



# STGB8NC60KD - STGD8NC60KD STGF8NC60KD - STGP8NC60KD

600 V - 8 A - short circuit rugged IGBT

## Features

- Lower on voltage drop ( $V_{CE(sat)}$ )
- Lower  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode
- Short circuit withstand time 10  $\mu s$

## Applications

- High frequency motor controls
- SMPS and PFC in both hard switch and resonant topologies
- Motor drivers

## Description

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

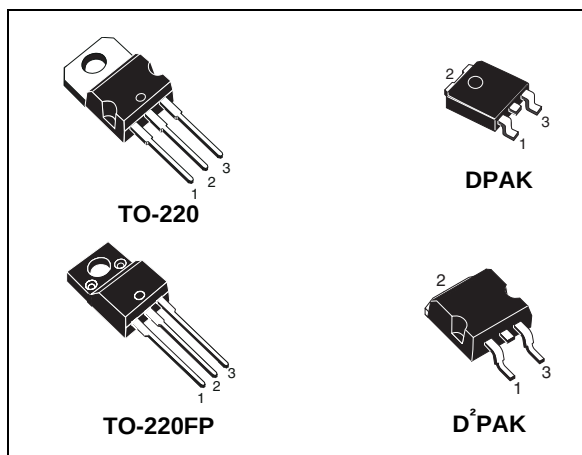


Figure 1. Internal schematic diagram

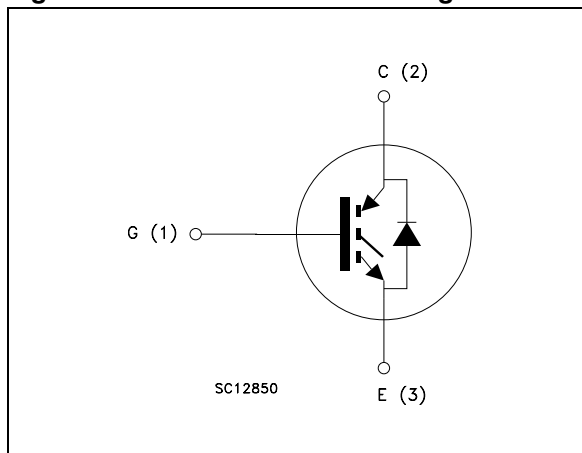


Table 1. Device summary

| Order codes   | Marking   | Package  | Packaging     |
|---------------|-----------|----------|---------------|
| STGB8NC60KDT4 | GB8NC60KD | D²PAK    | Tape and reel |
| STGD8NC60KDT4 | GD8NC60KD | DPAK     | Tape and reel |
| STGF8NC60KD   | GF8NC60KD | TO-220FP | Tube          |
| STGP8NC60KD   | GP8NC60KD | TO-220   | 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 | DPAK | TO-220FP |      |
| 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                                                                                              | 15                           |      | 7        | A    |
| I <sub>C</sub> <sup>(1)</sup>  | Collector current (continuous) at T <sub>C</sub> = 100 °C                                                                                             | 8                            |      | 4        | A    |
| I <sub>CL</sub> <sup>(2)</sup> | Turn-off latching current                                                                                                                             | 30                           |      |          | A    |
| I <sub>CP</sub> <sup>(3)</sup> | Pulsed collector current                                                                                                                              | 30                           |      |          | A    |
| V <sub>GE</sub>                | Gate-emitter voltage                                                                                                                                  | ±20                          |      |          | V    |
| I <sub>F</sub>                 | Diode RMS forward current at T <sub>C</sub> = 25 °C                                                                                                   | 7                            |      |          | A    |
| I <sub>FSM</sub>               | Surge not repetitive forward current<br>t <sub>p</sub> = 10 ms sinusoidal                                                                             | 20                           |      |          | A    |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat sink<br>(t = 1 s; T <sub>C</sub> = 25 °C)                                    | --                           | --   | 2500     | V    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                                                           | 65                           | 62   | 24       | W    |
| T <sub>j</sub>                 | Operating junction temperature                                                                                                                        | – 55 to 150                  |      |          | °C   |
| T <sub>scw</sub>               | Short circuit withstand time<br>(V <sub>CE</sub> = 0.5 V <sub>BR(CES)</sub> , T <sub>C</sub> = 125 °C, R <sub>G</sub> = 10 Ω, V <sub>GE</sub> = 12 V) | 10                           |      |          | µs   |

1. Calculated according to the iterative formula:

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

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

3. Pulse width limited by max junction temperature allowed

**Table 3. Thermal resistance**

| Symbol                | Parameter                                  | Value                        |      |          | Unit |
|-----------------------|--------------------------------------------|------------------------------|------|----------|------|
|                       |                                            | D <sup>2</sup> PAK<br>TO-220 | DPAK | TO-220FP |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max IGBT  | 1.9                          | 2.0  | 5.1      | °C/W |
| R <sub>thj-case</sub> | Thermal resistance junction-case max diode | 4                            | 4.5  | 7        | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max    | 62.5                         |      |          | °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               | $V_{GE}=15\text{ V}$ , $I_C = 3\text{ A}$<br>$V_{GE}=15\text{ V}$ , $I_C = 3\text{ A}$ , $T_C = 125^{\circ}\text{C}$ |      | 2.2<br>1.8 | 2.75      | V<br>V              |
| $V_{GE(th)}$   | Gate threshold voltage                             | $V_{CE}=V_{GE}$ , $I_C = 250\text{ }\mu\text{A}$                                                                     | 4.5  |            | 6.5       | 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                  |
| $g_{fs}^{(1)}$ | Forward transconductance                           | $V_{CE}=15\text{ V}$ , $I_C = 3\text{ A}$                                                                            |      | 1.9        |           | S                   |

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

**Table 5. 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 | $V_{CE}=25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GE}=0$                                 |      | 380<br>46<br>8.5 |      | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{ge}$<br>$Q_{gc}$       | Total gate charge<br>Gate-emitter charge<br>Gate-collector charge       | $V_{CE}=390\text{ V}$ , $I_C = 3\text{ A}$ ,<br>$V_{GE}=15\text{ V}$ ,<br>(see Figure 20) |      | 19<br>5<br>9     |      | nC<br>nC<br>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) <sub>on</sub> | Turn-on delay time<br>Current rise time<br>Turn-on current slope | $V_{CC}=390\text{ V}$ , $I_C = 3\text{ A}$<br>$R_G = 10\text{ }\Omega$ , $V_{GE}=15\text{ V}$<br>(see Figure 21)                                  |      | 17<br>6<br>655     |      | ns<br>ns<br>A/ $\mu\text{s}$ |
| $t_{d(on)}$<br>$t_r$<br>(di/dt) <sub>on</sub> | Turn-on delay time<br>Current rise time<br>Turn-on current slope | $V_{CC}=390\text{ V}$ , $I_C = 3\text{ A}$<br>$R_G = 10\text{ }\Omega$ , $V_{GE}=15\text{ V}$ ,<br>$T_C = 125^{\circ}\text{C}$<br>(see Figure 21) |      | 16.5<br>6.5<br>575 |      | ns<br>ns<br>A/ $\mu\text{s}$ |

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

| Symbol         | Parameter             | Test conditions                                      | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|------------------------------------------------------|------|------|------|------|
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$ ,       |      | 33   |      | ns   |
| $t_{d(off)}$   | Turn-off delay time   | $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$       |      | 72   |      | ns   |
| $t_f$          | Current fall time     | (see Figure 21)                                      |      | 82   |      | ns   |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$ ,       |      | 60   |      | ns   |
| $t_{d(off)}$   | Turn-off delay time   | $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,     |      | 106  |      | ns   |
| $t_f$          | Current fall time     | $T_C = 125\text{ }^\circ\text{C}$<br>(see Figure 21) |      | 136  |      | ns   |

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

| Symbol          | Parameter                 | Test conditions                                      | Min. | Typ. | Max. | Unit          |
|-----------------|---------------------------|------------------------------------------------------|------|------|------|---------------|
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$         |      | 55   |      | $\mu\text{J}$ |
| $E_{off}^{(2)}$ | Turn-off switching losses | $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$          |      | 85   |      | $\mu\text{J}$ |
| $E_{ts}$        | Total switching losses    | (see Figure 21)                                      |      | 140  |      | $\mu\text{J}$ |
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CC} = 390\text{ V}$ , $I_C = 3\text{ A}$         |      | 87   |      | $\mu\text{J}$ |
| $E_{off}^{(2)}$ | Turn-off switching losses | $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,        |      | 162  |      | $\mu\text{J}$ |
| $E_{ts}$        | Total switching losses    | $T_C = 125\text{ }^\circ\text{C}$<br>(see Figure 21) |      | 249  |      | $\mu\text{J}$ |

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-pak diode, the co-pak 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

**Table 8. Collector-emitter diode**

| Symbol    | Parameter                | Test conditions                                                              | Min. | Typ.       | Max. | Unit   |
|-----------|--------------------------|------------------------------------------------------------------------------|------|------------|------|--------|
| $V_F$     | Forward on-voltage       | $I_F = 3\text{ A}$<br>$I_F = 3\text{ A}$ , $T_C = 125\text{ }^\circ\text{C}$ |      | 1.6<br>1.3 | 2.1  | V<br>V |
| $t_{rr}$  | Reverse recovery time    | $I_F = 3\text{ A}$ , $V_R = 30\text{ V}$ ,                                   |      | 23.5       |      | ns     |
| $Q_{rr}$  | Reverse recovery charge  | $di/dt = 100\text{ A}/\mu\text{s}$                                           |      | 16.5       |      | nC     |
| $I_{rrm}$ | Reverse recovery current | (see Figure 22)                                                              |      | 1.4        |      | A      |
| $t_{rr}$  | Reverse recovery time    | $I_F = 3\text{ A}$ , $V_R = 30\text{ V}$ ,                                   |      | 39         |      | ns     |
| $Q_{rr}$  | Reverse recovery charge  | $T_C = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$       |      | 39         |      | nC     |
| $I_{rrm}$ | Reverse recovery current | (see Figure 22)                                                              |      | 2          |      | A      |

## 2.1      Electrical characteristics (curves)

Figure 2.      Output characteristics

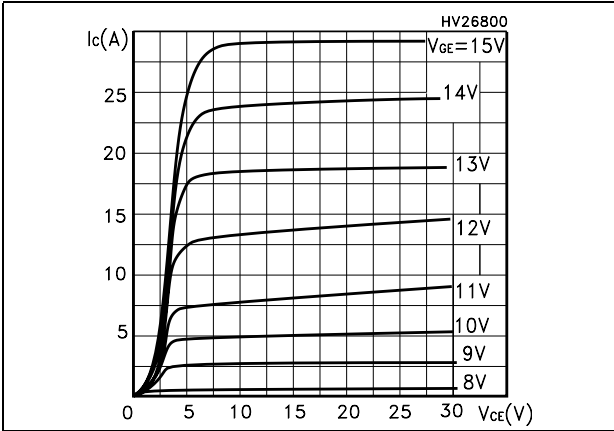


Figure 3.      Transfer characteristics

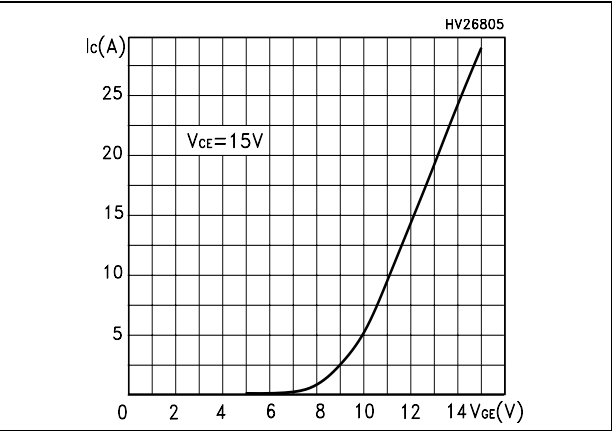


Figure 4.      Transconductance

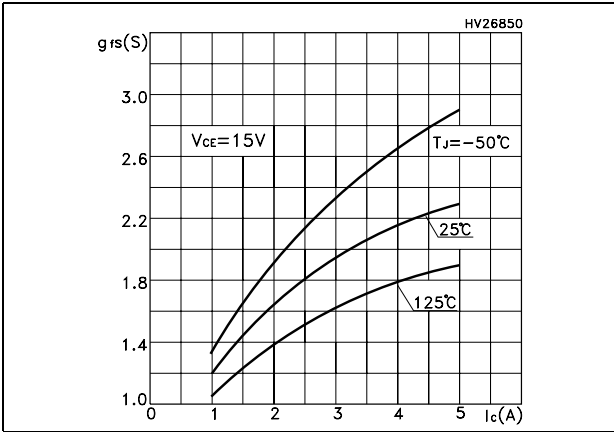


Figure 5.      Collector-emitter on voltage vs temperature

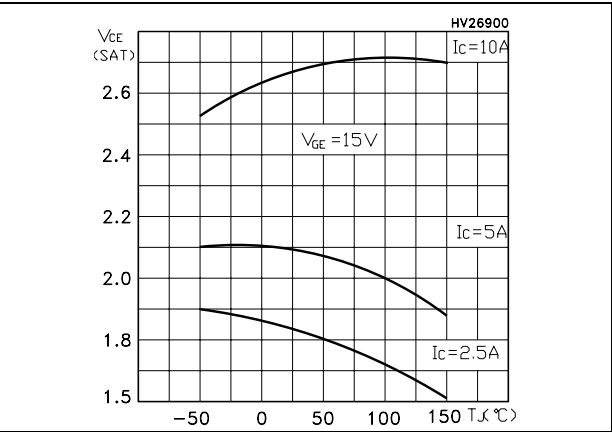


Figure 6.      Gate charge vs gate-source voltage      Figure 7.      Capacitance variations

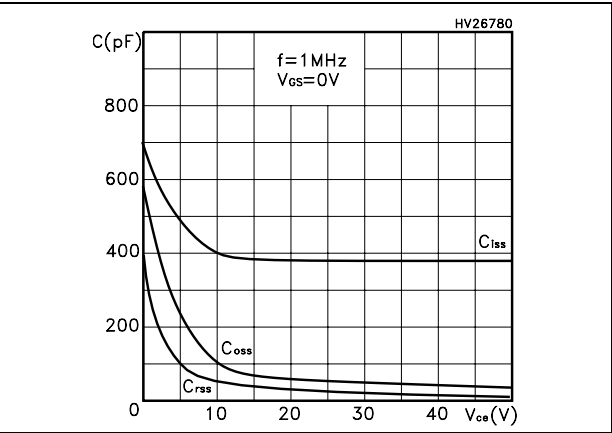
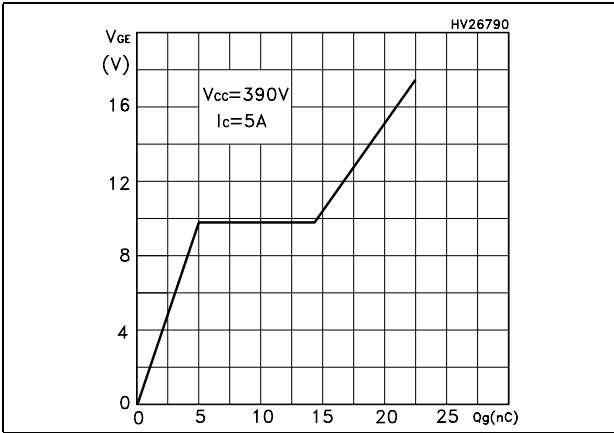


Figure 8. Normalized gate threshold voltage vs temperature

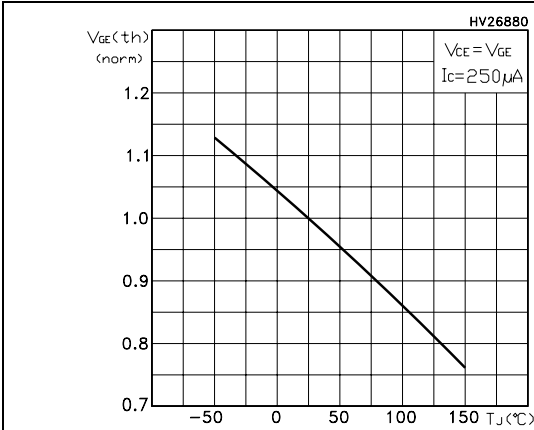


Figure 9. Collector-emitter on voltage vs collector current

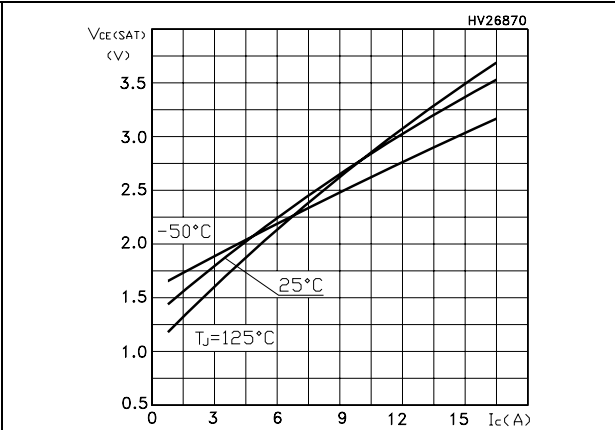


Figure 10. Normalized breakdown voltage vs temperature

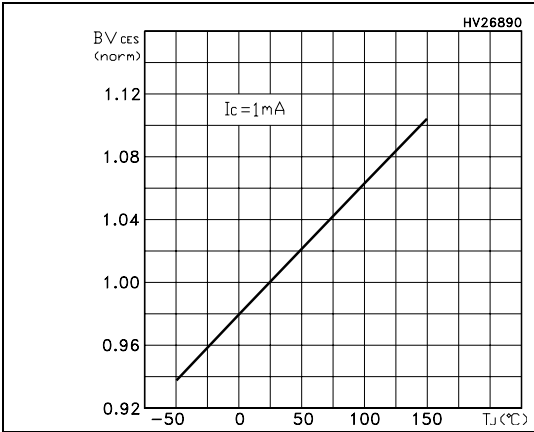


Figure 11. Switching losses vs temperature

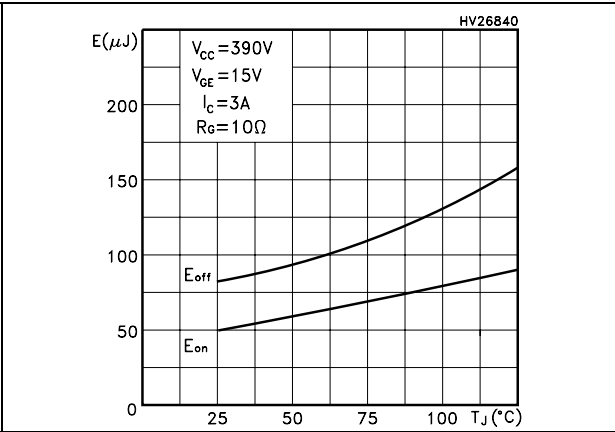


Figure 12. Switching losses vs gate resistance

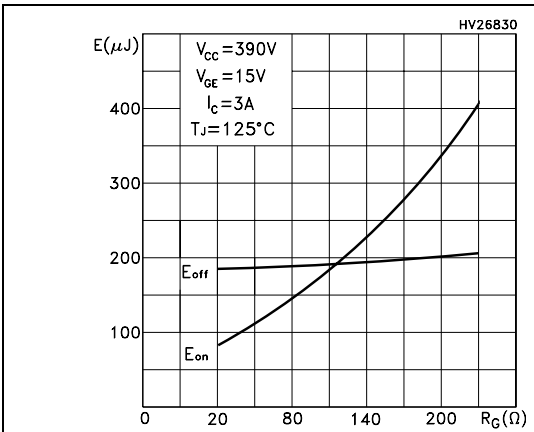


Figure 13. Switching losses vs collector current

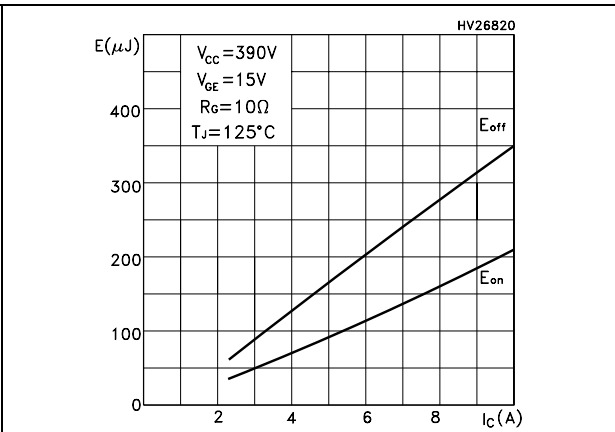


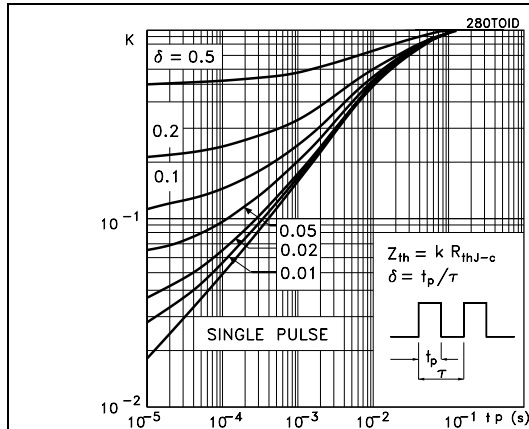
Figure 14. Thermal impedance for TO-220/  
D<sup>2</sup>PAK

Figure 15. Turn-off SOA

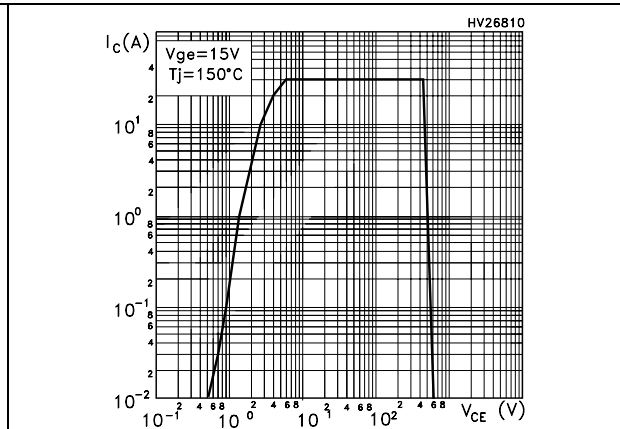
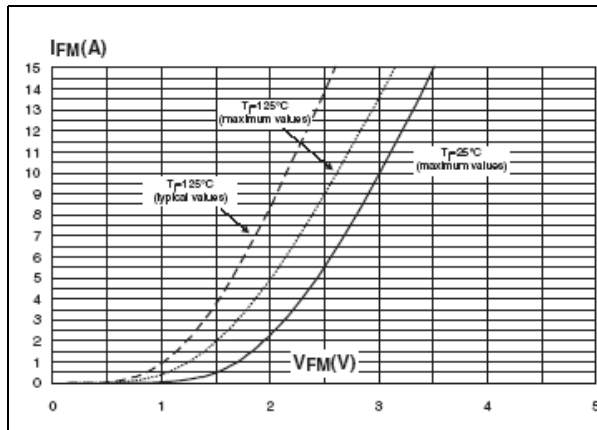
Figure 16. Forward voltage drop versus  
forward current

Figure 17. Thermal impedance for DPAK

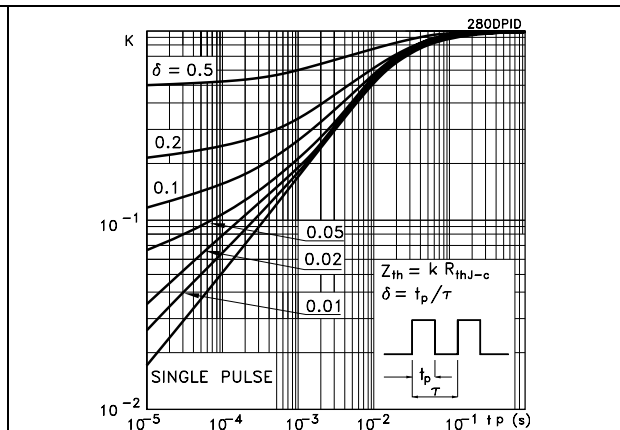
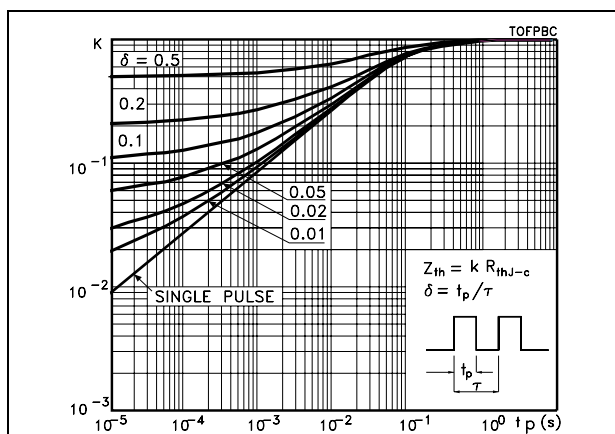


Figure 18. Thermal impedance for TO-220FP



3 Test circuit

Figure 19. Test circuit for inductive load switching

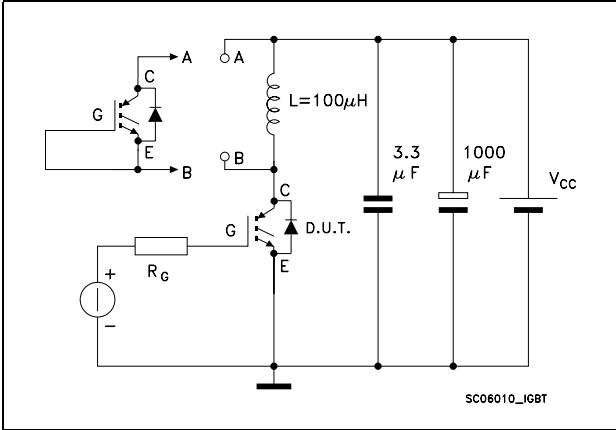


Figure 20. Gate charge test circuit

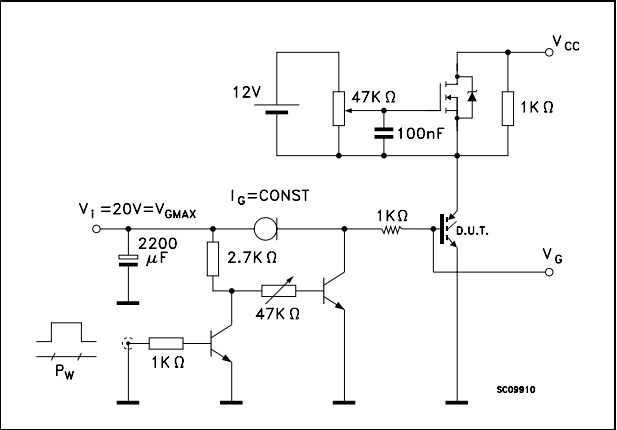


Figure 21. Switching waveform

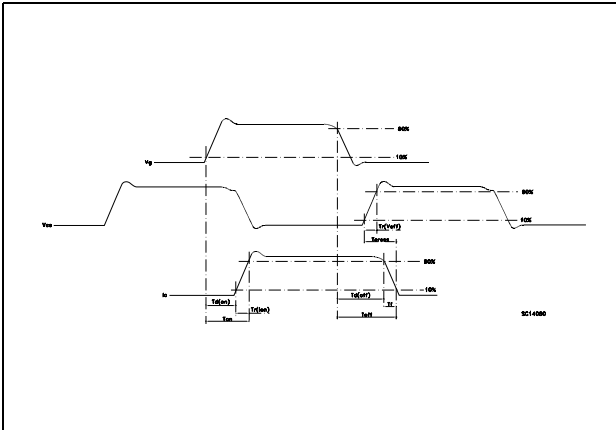
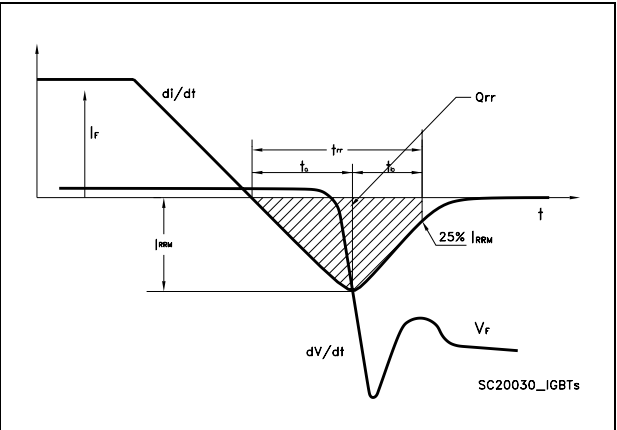


Figure 22. Diode recovery time waveform

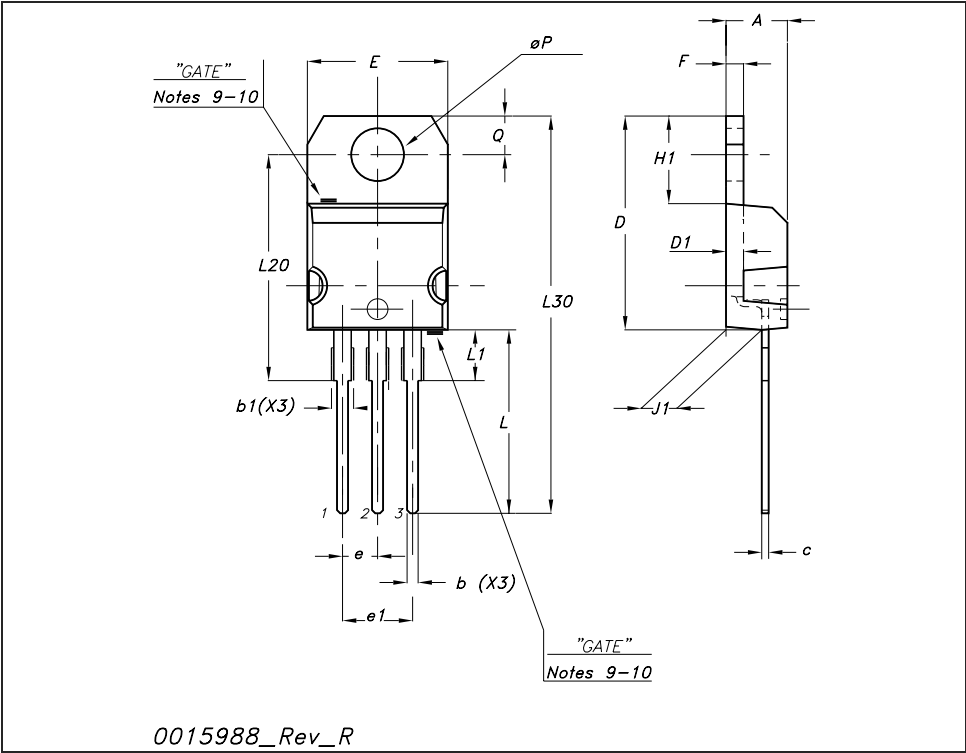


## 4 Package mechanical data

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)

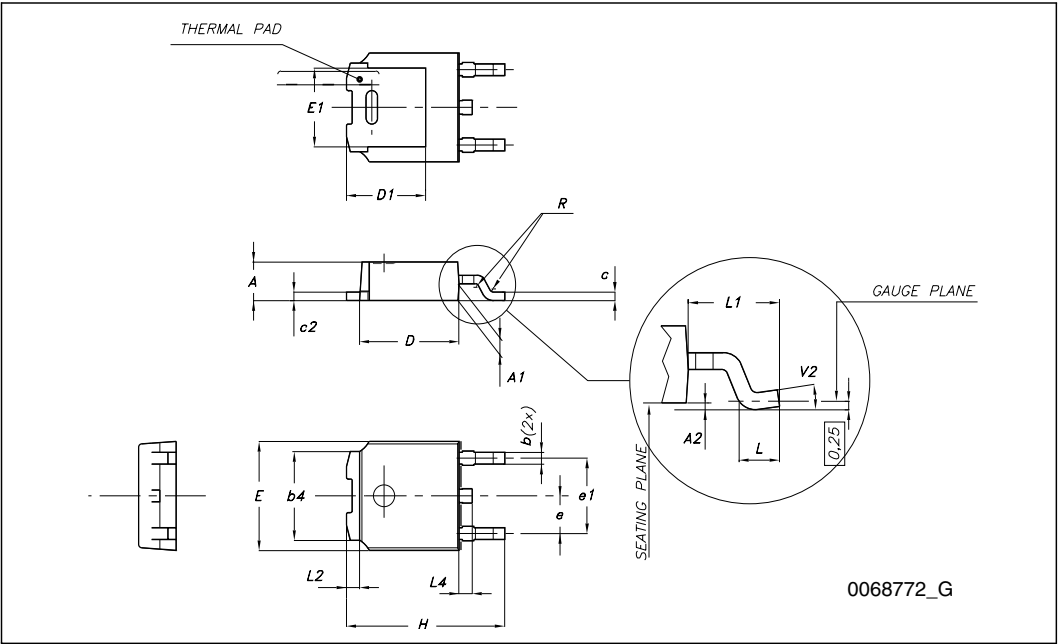
TO-220 mechanical data

| 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 |



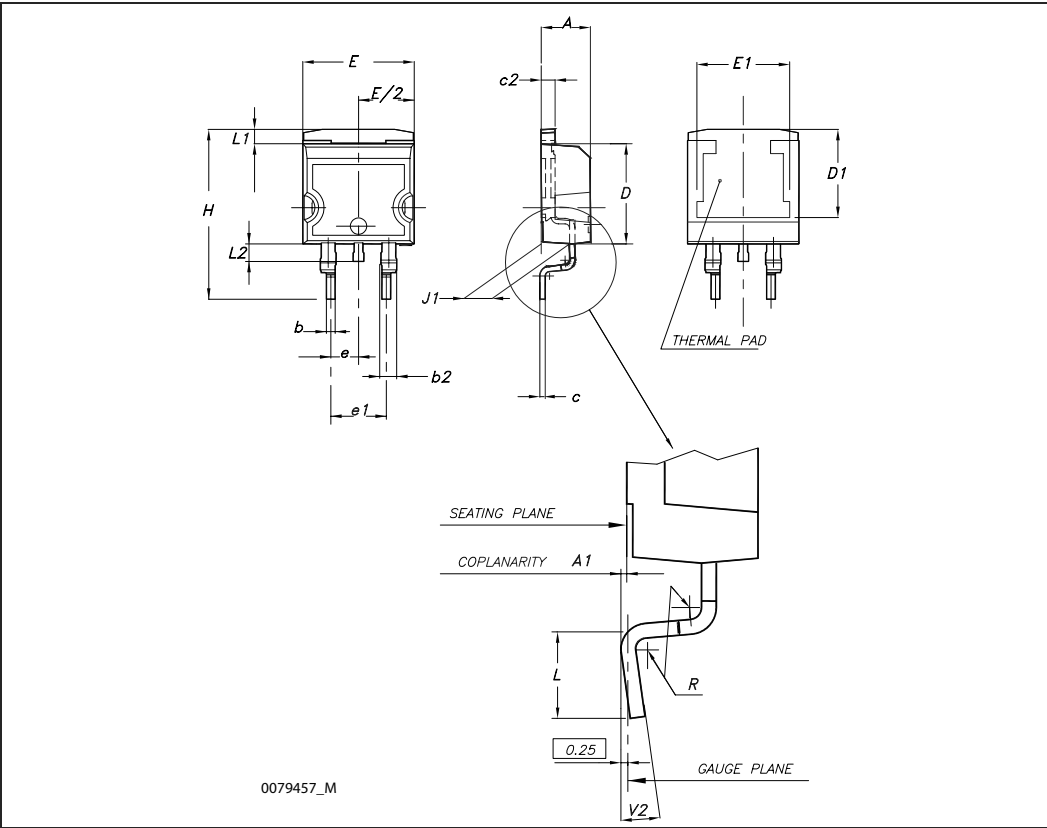
TO-252 (DPAK) mechanical data

| DIM. | mm.  |      |       |
|------|------|------|-------|
|      | min. | typ  | max.  |
| A    | 2.20 |      | 2.40  |
| A1   | 0.90 |      | 1.10  |
| A2   | 0.03 |      | 0.23  |
| b    | 0.64 |      | 0.90  |
| b4   | 5.20 |      | 5.40  |
| c    | 0.45 |      | 0.60  |
| c2   | 0.48 |      | 0.60  |
| D    | 6.00 |      | 6.20  |
| D1   |      | 5.10 |       |
| E    | 6.40 |      | 6.60  |
| E1   |      | 4.70 |       |
| e    |      | 2.28 |       |
| e1   | 4.40 |      | 4.60  |
| H    | 9.35 |      | 10.10 |
| L    | 1    |      |       |
| L1   |      | 2.80 |       |
| L2   |      | 0.80 |       |
| L4   | 0.60 |      | 1     |
| R    |      | 0.20 |       |
| V2   | 0°   |      | 8°    |



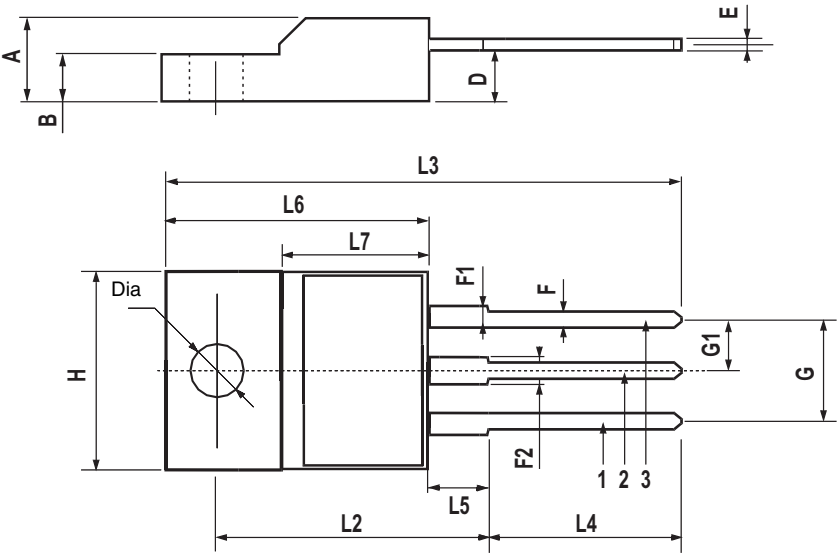
D<sup>2</sup>PAK (TO-263) mechanical data

| 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°    |



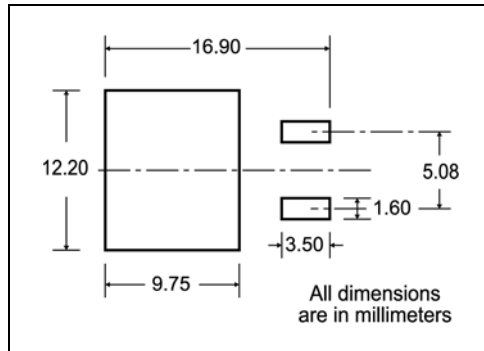
TO-220FP mechanical data

| Dim. | mm.   |     |       | inch  |       |       |
|------|-------|-----|-------|-------|-------|-------|
|      | Min.  | Typ | Max.  | Min.  | Typ.  | Max.  |
| A    | 4.40  |     | 4.60  | 0.173 |       | 0.181 |
| B    | 2.5   |     | 2.7   | 0.098 |       | 0.106 |
| D    | 2.5   |     | 2.75  | 0.098 |       | 0.108 |
| E    | 0.45  |     | 0.70  | 0.017 |       | 0.027 |
| F    | 0.75  |     | 1.00  | 0.030 |       | 0.039 |
| F1   | 1.15  |     | 1.50  | 0.045 |       | 0.067 |
| F2   | 1.15  |     | 1.50  | 0.045 |       | 0.067 |
| G    | 4.95  |     | 5.20  | 0.195 |       | 0.204 |
| G1   | 2.40  |     | 2.70  | 0.094 |       | 0.106 |
| H    | 10    |     | 10.40 | 0.393 |       | 0.409 |
| L2   |       | 16  |       |       | 0.630 |       |
| L3   | 28.6  |     | 30.6  | 1.126 |       | 1.204 |
| L4   | 9.80  |     | 10.60 | 0.385 |       | 0.417 |
| L5   | 2.9   |     | 3.6   | 0.114 |       | 0.141 |
| L6   | 15.90 |     | 16.40 | 0.626 |       | 0.645 |
| L7   | 9     |     | 9.30  | 0.354 |       | 0.366 |
| Dia  | 3     |     | 3.2   | 0.118 |       | 0.126 |

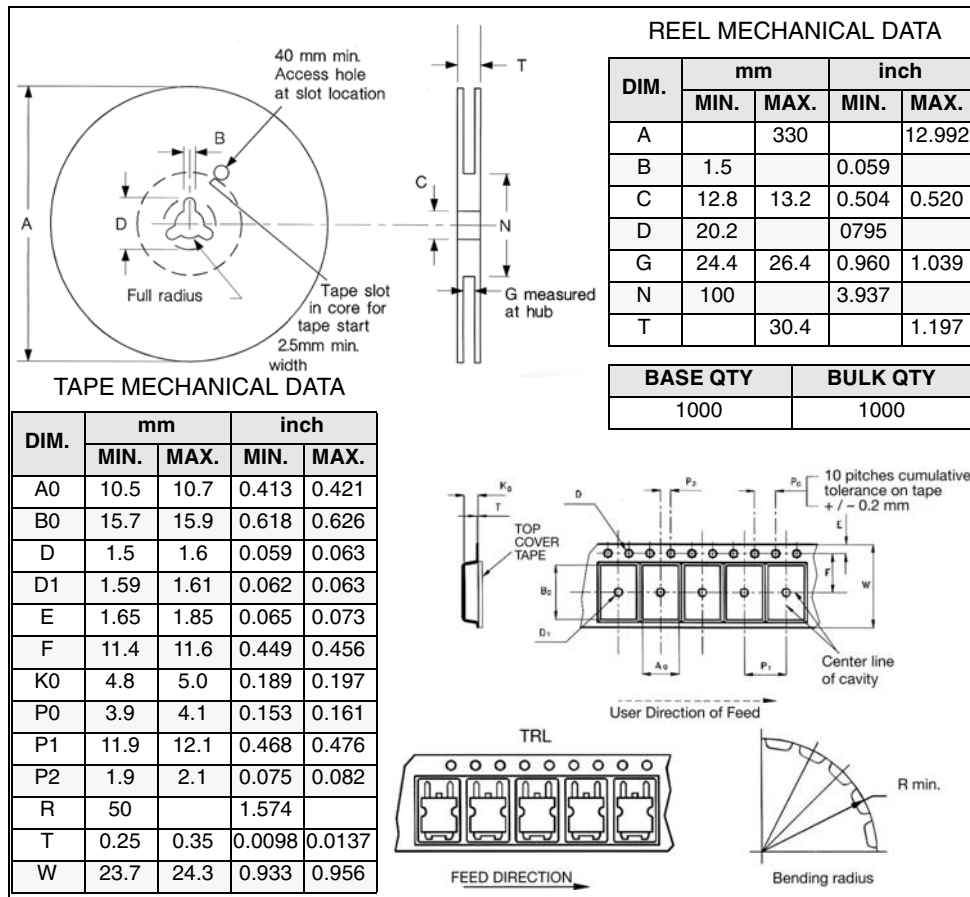


## 5 Packaging mechanical data

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

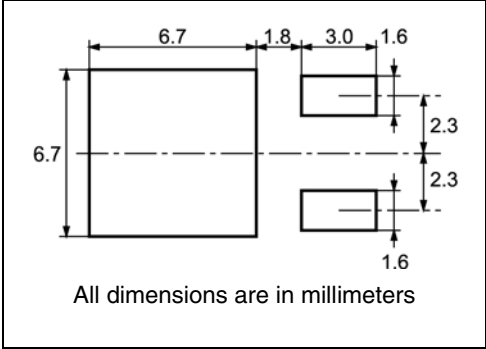


### TAPE AND REEL SHIPMENT

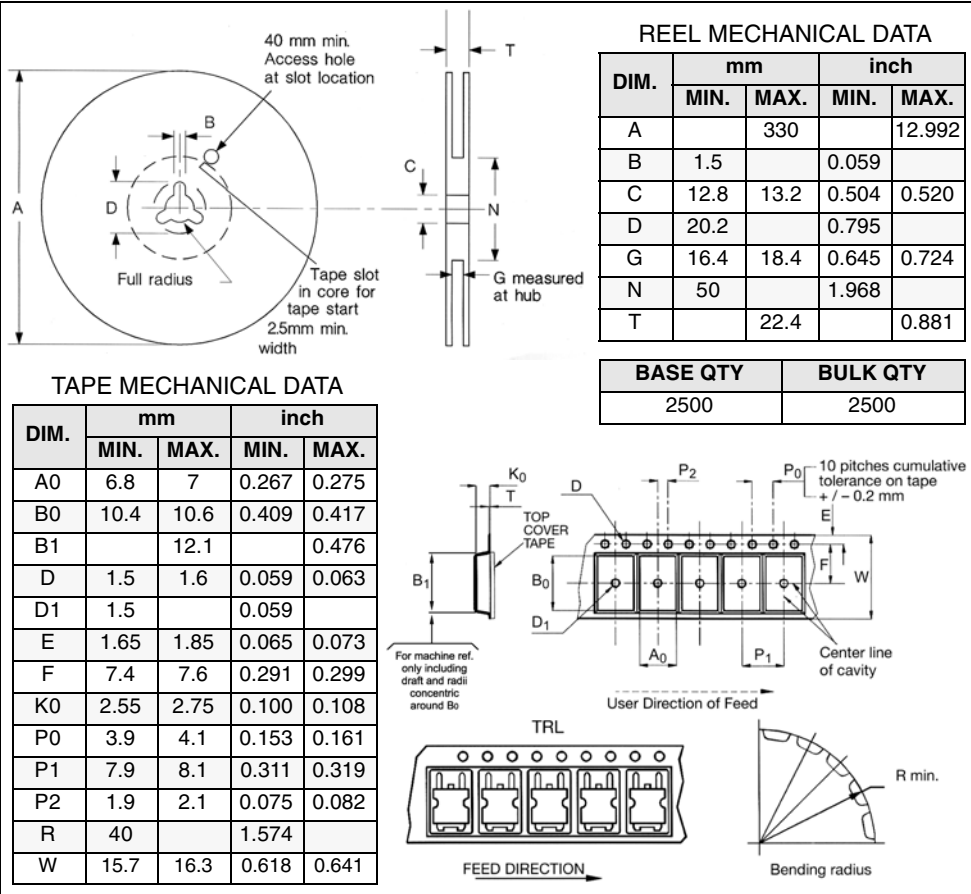


\* on sales type

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT



## 6 Revision history

Table 9. Document revision history

| Date        | Revision | Changes                                                         |
|-------------|----------|-----------------------------------------------------------------|
| 02-Oct-2007 | 1        | First release                                                   |
| 01-Apr-2008 | 2        | Updated <a href="#">Figure 14</a> and <a href="#">Figure 17</a> |

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