



# STGB19NC60W STGP19NC60W, STGW19NC60W

19 A - 600 V - ultra fast IGBT

## Features

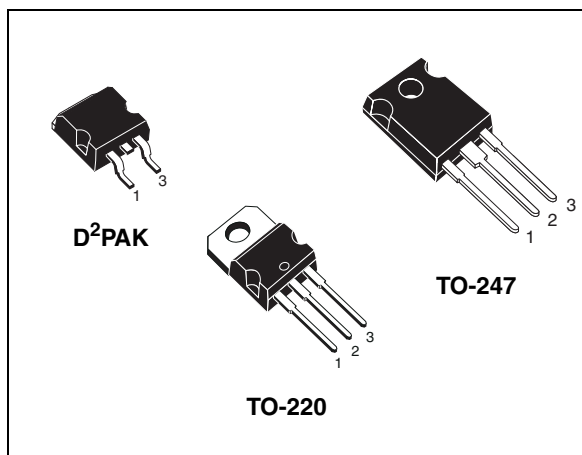
- High frequency operation
- Low  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)

## Applications

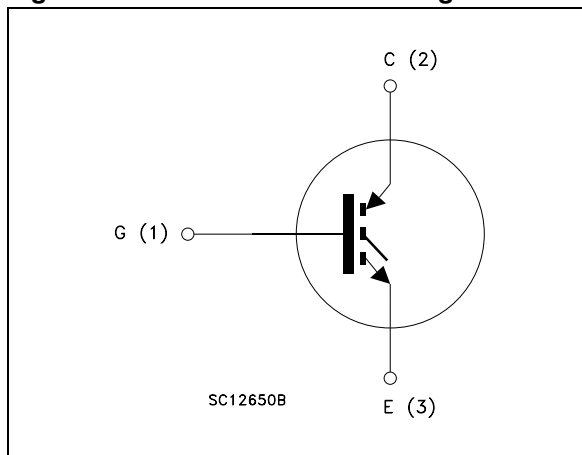
- High frequency motor controls, inverters, UPS
- HF, SMPS and PFC in both hard switch and resonant topologies

## 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 codes   | Marking   | Package | Packaging     |
|---------------|-----------|---------|---------------|
| STGB19NC60WT4 | GB19NC60W | D²PAK   | Tape and reel |
| STGP19NC60W   | P19NC60W  | TO-220  | Tube          |
| STGW19NC60W   | W19NC60W  | TO-247  | Tube          |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter                                                | Value                        |        | Unit |
|--------------------------------|----------------------------------------------------------|------------------------------|--------|------|
|                                |                                                          | D <sup>2</sup> PAK<br>TO-220 | TO-247 |      |
| V <sub>CES</sub>               | Collector-emitter voltage (V <sub>GE</sub> = 0)          | 600                          |        | V    |
| I <sub>C</sub> <sup>(1)</sup>  | Collector current (continuous) at T <sub>C</sub> = 25°C  | 40                           | 42     | A    |
| I <sub>C</sub> <sup>(1)</sup>  | Collector current (continuous) at T <sub>C</sub> = 100°C | 22                           | 23     | A    |
| I <sub>CL</sub> <sup>(2)</sup> | Turn-off latching current                                | 30                           |        | A    |
| V <sub>GE</sub>                | Gate-emitter voltage                                     | ±20                          |        | V    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25°C               | 130                          | 140    | W    |
| T <sub>j</sub>                 | Operating junction temperature                           | -65 to 150                   |        | °C   |

1. Calculated according to the iterative formula:

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

2. V<sub>CLAMP</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 15 V, R<sub>G</sub> = 10 Ω, T<sub>J</sub> = 150 °C

**Table 3. Thermal resistance**

| Symbol                | Parameter                               | Value                        |        | Unit |
|-----------------------|-----------------------------------------|------------------------------|--------|------|
|                       |                                         | D <sup>2</sup> PAK<br>TO-220 | TO-247 |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max    | 0.95                         | 0.9    | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max | 62.5                         | 50     | °C/W |

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}\text{C}$  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               | $V_{GE}=15\text{ V}$ , $I_C=12\text{ A}$<br>$V_{GE}=15\text{ V}$ , $I_C=12\text{ A}$ , $T_C=125^{\circ}\text{C}$ |      | 2.1<br>1.8 | 2.5       | V<br>V              |
| $V_{GE(th)}$  | Gate threshold voltage                             | $V_{CE}=V_{GE}$ , $I_C=250\text{ }\mu\text{A}$                                                                   | 3.75 |            | 5.75      | V                   |
| $I_{CES}$     | Collector cut-off current ( $V_{GE}=0$ )           | $V_{CE}=600\text{ V}$<br>$V_{CE}=600\text{ V}$ , $T_C=125^{\circ}\text{C}$                                       |      |            | 150<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                           | $V_{CE}=15\text{ V}$ , $I_C=12\text{ A}$                                                                         |      | 10         |           | S                   |

**Table 5. Dynamic**

| Symbol    | Parameter                    | Test conditions                                         | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---------------------------------------------------------|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE}=25\text{ V}$ , $f=1\text{ MHz}$ ,<br>$V_{GE}=0$ |      | 1180 |      | pF   |
| $C_{oes}$ | Output capacitance           |                                                         |      | 130  |      | pF   |
| $C_{res}$ | Reverse transfer capacitance |                                                         |      | 26   |      | pF   |
| $Q_g$     | Total gate charge            | $V_{CE}=390\text{ V}$ , $I_C=12\text{ A}$ ,             |      | 53   |      | nC   |
| $Q_{ge}$  | Gate-emitter charge          | $V_{GE}=15\text{ V}$ ,                                  |      | 10   |      | nC   |
| $Q_{gc}$  | Gate-collector charge        | <a href="#">Figure 16</a>                               |      | 21   |      | nC   |

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

| Symbol         | Parameter             | Test conditions                                                                                                                                          | Min. | Typ. | Max. | Unit       |
|----------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br><a href="#">Figure 17</a>                              |      | 25   |      | ns         |
| $t_r$          | Current rise time     |                                                                                                                                                          |      | 7    |      | ns         |
| $(di/dt)_{on}$ | Turn-on current slope |                                                                                                                                                          |      | 1600 |      | A/ $\mu$ s |
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125^\circ\text{C}$<br><a href="#">Figure 17</a> |      | 25   |      | ns         |
| $t_r$          | Current rise time     |                                                                                                                                                          |      | 8    |      | ns         |
| $(di/dt)_{on}$ | Turn-on current slope |                                                                                                                                                          |      | 1400 |      | A/ $\mu$ s |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br><a href="#">Figure 17</a>                              |      | 22   |      | ns         |
| $t_{d(off)}$   | Turn-off delay time   |                                                                                                                                                          |      | 90   |      | ns         |
| $t_f$          | Current fall time     |                                                                                                                                                          |      | 43   |      | ns         |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125^\circ\text{C}$<br><a href="#">Figure 17</a> |      | 47   |      | ns         |
| $t_{d(off)}$   | Turn-off delay time   |                                                                                                                                                          |      | 127  |      | ns         |
| $t_f$          | Current fall time     |                                                                                                                                                          |      | 77   |      | ns         |

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

| Symbol          | Parameter                 | Test conditions                                                                                                                                          | Min. | Typ. | Max. | Unit    |
|-----------------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------|
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br><a href="#">Figure 17</a>                              |      | 81   |      | $\mu$ J |
| $E_{off}^{(2)}$ | Turn-off switching losses |                                                                                                                                                          |      | 125  |      | $\mu$ J |
| $E_{ts}$        | Total switching losses    |                                                                                                                                                          |      | 206  |      | $\mu$ J |
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_C = 125^\circ\text{C}$<br><a href="#">Figure 17</a> |      | 161  |      | $\mu$ J |
| $E_{off}^{(2)}$ | Turn-off switching losses |                                                                                                                                                          |      | 255  |      | $\mu$ J |
| $E_{ts}$        | Total switching losses    |                                                                                                                                                          |      | 416  |      | $\mu$ J |

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in [Figure 15](#). If the IGBT is offered in a package with a co-pak diode, the co-pak diode is used as external diode. IGBTs & Diode are at the same temperature ( $25^\circ\text{C}$  and  $125^\circ\text{C}$ )
2. Turn-off losses include also the tail of the collector current

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

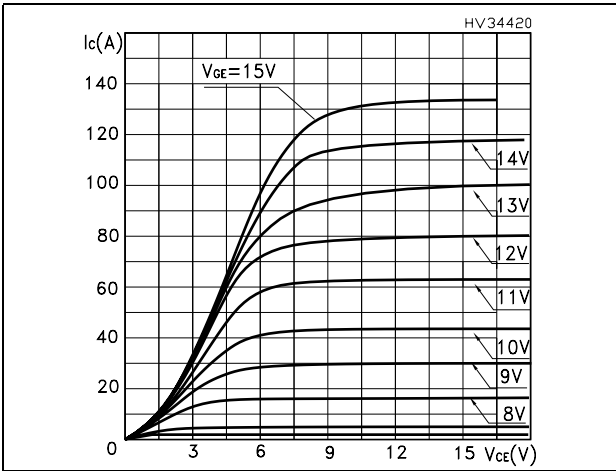


Figure 3. Transfer characteristics

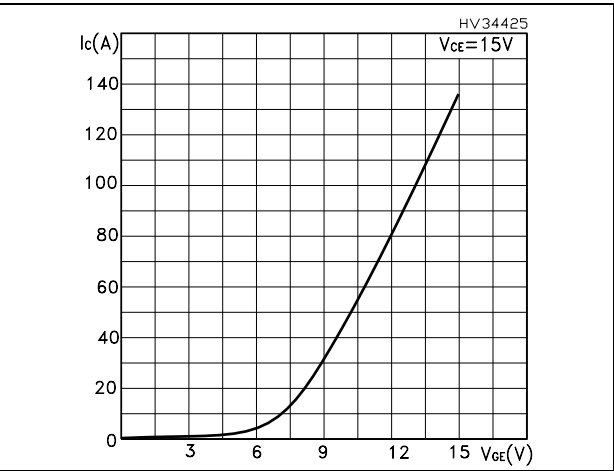


Figure 4. Transconductance

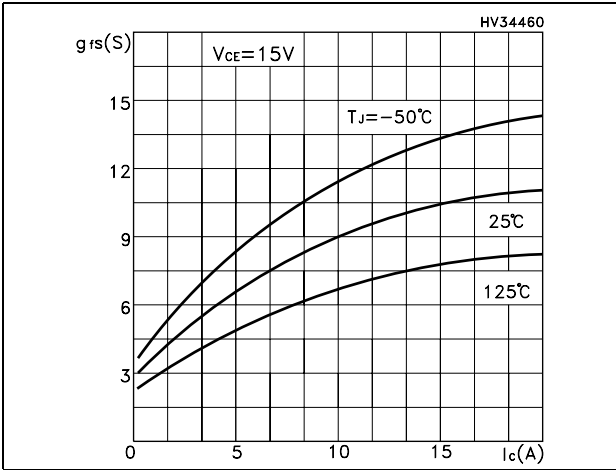


Figure 5. Collector-emitter on voltage vs temperature

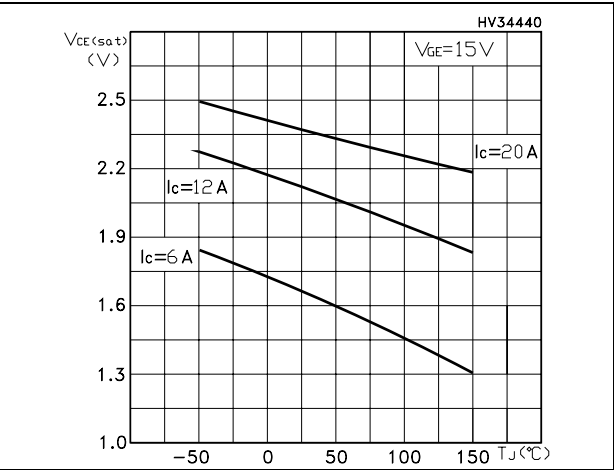


Figure 6. Gate charge vs gate-source voltage

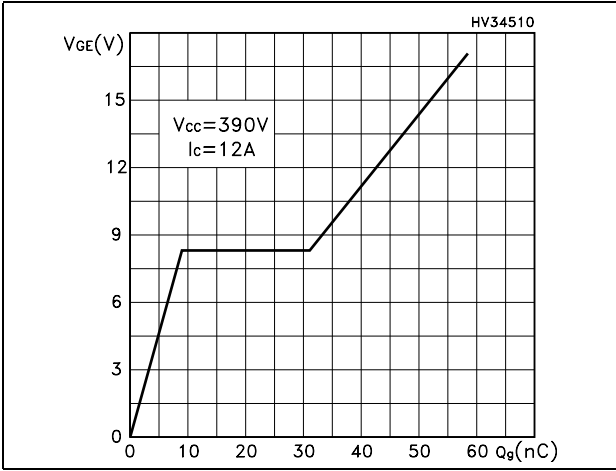


Figure 7. Capacitance variations

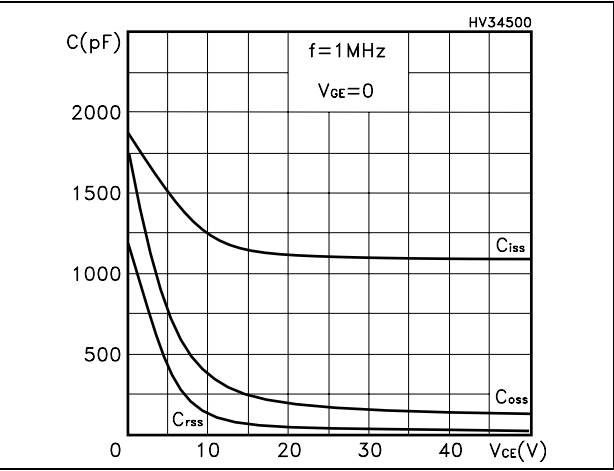


Figure 8. Normalized gate threshold voltage vs temperature

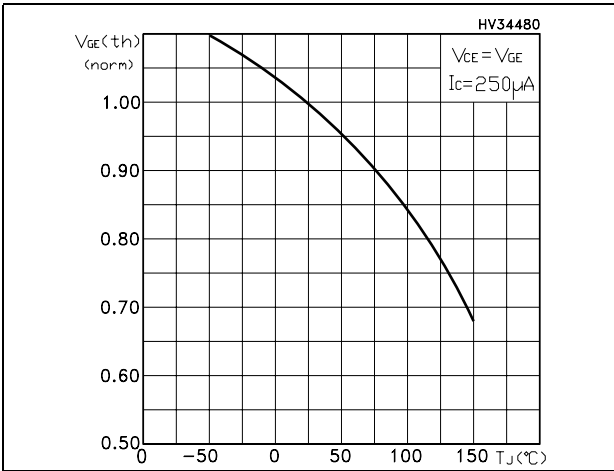


Figure 9. Collector-emitter on voltage vs collector current

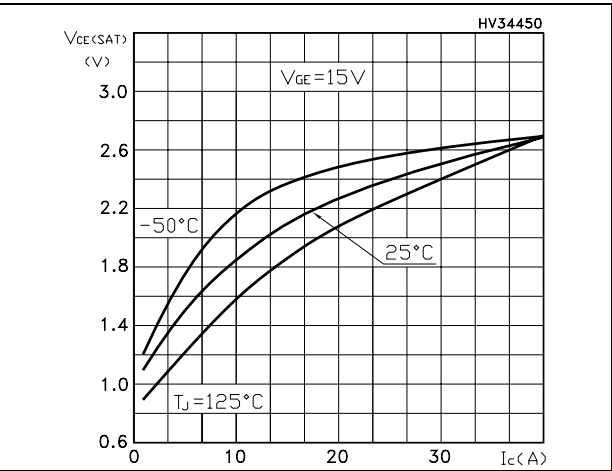


Figure 10. Normalized breakdown voltage vs temperature

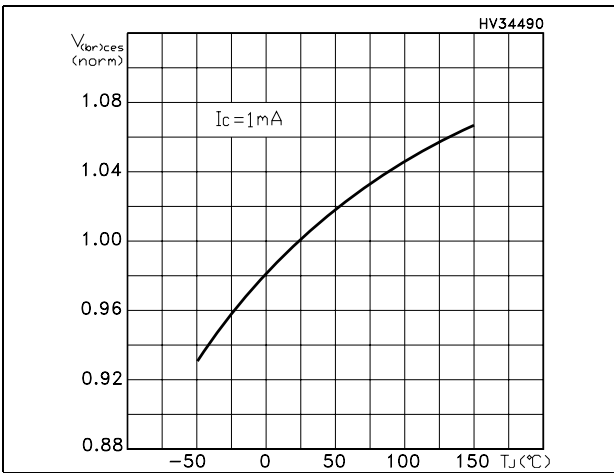


Figure 11. Switching losses vs temperature

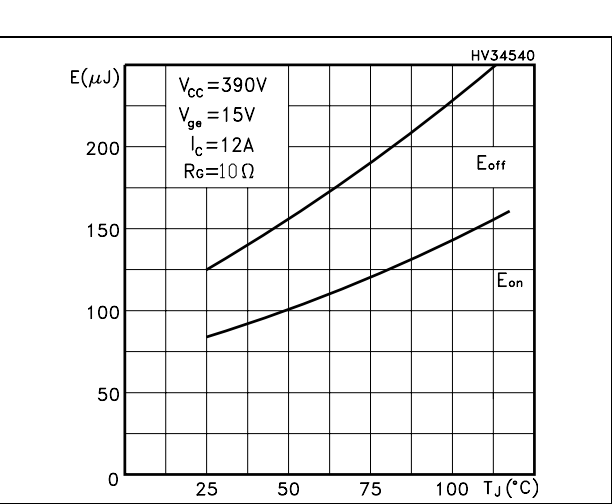


Figure 12. Switching losses vs gate resistance

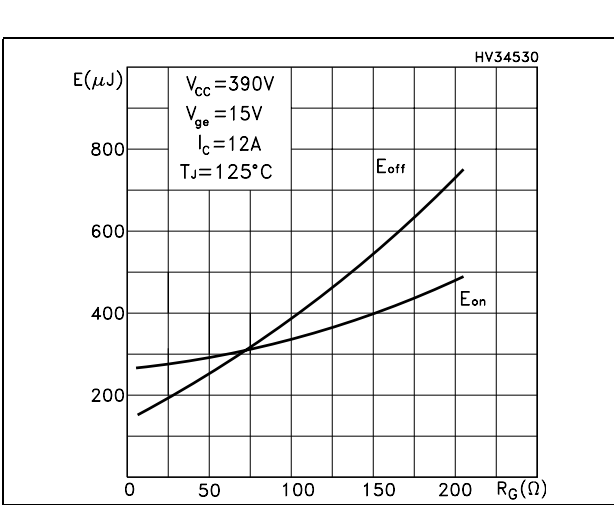


Figure 13. Switching losses vs collector current

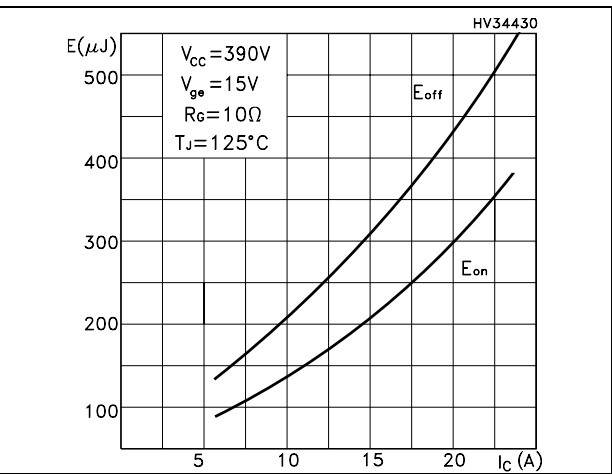
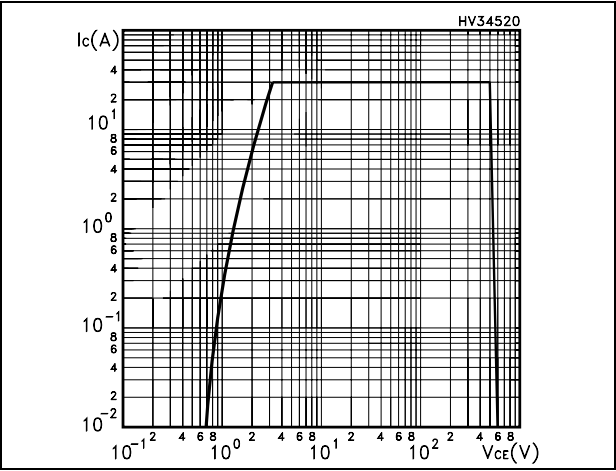


Figure 14. Turn-off SOA





### 3 Test circuit

Figure 15. Test circuit for inductive load switching

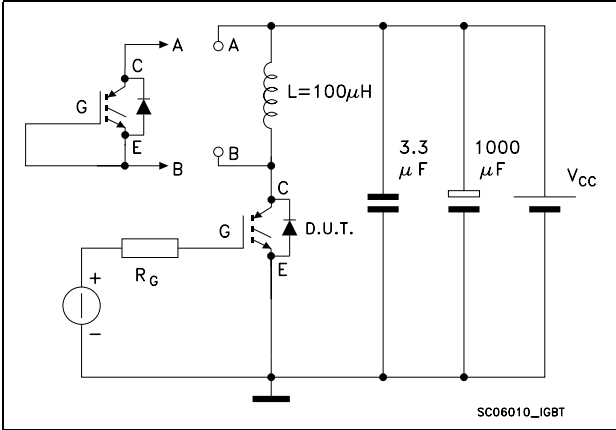


Figure 16. Gate charge test circuit

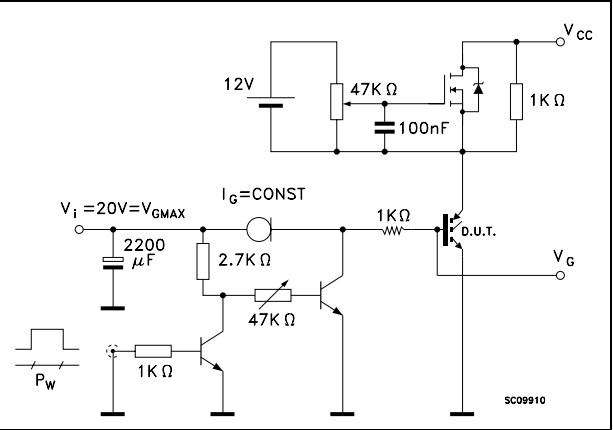
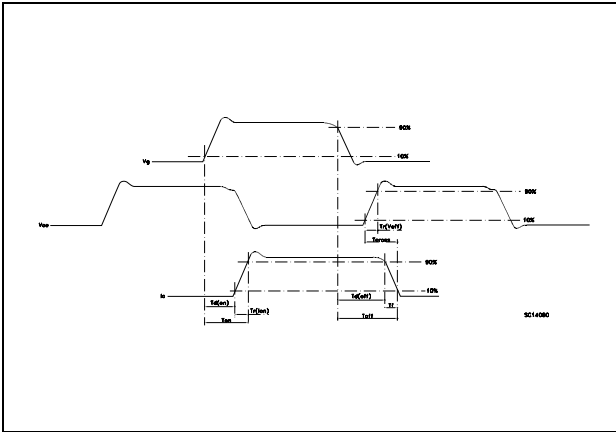


Figure 17. Switching waveform

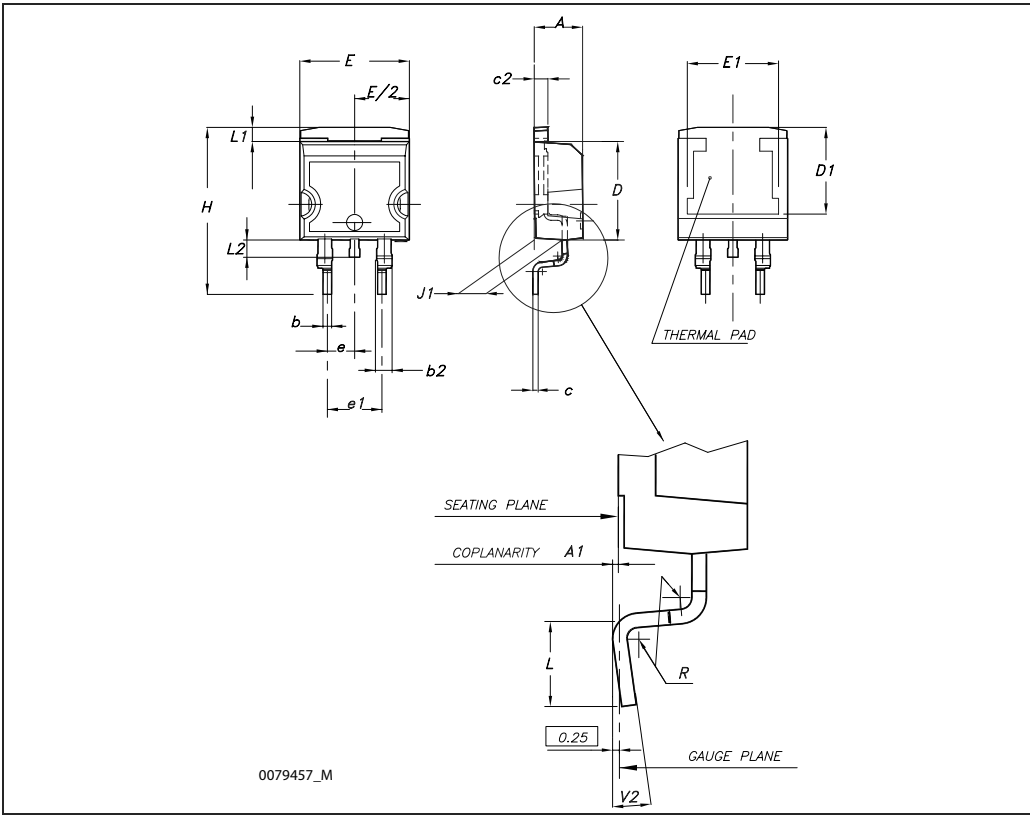


## 4 Package mechanical data

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)

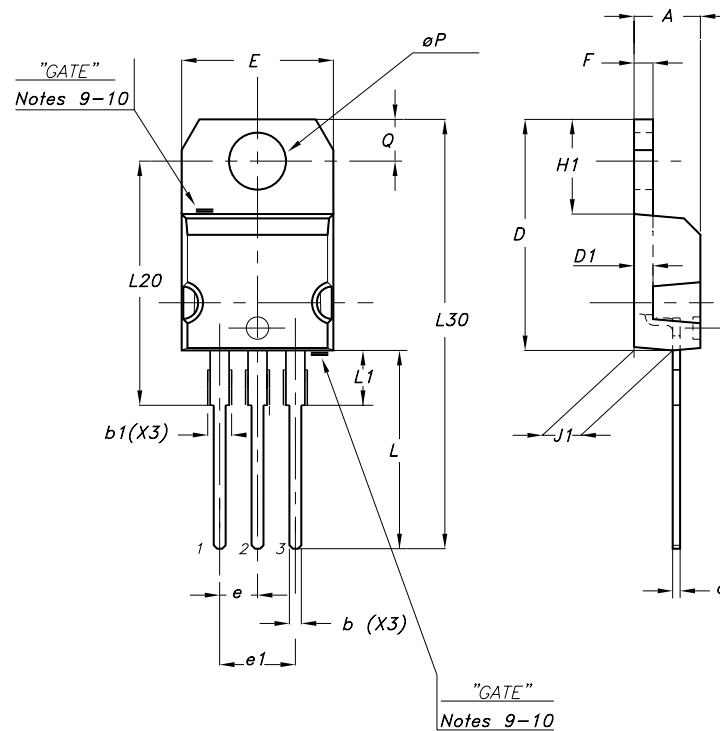
D<sup>2</sup>PAK (TO-263) mechanical data

| Dim | mm   |      |       | inch  |       |       |
|-----|------|------|-------|-------|-------|-------|
|     | Min  | Typ  | Max   | Min   | Typ   | Max   |
| A   | 4.40 |      | 4.60  | 0.173 |       | 0.181 |
| A1  | 0.03 |      | 0.23  | 0.001 |       | 0.009 |
| b   | 0.70 |      | 0.93  | 0.027 |       | 0.037 |
| b2  | 1.14 |      | 1.70  | 0.045 |       | 0.067 |
| c   | 0.45 |      | 0.60  | 0.017 |       | 0.024 |
| c2  | 1.23 |      | 1.36  | 0.048 |       | 0.053 |
| D   | 8.95 |      | 9.35  | 0.352 |       | 0.368 |
| D1  | 7.50 |      |       | 0.295 |       |       |
| E   | 10   |      | 10.40 | 0.394 |       | 0.409 |
| E1  | 8.50 |      |       | 0.334 |       |       |
| e   |      | 2.54 |       |       | 0.1   |       |
| e1  | 4.88 |      | 5.28  | 0.192 |       | 0.208 |
| H   | 15   |      | 15.85 | 0.590 |       | 0.624 |
| J1  | 2.49 |      | 2.69  | 0.099 |       | 0.106 |
| L   | 2.29 |      | 2.79  | 0.090 |       | 0.110 |
| L1  | 1.27 |      | 1.40  | 0.05  |       | 0.055 |
| L2  | 1.30 |      | 1.75  | 0.051 |       | 0.069 |
| R   |      | 0.4  |       |       | 0.016 |       |
| V2  | 0°   |      | 8°    | 0°    |       | 8°    |



## TO-220 mechanical data

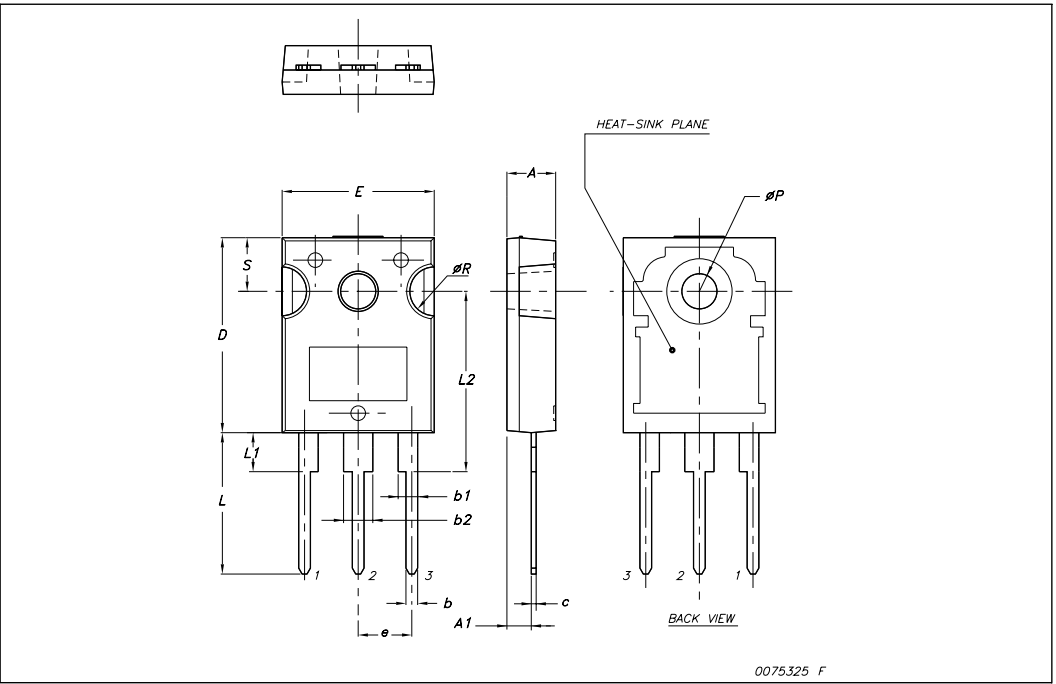
| Dim | mm    |       |       | inch  |       |       |
|-----|-------|-------|-------|-------|-------|-------|
|     | Min   | Typ   | Max   | Min   | Typ   | Max   |
| A   | 4.40  |       | 4.60  | 0.173 |       | 0.181 |
| b   | 0.61  |       | 0.88  | 0.024 |       | 0.034 |
| b1  | 1.14  |       | 1.70  | 0.044 |       | 0.066 |
| c   | 0.48  |       | 0.70  | 0.019 |       | 0.027 |
| D   | 15.25 |       | 15.75 | 0.6   |       | 0.62  |
| D1  |       | 1.27  |       |       | 0.050 |       |
| E   | 10    |       | 10.40 | 0.393 |       | 0.409 |
| e   | 2.40  |       | 2.70  | 0.094 |       | 0.106 |
| e1  | 4.95  |       | 5.15  | 0.194 |       | 0.202 |
| F   | 1.23  |       | 1.32  | 0.048 |       | 0.051 |
| H1  | 6.20  |       | 6.60  | 0.244 |       | 0.256 |
| J1  | 2.40  |       | 2.72  | 0.094 |       | 0.107 |
| L   | 13    |       | 14    | 0.511 |       | 0.551 |
| L1  | 3.50  |       | 3.93  | 0.137 |       | 0.154 |
| L20 |       | 16.40 |       |       | 0.645 |       |
| L30 |       | 28.90 |       |       | 1.137 |       |
| ØP  | 3.75  |       | 3.85  | 0.147 |       | 0.151 |
| Q   | 2.65  |       | 2.95  | 0.104 |       | 0.116 |



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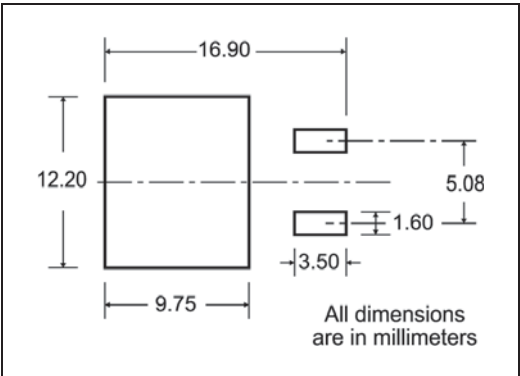
TO-247 Mechanical data

| 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  |       |

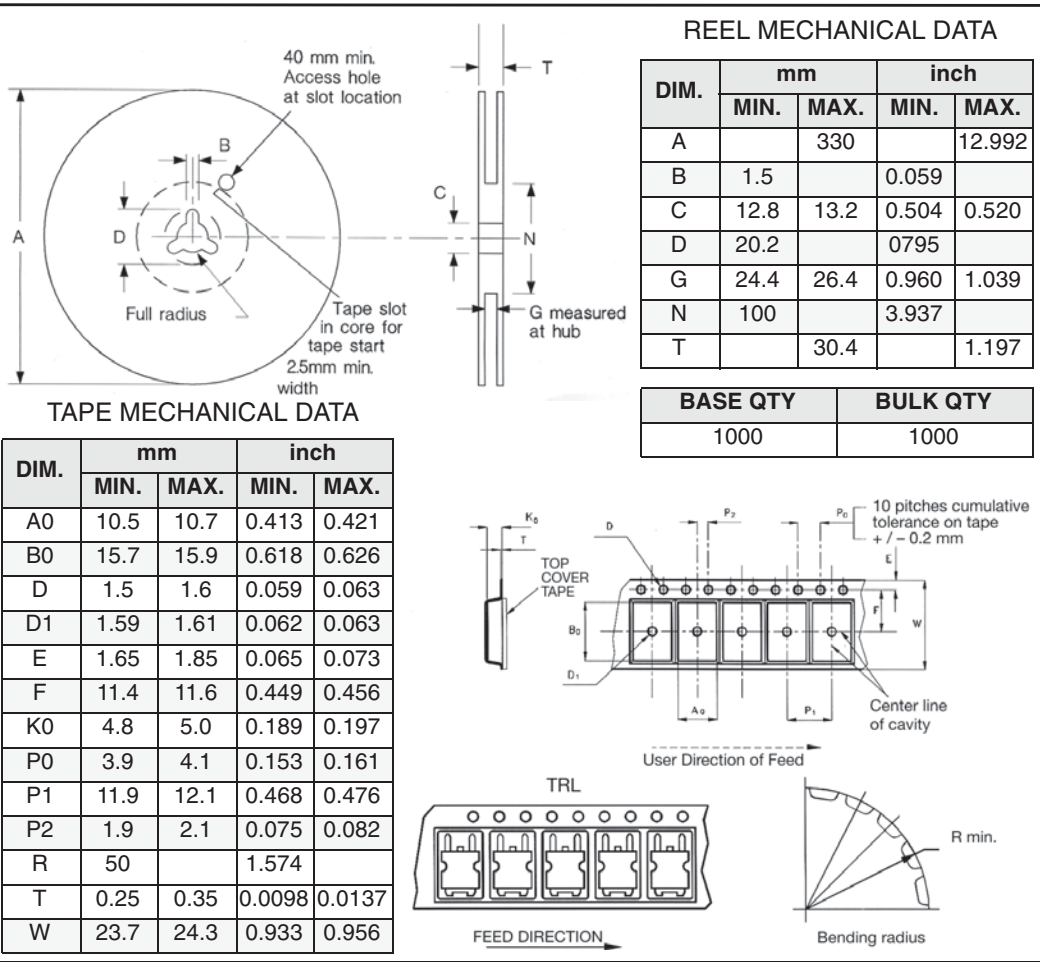


# 5 Packaging mechanical data

## D<sup>2</sup>PAK FOOTPRINT



## TAPE AND REEL SHIPMENT



## 6 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                          |
|-------------|----------|--------------------------------------------------|
| 04-Oct-2006 | 1        | Initial release.                                 |
| 08-May-2007 | 2        | Modified value on <a href="#">Table 2</a>        |
| 20-Nov-2008 | 3        | Inserted packages: D <sup>2</sup> PAK and TO-247 |

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