



# STGB14NC60K STGD14NC60K

N-channel 14A - 600V -DPAK - D<sup>2</sup>PAK  
Short circuit rated PowerMESH™ IGBT

## General features

| Type        | V <sub>CES</sub> | V <sub>CE(sat)</sub><br>(Max) @ 25°C | I <sub>C</sub><br>@ 100°C |
|-------------|------------------|--------------------------------------|---------------------------|
| STGB14NC60K | 600V             | <2.5V                                | 14A                       |
| STGD14NC60K | 600V             | <2.5V                                | 14A                       |

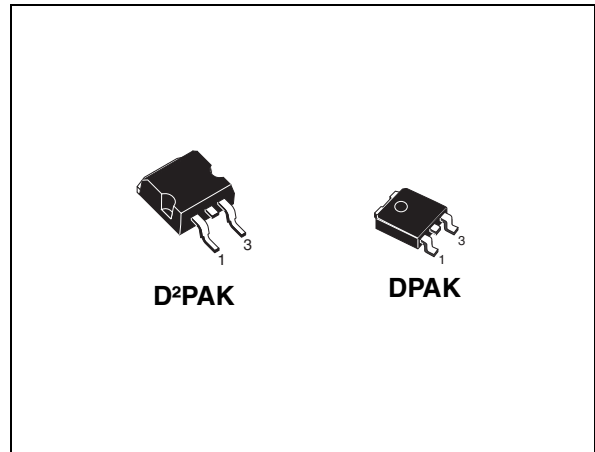
- Low on-voltage drop (V<sub>cesat</sub>)
- Low C<sub>res</sub> / C<sub>ies</sub> ratio ( no cross conduction susceptibility)
- Short circuit withstand time 10μs

## Description

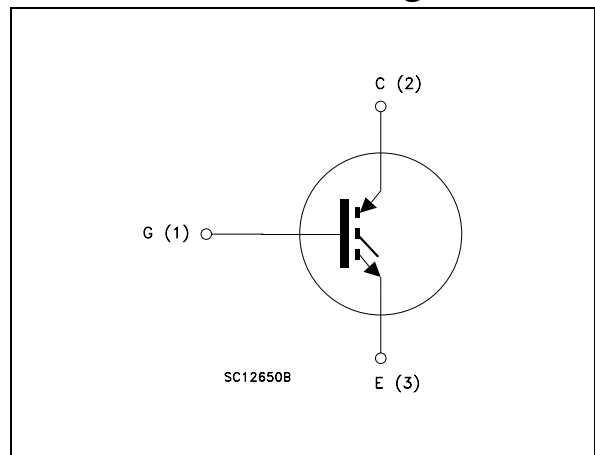
Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the Power MESH™ IGBTs, with outstanding performances. The suffix "K" identifies a family optimized for high frequency motor control applications with short circuit withstand capability.

## Applications

- High frequency inverters
- Motor drivers with short circuit protection



## Internal schematic diagram



## Order codes

| Part number   | Marking   | Package            | Packaging   |
|---------------|-----------|--------------------|-------------|
| STGB14NC60KT4 | GB14NC60K | D <sup>2</sup> PAK | Tape & reel |
| STGD14NC60KT4 | GD14NC60K | DPAK               | Tape & reel |

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter                                                                                                                         | Value       | Unit             |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------|------------------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GS} = 0$ )                                                                                        | 600         | V                |
| $I_C^{(1)}$    | Collector current (continuous) at $T_C = 25^\circ\text{C}$                                                                        | 25          | A                |
| $I_C^{(1)}$    | Collector current (continuous) at $T_C = 100^\circ\text{C}$                                                                       | 14          | A                |
| $I_{CL}^{(2)}$ | Collector current (pulsed)                                                                                                        | 50          | A                |
| $V_{GE}$       | Gate-emitter voltage                                                                                                              | $\pm 20$    | V                |
| $P_{TOT}$      | Total dissipation at $T_C = 25^\circ\text{C}$                                                                                     | 80          | W                |
| $t_{scw}$      | Short circuit withstand time, $V_{CE} = 0.5V_{BR(CES)}$ ,<br>$T_J = 125^\circ\text{C}$ , $R_G = 10\Omega$ , $V_{GE} = 12\text{V}$ | 10          | $\mu\text{s}$    |
| $T_{stg}$      | Storage temperature                                                                                                               | – 55 to 150 | $^\circ\text{C}$ |
| $T_J$          | Operating junction temperature                                                                                                    |             |                  |

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.  $V_{clamp} = 480\text{V}$ ,  $T_J = 150^\circ\text{C}$ ,  $R_G = 10\Omega$ ,  $V_{GE} = 15\text{V}$

**Table 2. Thermal resistance**

| Symbol         | Parameter                               | Value | Unit               |
|----------------|-----------------------------------------|-------|--------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max    | 1.25  | $^\circ\text{C/W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max | 62.5  | $^\circ\text{C/W}$ |

## 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                   |
| $I_{GES}$      | Gate-emitter leakage current ( $V_{CE} = 0$ ) | $V_{GE} = \pm 20\text{V}$ , $V_{CE} = 0$                                                                                |      |            | $\pm 100$ | nA                  |
| $I_{CES}$      | Collector cut-off current ( $V_{GE} = 0$ )    | $V_{CE} = \text{Max rating}$ , $T_C = 25^{\circ}\text{C}$<br>$V_{CE} = \text{Max rating}$ , $T_C = 125^{\circ}\text{C}$ |      |            | 150<br>1  | $\mu\text{A}$<br>mA |
| $V_{GE(th)}$   | Gate threshold voltage                        | $V_{CE} = V_{GE}$ , $I_C = 250\mu\text{A}$                                                                              | 4.5  |            | 6.5       | V                   |
| $V_{CE(SAT)}$  | Collector-emitter saturation voltage          | $V_{GE} = 15\text{V}$ , $I_C = 7\text{A}$<br>$V_{GE} = 15\text{V}$ , $I_C = 7\text{A}$ , $T_C = 125^{\circ}\text{C}$    |      | 2.0<br>1.8 | 2.5       | V<br>V              |
| $g_{fs}^{(1)}$ | Forward transconductance                      | $V_{CE} = 15\text{V}$ , $I_C = 7\text{A}$                                                                               |      | 3          |           | S                   |

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

**Table 4. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                          | Min. | Typ.                | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------|---------------------|------|----------------|
| $C_{ies}$<br>$C_{oes}$<br>$C_{res}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{CE} = 25\text{V}$ , $f = 1\text{MHz}$ , $V_{GE} = 0$                                 |      | 760<br>86<br>15.5   |      | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{ge}$<br>$Q_{gc}$       | Total gate charge<br>Gate-emitter charge<br>Gate-collector charge       | $V_{CE} = 390\text{V}$ , $I_C = 7\text{A}$ ,<br>$V_{GE} = 15\text{V}$<br>(see Figure 17) |      | 34.4<br>8.1<br>16.4 |      | nC<br>nC<br>nC |

**Table 5. Switching on/off (inductive load)**

| Symbol         | Parameter             | Test conditions                     | Min. | Typ. | Max. | Unit       |
|----------------|-----------------------|-------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 390V, I_C = 7A$           |      | 22.5 |      | ns         |
| $t_r$          | Current rise time     | $R_G = 10\Omega, V_{GE} = 15V,$     |      | 8.5  |      | ns         |
| $(di/dt)_{on}$ | Turn-on current slope | $T_J = 25^\circ C$ (see Figure 16)  |      | 700  |      | A/ $\mu s$ |
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 390V, I_C = 7A$           |      | 22   |      | ns         |
| $t_r$          | Current rise time     | $R_G = 10\Omega, V_{GE} = 15V,$     |      | 9.5  |      | ns         |
| $(di/dt)_{on}$ | Turn-on current slope | $T_J = 125^\circ C$ (see Figure 16) |      | 680  |      | A/ $\mu s$ |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390V, I_C = 7A,$          |      | 60   |      | ns         |
| $t_{d(off)}$   | Turn-off delay time   | $R_{GE} = 10\Omega, V_{GE} = 15V$   |      | 116  |      | ns         |
| $t_f$          | Current fall time     | $T_J = 25^\circ C$ (see Figure 16)  |      | 75   |      | ns         |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390V, I_C = 7A,$          |      | 24   |      | ns         |
| $t_{d(off)}$   | Turn-off delay time   | $R_{GE} = 10\Omega, V_{GE} = 15V$   |      | 196  |      | ns         |
| $t_f$          | Current fall time     | $T_J = 125^\circ C$ (see Figure 16) |      | 144  |      | ns         |

**Table 6. Switching energy (inductive load)**

| Symbol          | Parameter                 | Test conditions                     | Min | Typ. | Max | Unit    |
|-----------------|---------------------------|-------------------------------------|-----|------|-----|---------|
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CC} = 390V, I_C = 7A$           |     | 82   |     | $\mu J$ |
| $E_{off}^{(2)}$ | Turn-off switching losses | $R_G = 10\Omega, V_{GE} = 15V,$     |     | 155  |     | $\mu J$ |
| $E_{ts}$        | Total switching losses    | $T_J = 25^\circ C$ (see Figure 16)  |     | 237  |     | $\mu J$ |
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CC} = 390V, I_C = 7A$           |     | 131  |     | $\mu J$ |
| $E_{off}^{(2)}$ | Turn-off switching losses | $R_G = 10\Omega, V_{GE} = 15V,$     |     | 370  |     | $\mu J$ |
| $E_{ts}$        | Total switching losses    | $T_J = 125^\circ C$ (see Figure 16) |     | 501  |     | $\mu J$ |

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in figure 2. 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°C and 125°C)
2. Turn-off losses include also the tail of the collector current.

2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

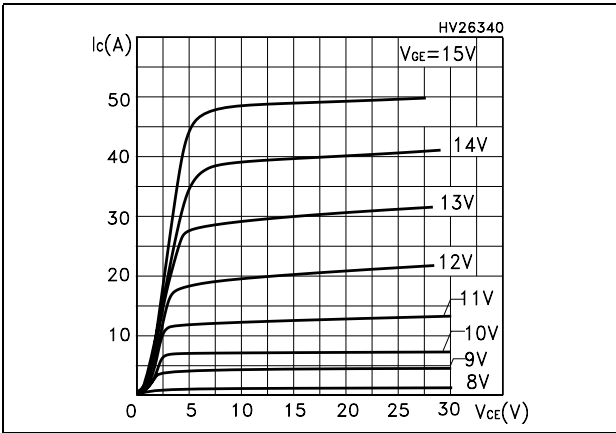


Figure 2. Transfer characteristics

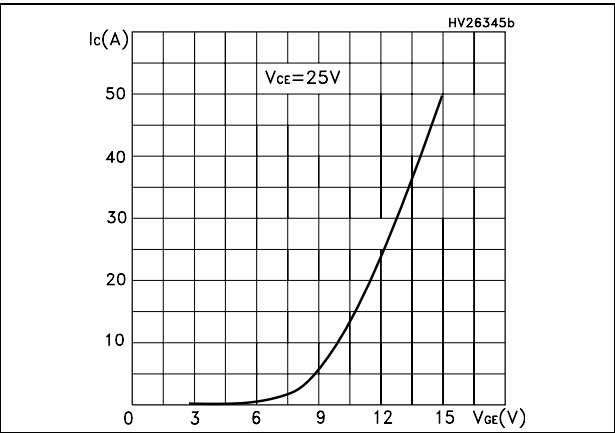


Figure 3. Transconductance

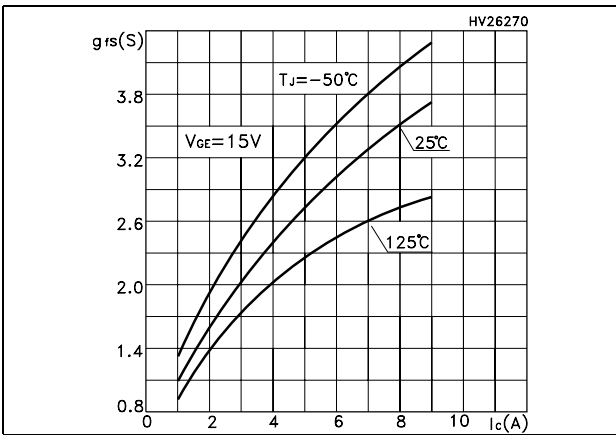


Figure 4. Collector-emitter on voltage vs temperature

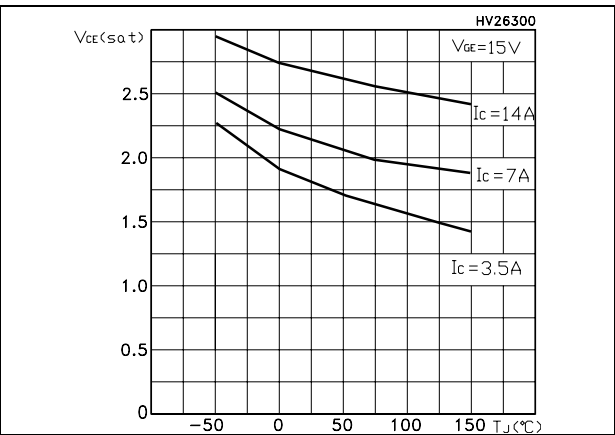


Figure 5. Collector-emitter on voltage vs collector current

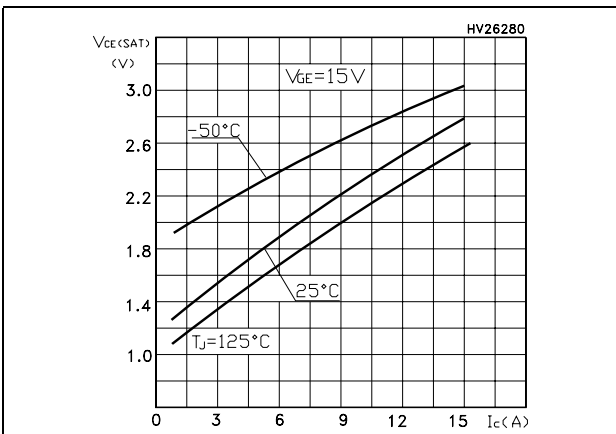


Figure 6. Normalized gate threshold vs temperature

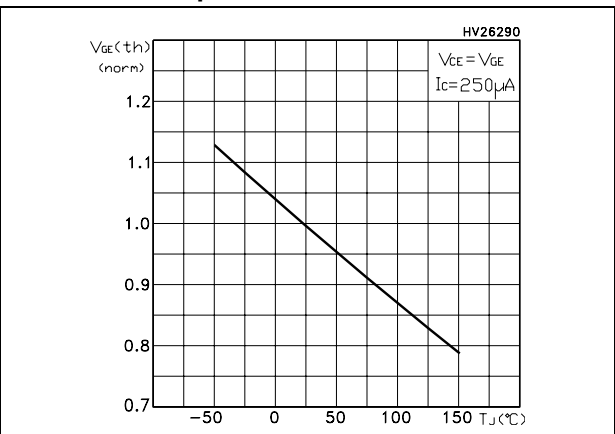


Figure 7. Normalized breakdown voltage vs temperature

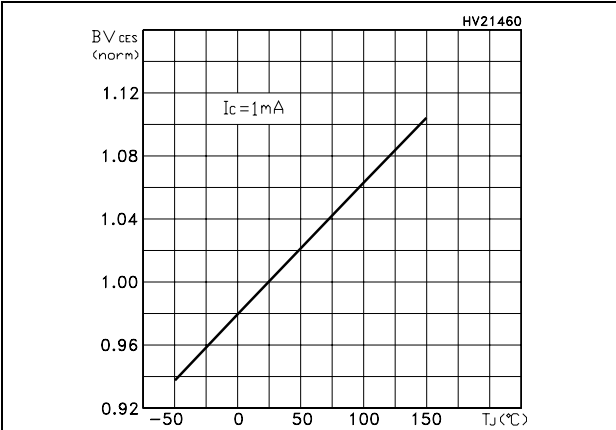


Figure 8. Gate charge vs gate-emitter voltage

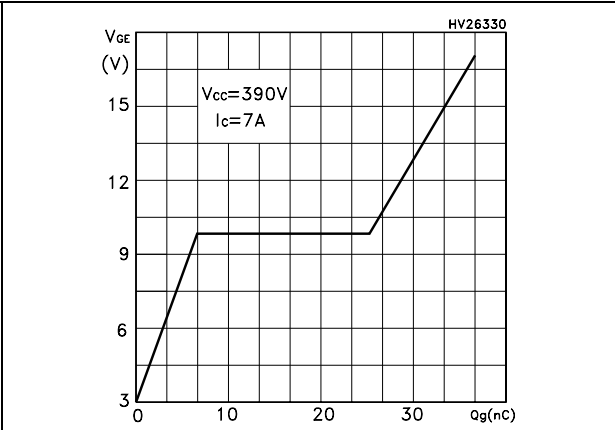


Figure 9. Capacitance variations

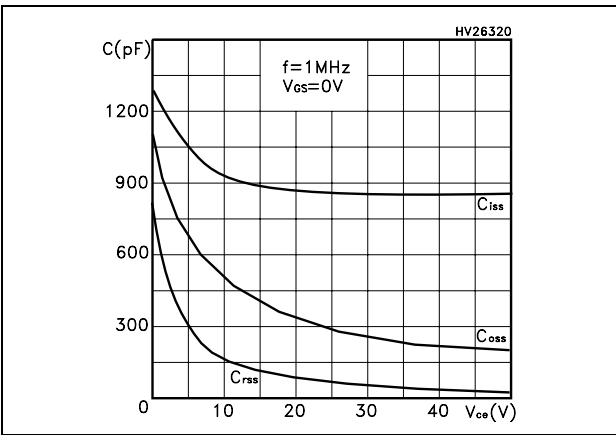


Figure 10. Switching losses vs temperature

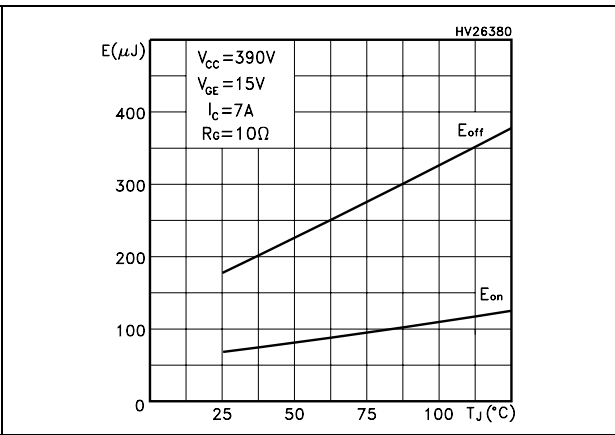


Figure 11. Switching losses vs gate resistance

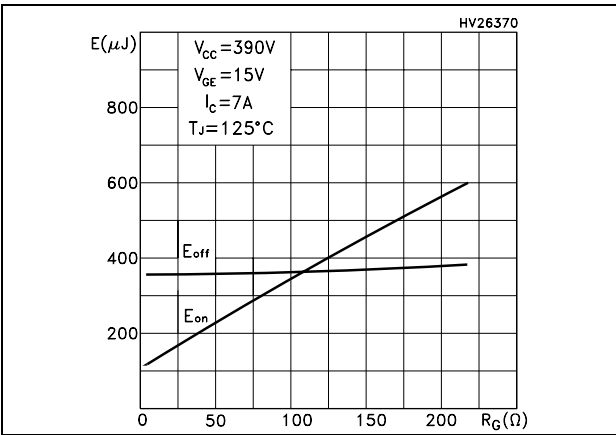


Figure 12. Switching losses vs collector current

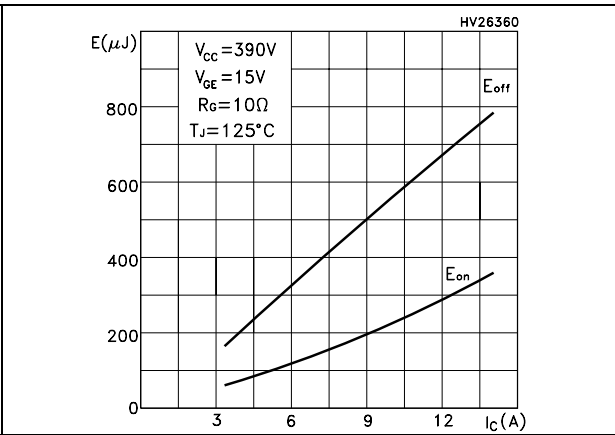


Figure 13. Thermal impedance

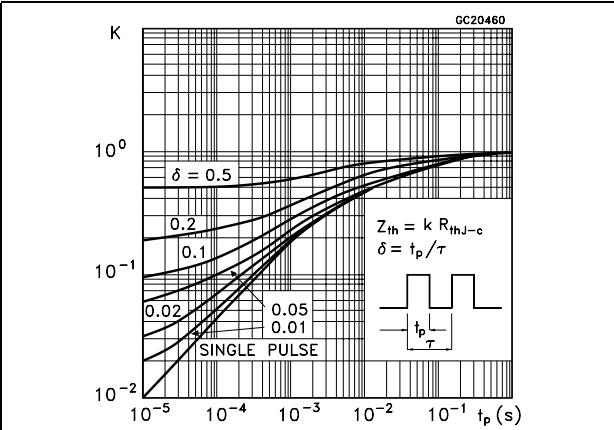


Figure 14. Turn-off SOA

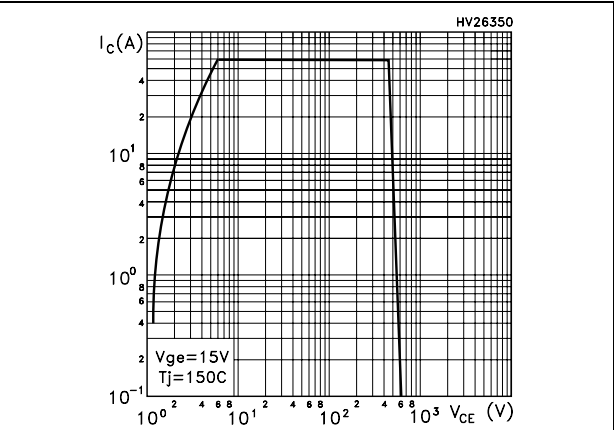
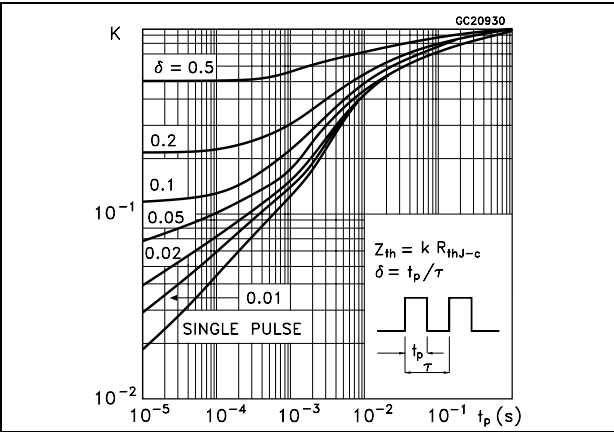


Figure 15. Thermal impedance for D<sup>2</sup>PAK



### 3 Test circuit

Figure 16. Test circuit for inductive load switching

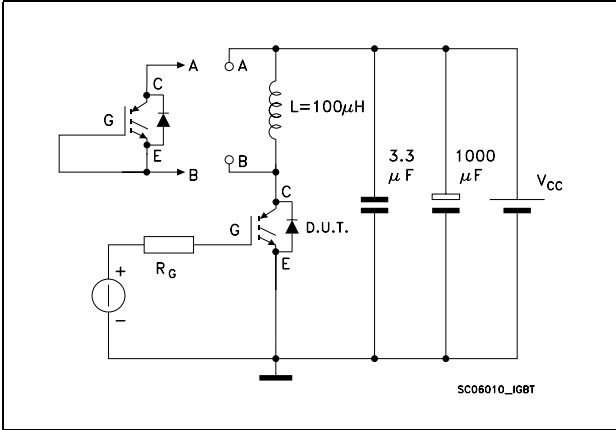


Figure 17. Gate charge test circuit

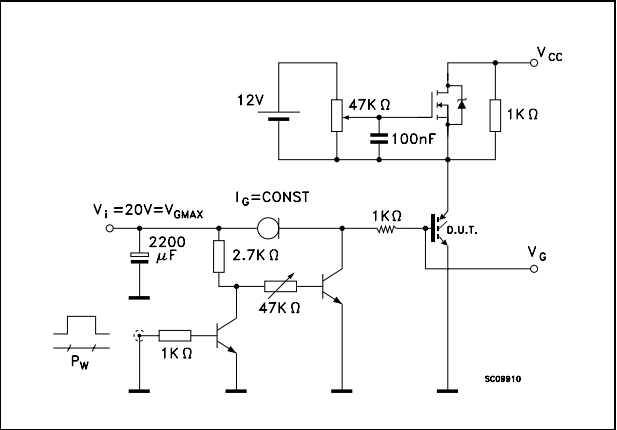


Figure 18. Switching waveforms

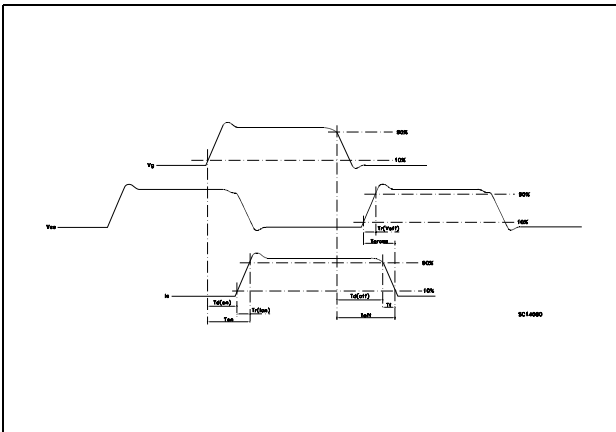
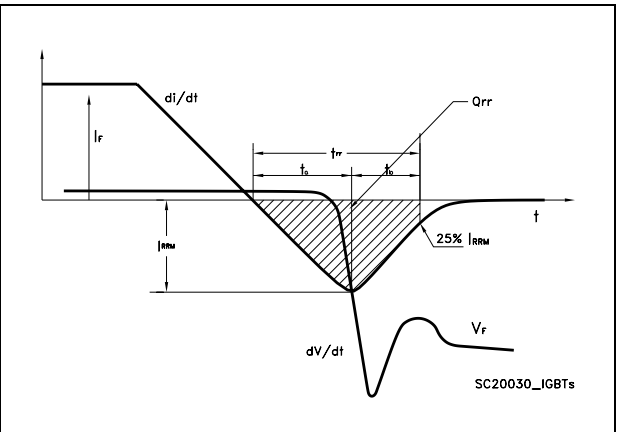


Figure 19. Diode recovery times waveform

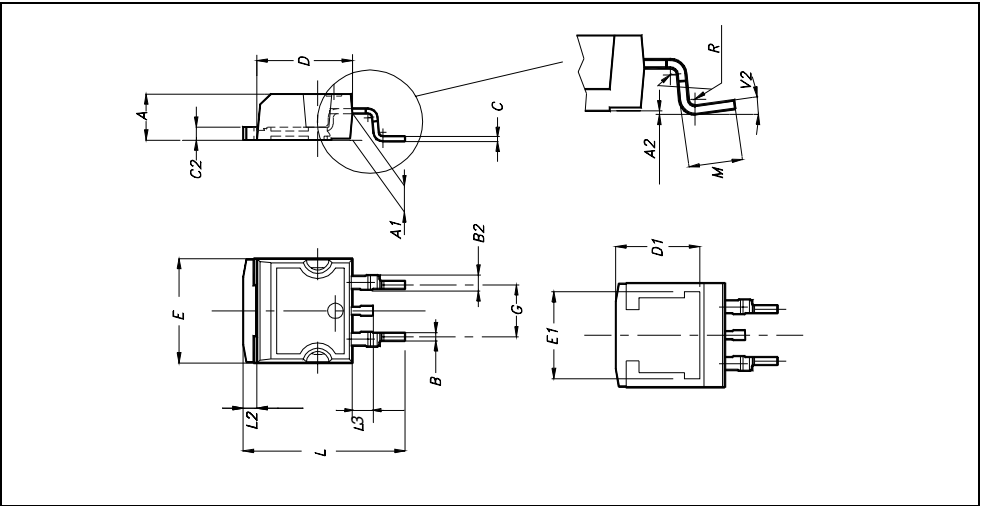


## 4 Package mechanical data

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 MECHANICAL DATA

| DIM. | mm.  |     |       | inch  |       |       |
|------|------|-----|-------|-------|-------|-------|
|      | MIN. | TYP | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |     | 4.6   | 0.173 |       | 0.181 |
| A1   | 2.49 |     | 2.69  | 0.098 |       | 0.106 |
| A2   | 0.03 |     | 0.23  | 0.001 |       | 0.009 |
| B    | 0.7  |     | 0.93  | 0.027 |       | 0.036 |
| B2   | 1.14 |     | 1.7   | 0.044 |       | 0.067 |
| C    | 0.45 |     | 0.6   | 0.017 |       | 0.023 |
| C2   | 1.23 |     | 1.36  | 0.048 |       | 0.053 |
| D    | 8.95 |     | 9.35  | 0.352 |       | 0.368 |
| D1   |      | 8   |       |       | 0.315 |       |
| E    | 10   |     | 10.4  | 0.393 |       |       |
| E1   |      | 8.5 |       |       | 0.334 |       |
| G    | 4.88 |     | 5.28  | 0.192 |       | 0.208 |
| L    | 15   |     | 15.85 | 0.590 |       | 0.625 |
| L2   | 1.27 |     | 1.4   | 0.050 |       | 0.055 |
| L3   | 1.4  |     | 1.75  | 0.055 |       | 0.068 |
| M    | 2.4  |     | 3.2   | 0.094 |       | 0.126 |
| R    |      | 0.4 |       |       | 0.015 |       |
| V2   | 0°   |     | 4°    |       |       |       |



| DPAK MECHANICAL DATA |      |      |      |       |       |       |
|----------------------|------|------|------|-------|-------|-------|
| DIM.                 | mm.  |      |      | inch  |       |       |
|                      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A                    | 2.2  |      | 2.4  | 0.086 |       | 0.094 |
| A1                   | 0.9  |      | 1.1  | 0.035 |       | 0.043 |
| A2                   | 0.03 |      | 0.23 | 0.001 |       | 0.009 |
| B                    | 0.64 |      | 0.9  | 0.025 |       | 0.035 |
| b4                   | 5.2  |      | 5.4  | 0.204 |       | 0.212 |
| C                    | 0.45 |      | 0.6  | 0.017 |       | 0.023 |
| C2                   | 0.48 |      | 0.6  | 0.019 |       | 0.023 |
| D                    | 6    |      | 6.2  | 0.236 |       | 0.244 |
| D1                   |      | 5.1  |      |       | 0.200 |       |
| E                    | 6.4  |      | 6.6  | 0.252 |       | 0.260 |
| E1                   |      | 4.7  |      |       | 0.185 |       |
| e                    |      | 2.28 |      |       | 0.090 |       |
| e1                   | 4.4  |      | 4.6  | 0.173 |       | 0.181 |
| H                    | 9.35 |      | 10.1 | 0.368 |       | 0.397 |
| L                    | 1    |      |      | 0.039 |       |       |
| (L1)                 |      | 2.8  |      |       | 0.110 |       |
| L2                   |      | 0.8  |      |       | 0.031 |       |
| L4                   | 0.6  |      | 1    | 0.023 |       | 0.039 |
| R                    |      | 0.2  |      |       | 0.008 |       |
| V2                   | 0°   |      | 8°   | 0°    |       | 8°    |

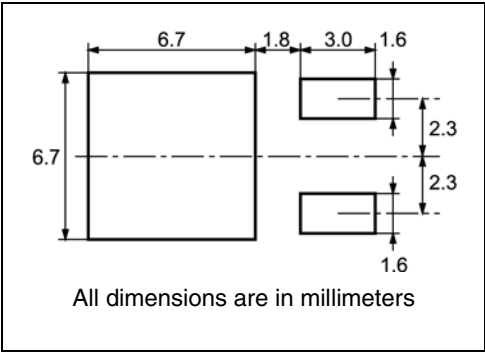
  

The mechanical drawing illustrates the DPAK package geometry. It includes a top view showing dimensions E, b4, L2, L4, H, e, e1, and L. A side view shows dimensions A, A1, A2, C2, D, D1, E1, and C. A detail view of the lead shows dimensions L1, L, V2, and a 0.25 gauge plane. A thermal pad is also indicated.

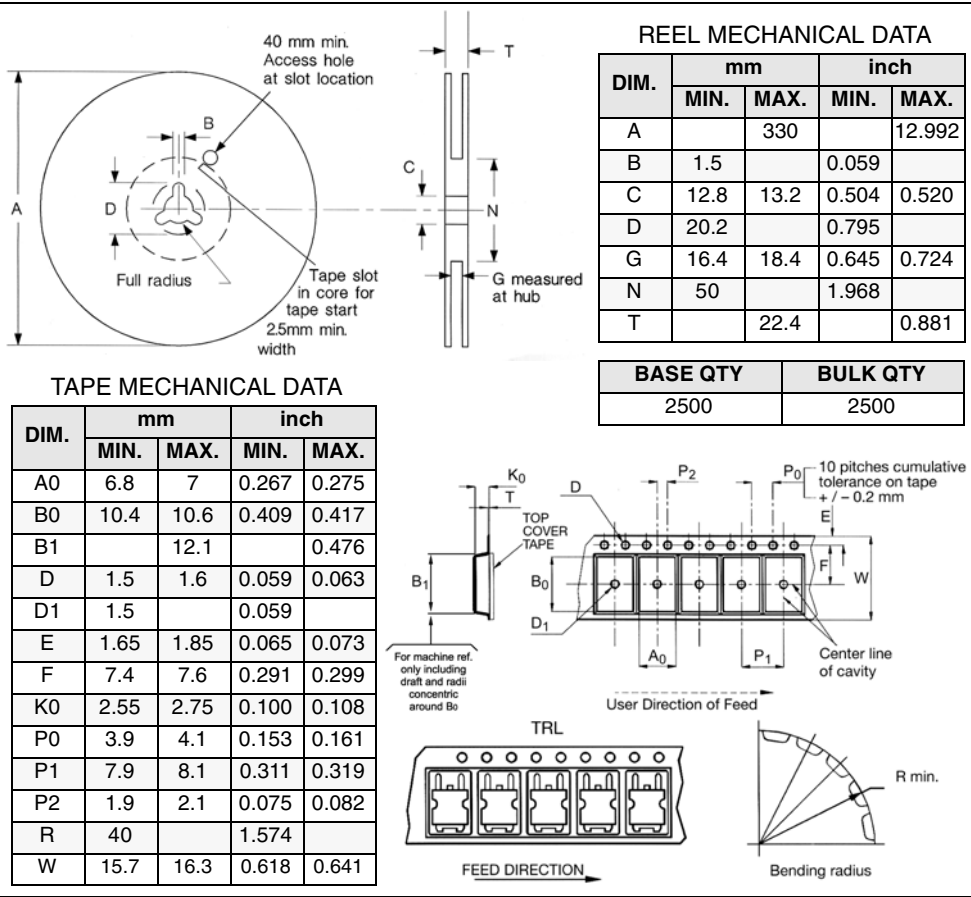
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# 5 Packaging mechanical data

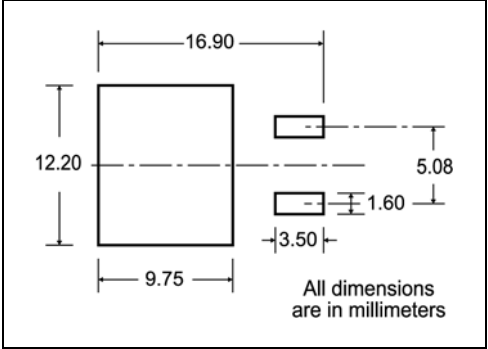
## DPAK FOOTPRINT



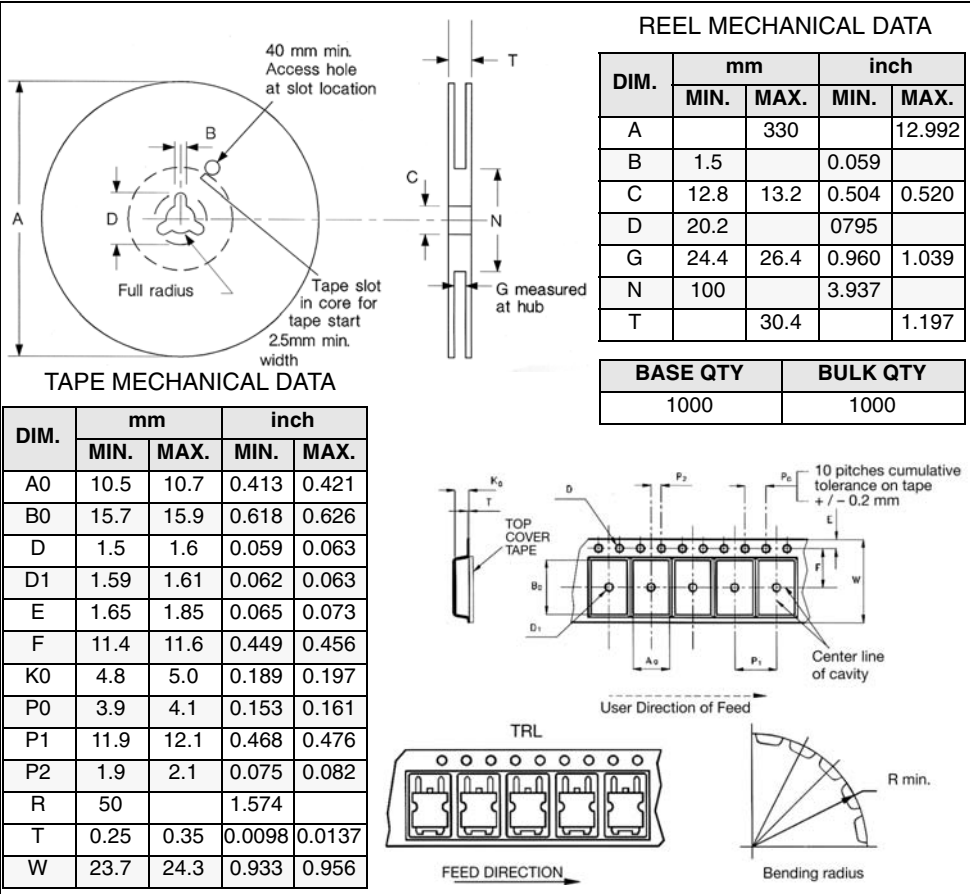
## TAPE AND REEL SHIPMENT



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



### TAPE AND REEL SHIPMENT



\* on sales type

## 6 Revision history

**Table 7. Revision history**

| <b>Date</b> | <b>Revision</b> | <b>Changes</b> |
|-------------|-----------------|----------------|
| 12-Jul-2006 | 1               | New release    |

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