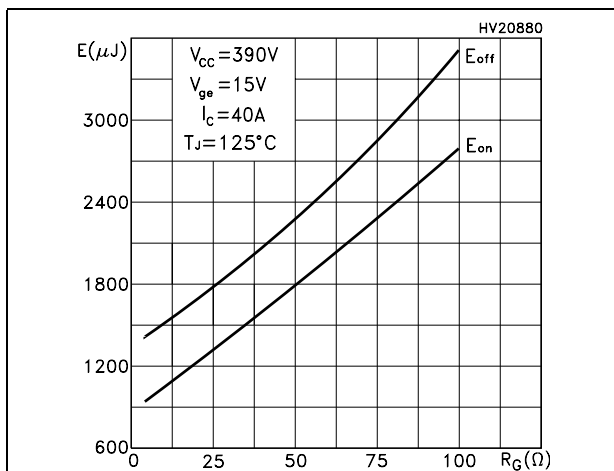


Figure 12. Switching losses vs collector current

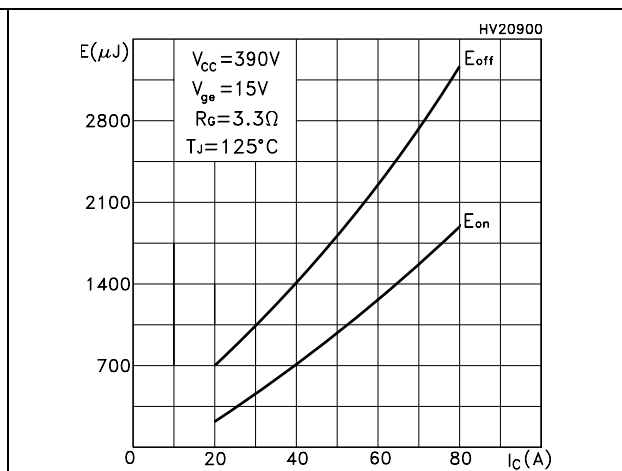




Figure 13. Turn-off SOA

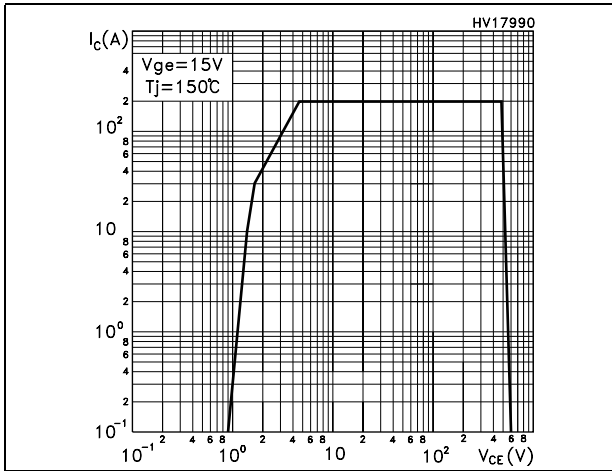


Figure 14. Thermal impedance

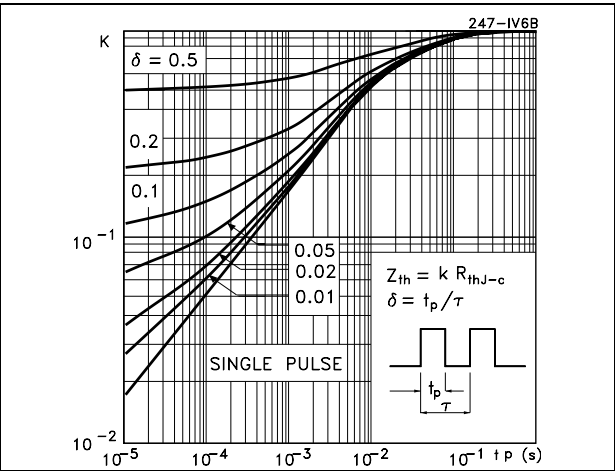
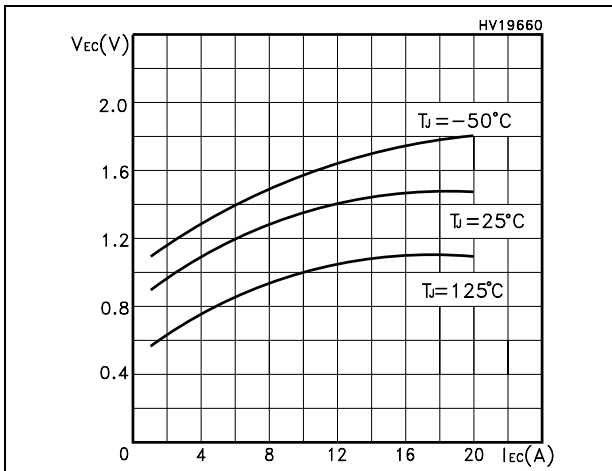


Figure 15. Emitter-collector diode characteristics



### 3 Test circuit

Figure 16. Test circuit for inductive load switching

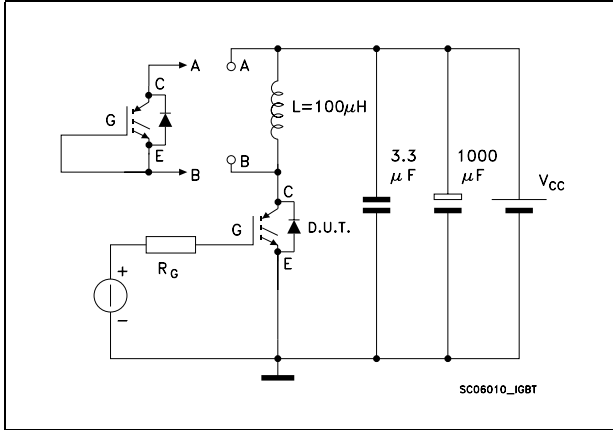


Figure 17. Gate charge test circuit

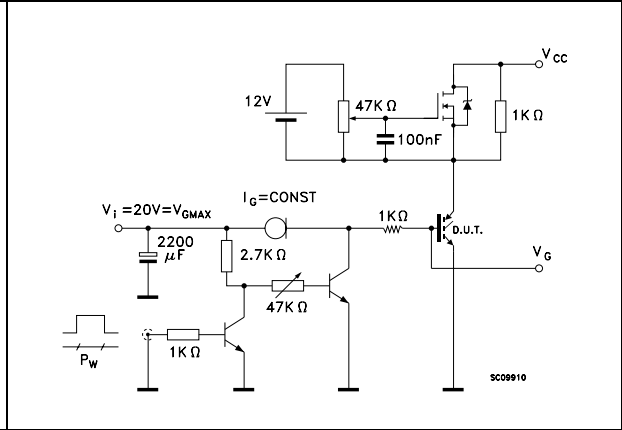


Figure 18. Switching waveform

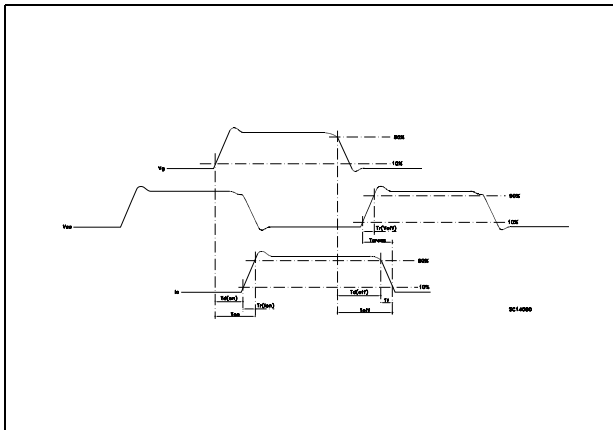
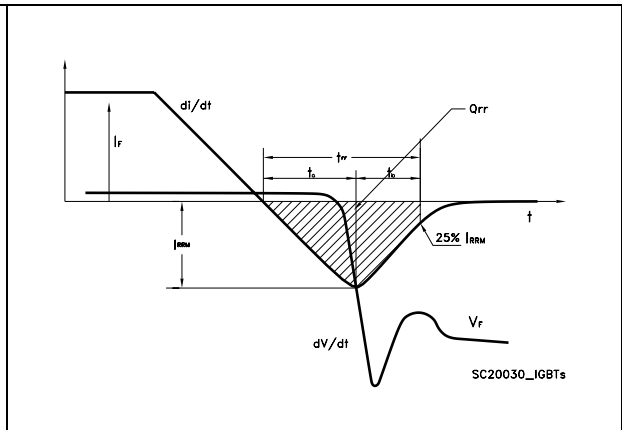


Figure 19. Diode recovery time waveform

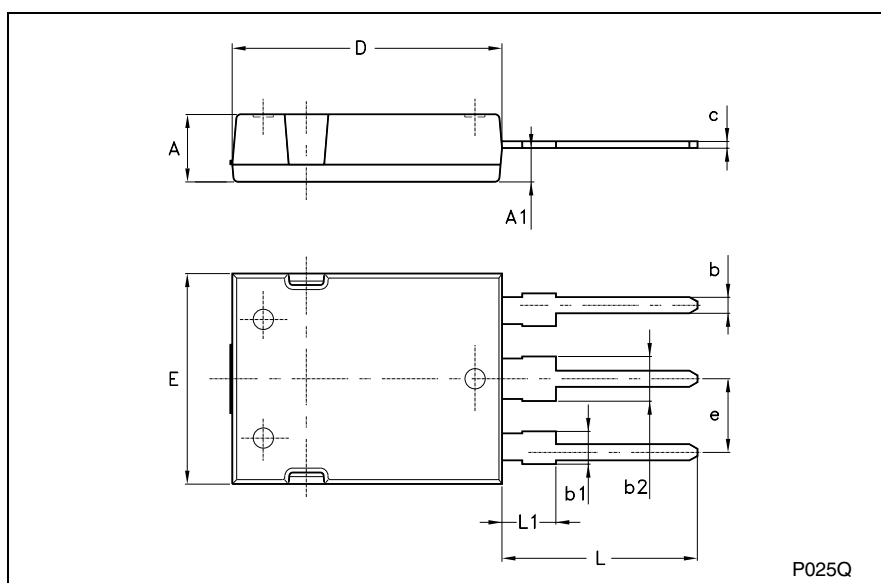


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

**Max247 MECHANICAL DATA**

| DIM. | mm    |      |       | inch |      |      |
|------|-------|------|-------|------|------|------|
|      | MIN.  | TYP. | MAX.  | MIN. | TYP. | MAX. |
| A    | 4.70  |      | 5.30  |      |      |      |
| A1   | 2.20  |      | 2.60  |      |      |      |
| b    | 1.00  |      | 1.40  |      |      |      |
| b1   | 2.00  |      | 2.40  |      |      |      |
| b2   | 3.00  |      | 3.40  |      |      |      |
| c    | 0.40  |      | 0.80  |      |      |      |
| D    | 19.70 |      | 20.30 |      |      |      |
| e    | 5.35  |      | 5.55  |      |      |      |
| E    | 15.30 |      | 15.90 |      |      |      |
| L    | 14.20 |      | 15.20 |      |      |      |
| L1   | 3.70  |      | 4.30  |      |      |      |



## 5 Revision history

**Table 8. Revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 07-Jun-2004 | 7        | Initial electronic version.  |
| 14-Jul-2004 | 8        | <i>Figure 15</i> has been update                                     |
| 13-Jul-2007 | 9        | The document has been reformatted, corrected error on <i>Table 4</i> |

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