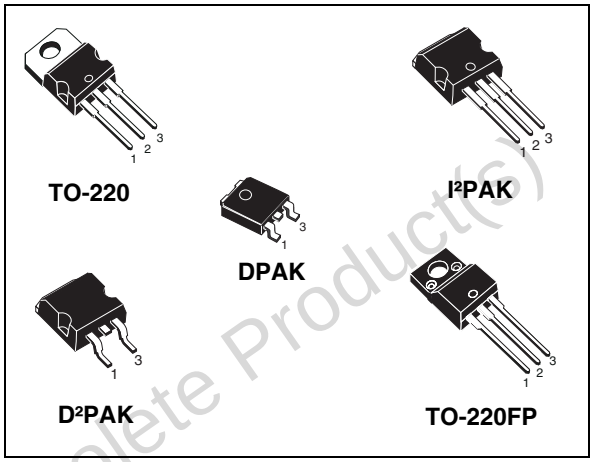
# STB12NM50N,STD12NM50N,STI12NM50N STF12NM50N, STP12NM50N

## N-channel 500 V, 0.29 Ω, 11 A MDmesh™ II Power MOSFET TO-220 - DPAK - D²PAK - I²PAK - TO-220FP

## Features

| Type | $V_{DSS}$ (@Tjmax) | $R_{DS(on)}$ max | $I_D$ |
|---|---|---|---|
| STB12NM50N | 550 V | 0.38 Ω | 11 A |
| STD12NM50N | 550 V | 0.38 Ω | 11 A |
| STI12NM50N | 550 V | 0.38 Ω | 11 A |
| STF12NM50N | 550 V | 0.38 Ω | 11 A (1) |
| STP12NM50N | 550 V | 0.38 Ω | 11 A |

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance




## Application

- Switching applications

## Description

This series of devices is realized with the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

**Figure 1. Internal schematic diagram**

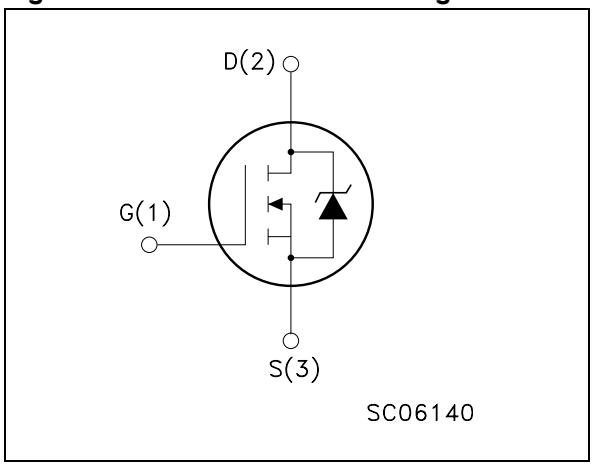



**Table 1. Device summary**

| Order codes | Marking | Package | Packaging |
|---|---|---|---|
| STB12NM50N | B12NM50N | D²PAK | Tape and reel |
| STD12NM50N | D12NM50N | DPAK | Tape and reel |
| STI12NM50N | I12NM50N | I²PAK | Tube |
| STF12NM50N | F12NM50N | TO-220FP | Tube |
| STP12NM50N | P12NM50N | TO-220 | Tube |

# Contents

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | TO-220 / I²PAK D²PAK / DPAK | TO-220FP | |
| $V_{DS}$ | Drain-source voltage ($V_{GS}$ = 0) | 500 | | V |
| $V_{GS}$ | Gate-source voltage | ± 25 | | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 11 | 11(1) | A |
| $I_D$ | Drain current (continuous) at $T_C$=100 °C | 6.7 | 6.7(1) | A |
| $I_{DM}$(2) | Drain current (pulsed) | 44 | 44 (1) | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 100 | 25 | W |
| dv/dt(3) | Peak diode recovery voltage slope | 15 | | V/ns |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s;$T_C$=25 °C) | -- | 2500 | V |
| $T_{stg}$ | Storage temperature | -55 to 150 | | °C |
| $T_J$ | Max. operating junction temperature | 150 | | °C |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 11A$, di/dt $\leq$ 400A/µs, $V_{DD}$ =80%$V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol | Parameter | Value | | | | | Unit |
|---|---|---|---|---|---|---|---|
| | | TO-220 | I²PAK | DPAK | D²PAK | TO-220FP | |
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 1.25 | | | | 5 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-amb max | 62.5 | | -- | -- | 62.5 | °C/W |
| $R_{thj\text{-}pcb}$ | Thermal resistance junction-pcb max | -- | -- | 50 | 30 | -- | °C/W |
| $T_l$ | Maximum lead temperature for soldering purposes | 300 | | | | | °C |

**Table 4. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AS}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by Tj Max) | 5 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting Tj=25°C, Id=Ias, Vdd=50V) | 350 | mJ |

# 2 Electrical characteristics

($T_{CASE}$=25 °C unless otherwise specified)

**Table 5. On/off states**

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D$ = 1 mA, $V_{GS}$= 0 | 500 | | | V |
| dv/dt(1) | Peak diode recovery voltage slope | $V_{DD}$=400 V, $I_D$=11 A, $V_{GS}$=10 V | | 44 | | V/ns |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = max rating,<br>$V_{DS}$ = max rating@125 °C | | | 1<br>100 | µA<br>µA |
| $I_{GSS}$ | Gate body leakage current ($V_{DS}$ = 0) | $V_{GS}$ = ±20 V | | | 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$= $V_{GS}$, $I_D$ = 250 µA | 2 | 3 | 4 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$= 10 V, $I_D$= 5.5 A | | 0.29 | 0.38 | Ω |

1. Characteristic value at turn off inductive load

**Table 6. Dynamic**

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$ (1) | Forward transconductance | $V_{DS}$ =15 V, $I_D$ = 5.5 A | | 8 | | S |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS}$ =50 V, f=1 MHz, $V_{GS}$=0 | | 940<br>100<br>10 | | pF<br>pF<br>pF |
| $C_{oss\ eq}$ (2) | Equivalent output capacitance | $V_{GS}$=0, $V_{DS}$ =0 to 400 V | | 130 | | pF |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$=400 V, $I_D$ = 11 A<br>$V_{GS}$ =10 V<br>*(see Figure 17)* | | 30<br>6<br>15 | | nC<br>nC<br>nC |
| $R_g$ | Gate input resistance | f=1 MHz Gate DC Bias=0<br>test signal level=20 mV<br>open drain | | 4.5 | | Ω |

1. Pulsed: pulse duration=300 µs, duty cycle 1.5%
2. $C_{oss\ eq}$ is defined as a constant equivalent capacitance giving the same charging time as $C_{oss}$ when $V_{DS}$ increases from 0 to 80% $V_{DSS}$

**Table 7. Switching times**

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on delay time<br>Rise time<br>Turn-off delay time<br>Fall time | $V_{DD}$=250 V, $I_D$= 5.5 A,<br>$R_G$=4.7 Ω, $V_{GS}$=10 V<br>*(see Figure 16)* | | 15<br>15<br>60<br>14 | | ns<br>ns<br>ns<br>ns |

**Table 8. Source drain diode**

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | | | 11 | A |
| $I_{SDM}$(1) | Source-drain current (pulsed) | | | | 44 | A |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$=11 A, $V_{GS}$=0 | | | 1.3 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$=11 A, $V_{DD}$=100 V<br>di/dt = 100 A/µs,<br>*(see Figure 18)* | | 340<br>3.5<br>20 | | ns<br>µC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$=11 A,<br>di/dt = 100 A/µs,<br>$V_{DD}$=100 V, Tj=150 °C<br>*(see Figure 18)* | | 420<br>4<br>20 | | ns<br>µC<br>A |

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration=300 µs, duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area for TO-220/ DPAK/ D²PAK / I²PAK**

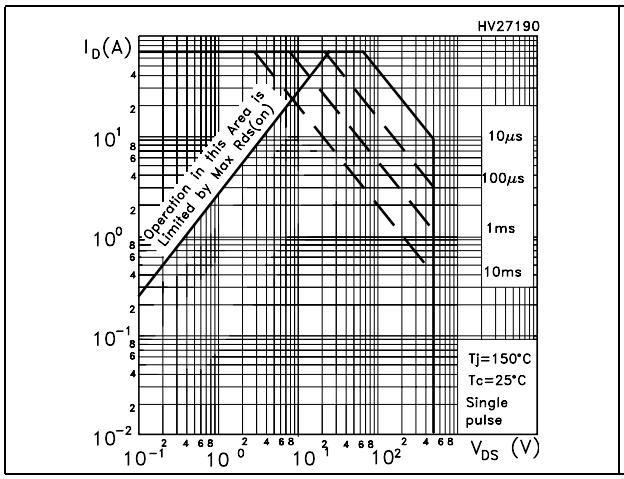



**Figure 3. Thermal impedance for TO-220/ DPAK/ D²PAK / I²PAK**

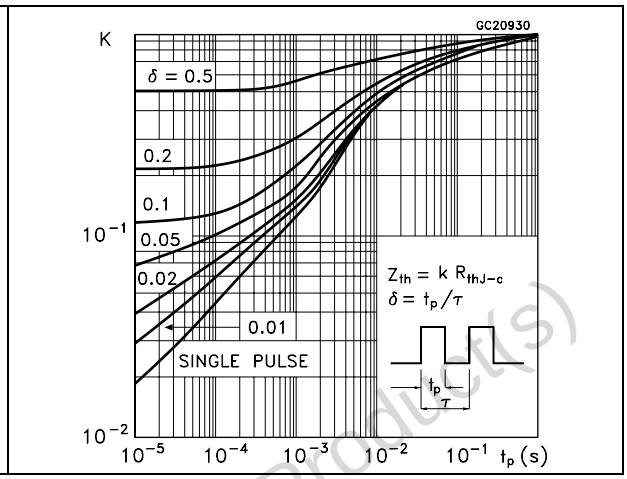



**Figure 4. Safe operating area for TO-220FP**

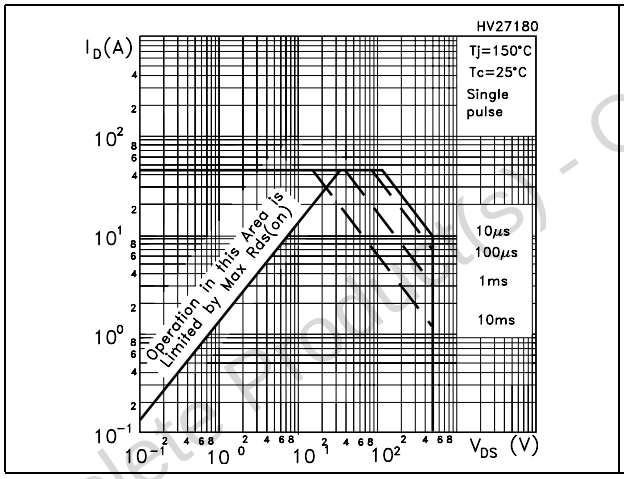



**Figure 5. Thermal impedance for TO-220FP**

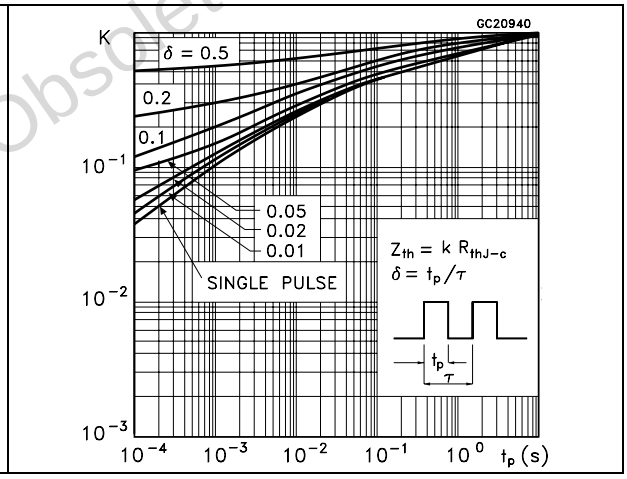



**Figure 6. Output characteristics**

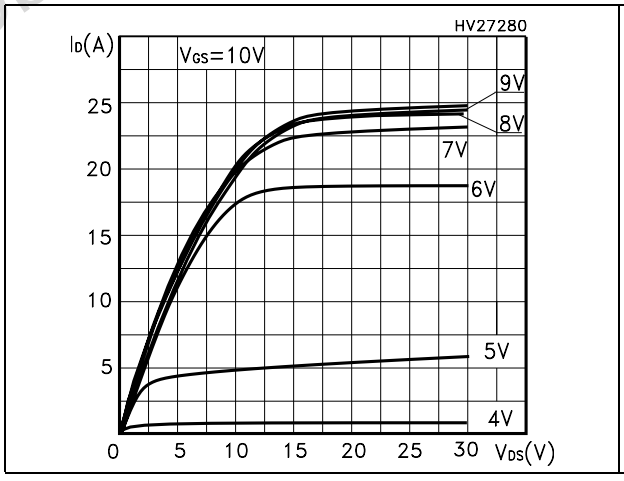



**Figure 7. Transfer characteristics**

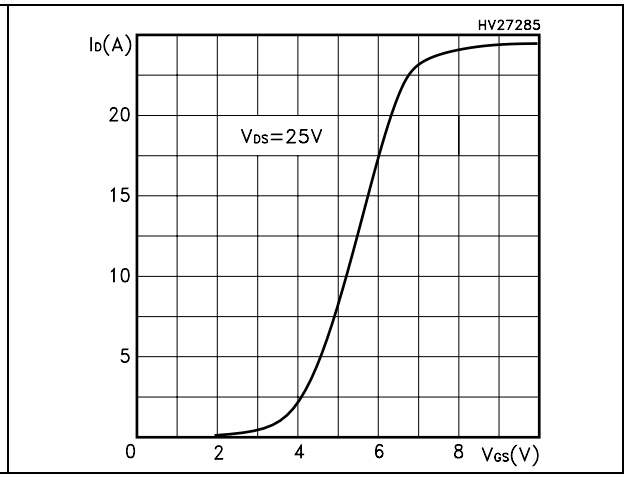


**Figure 8. Transconductance**

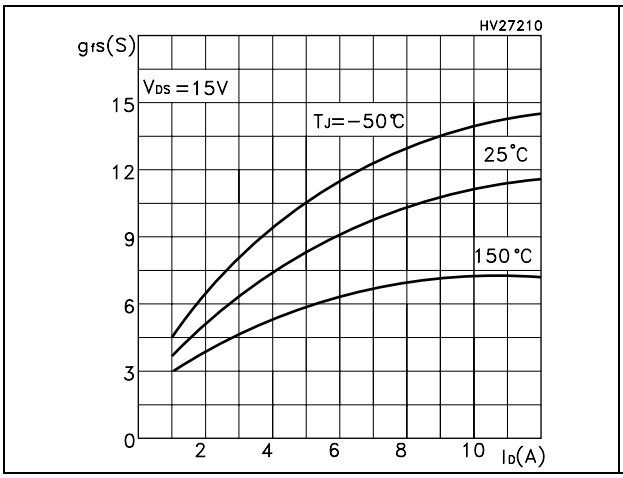



**Figure 9. Static drain-source on resistance**

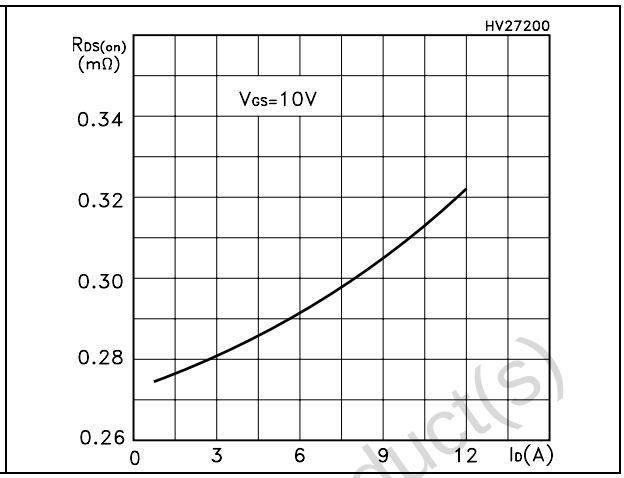



**Figure 10. Gate charge vs gate-source voltage**

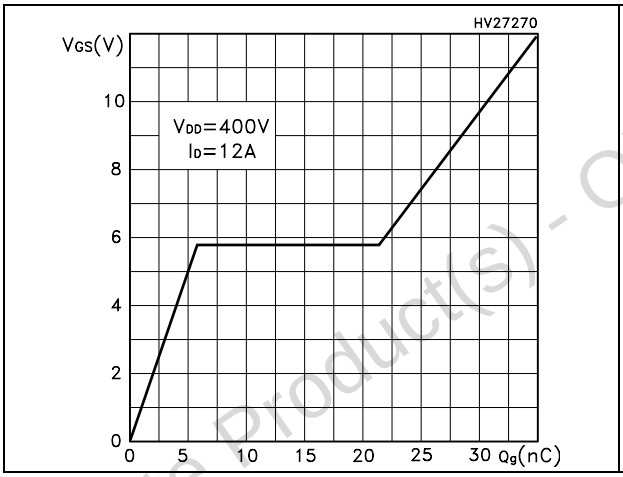



**Figure 11. Capacitance variations**

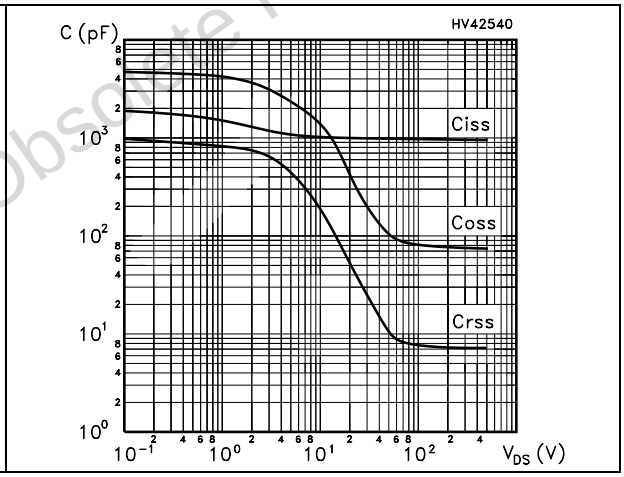



**Figure 12. Normalized gate threshold voltage vs temperature**

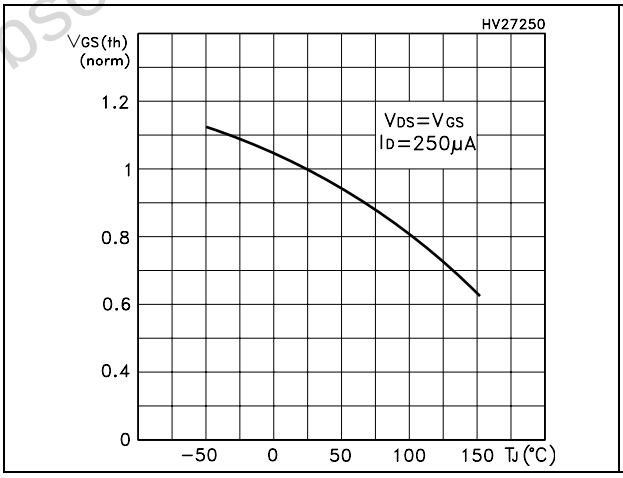



**Figure 13. Normalized on resistance vs temperature**

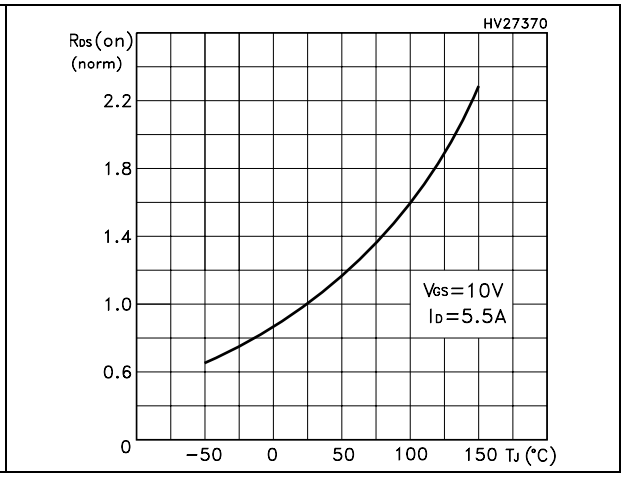


**Figure 14. Source-drain diode forward characteristics**

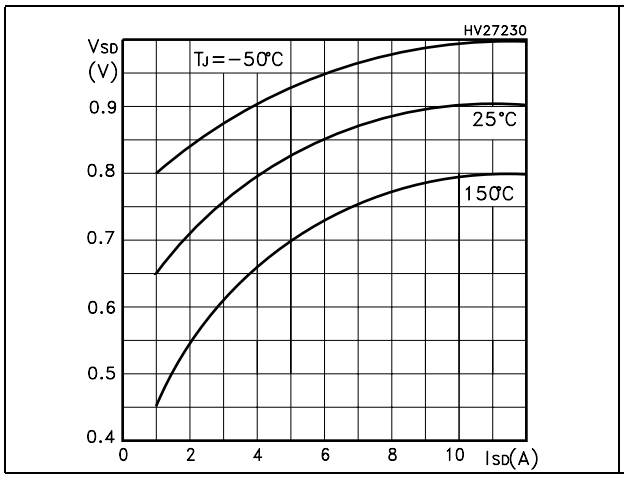
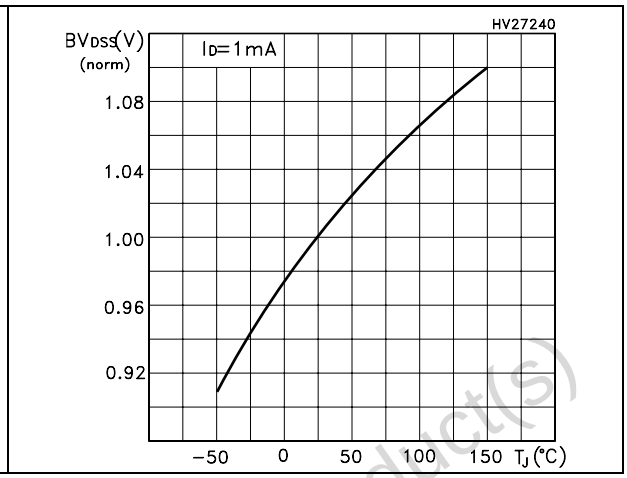



**Figure 15. Normalized $B_{VDSS}$ vs temperature**



# 3 Test circuit

**Figure 16. Switching times test circuit for resistive load**

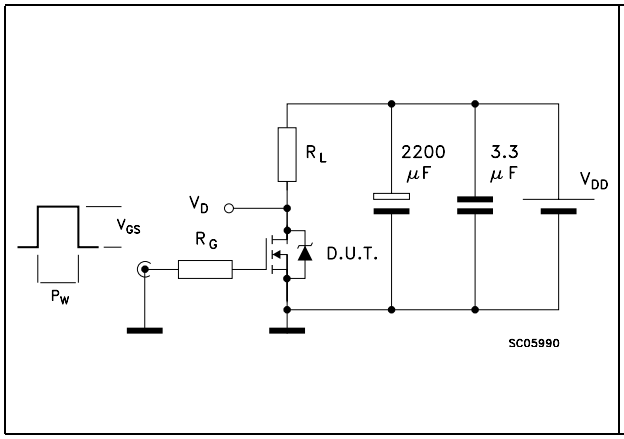



**Figure 17. Gate charge test circuit**

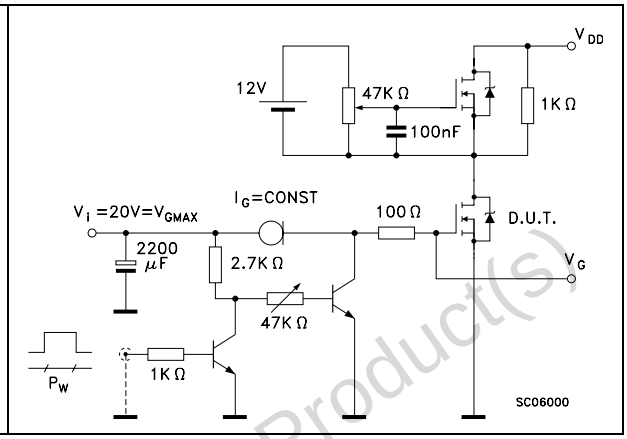



**Figure 18. Test circuit for inductive load switching and diode recovery times**

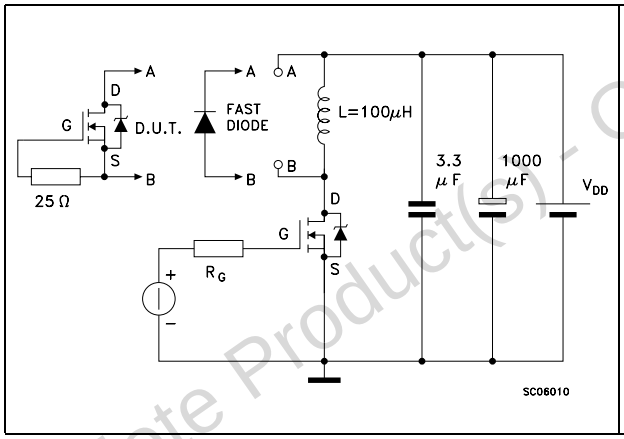



**Figure 19. Unclamped Inductive load test circuit**

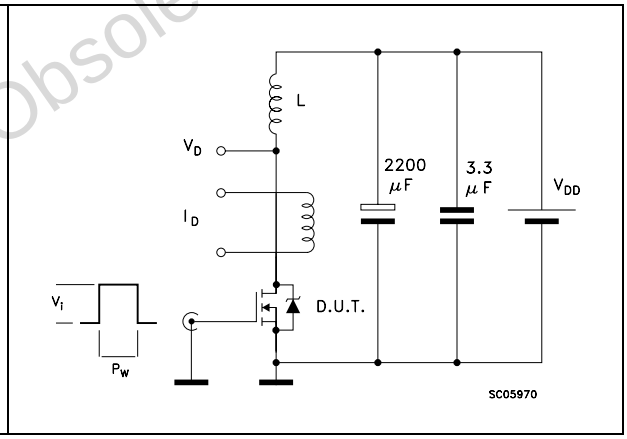



**Figure 20. Unclamped inductive waveform**

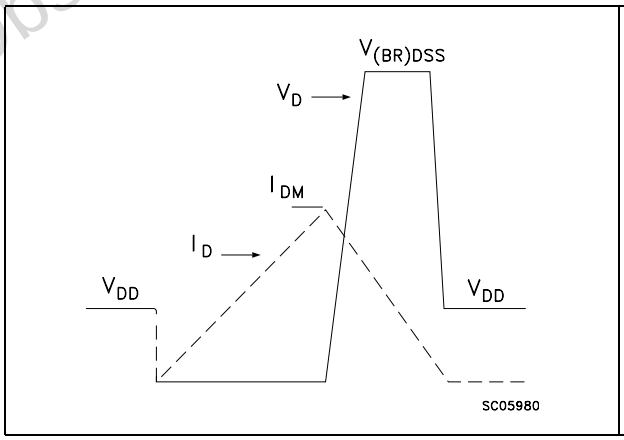
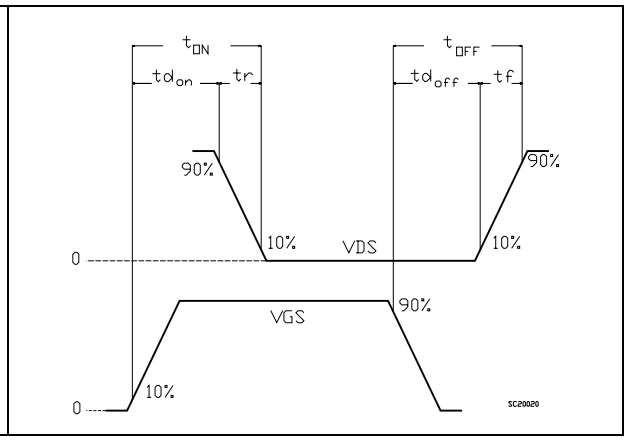



**Figure 21. Switching time waveform**

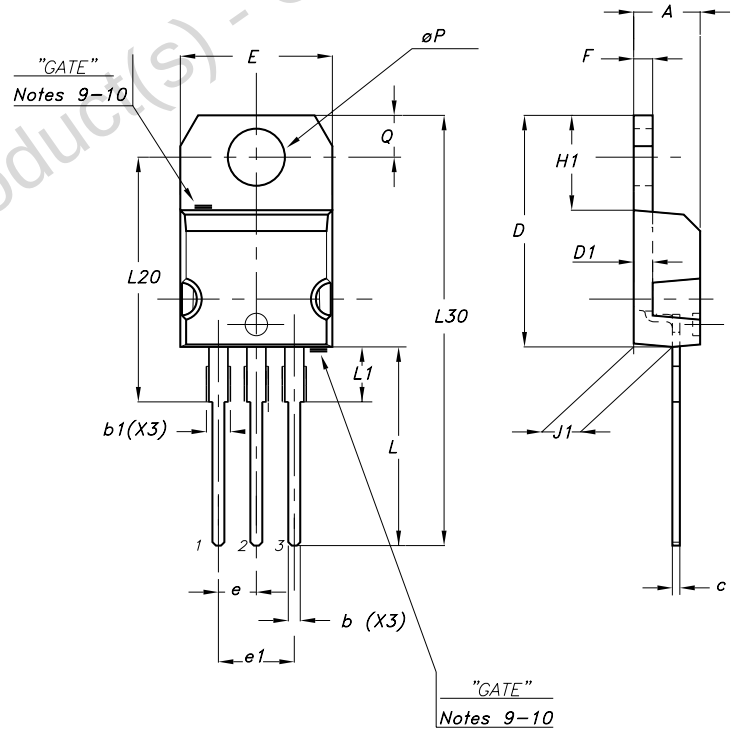


# 4 Package mechanical data

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*

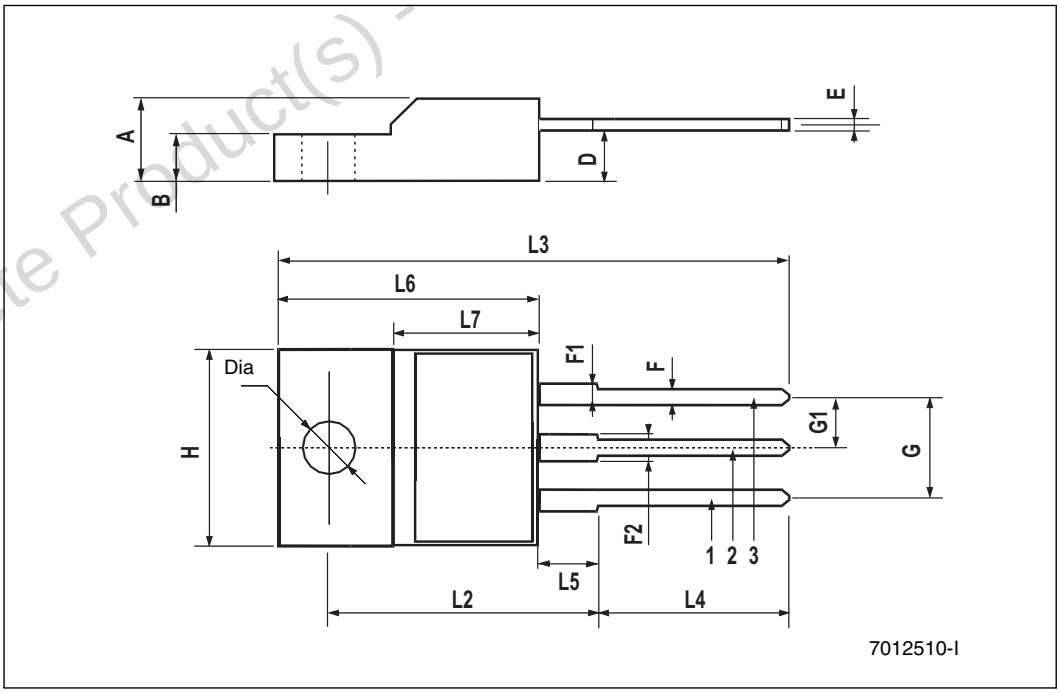
## TO-220 mechanical data

| 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 |



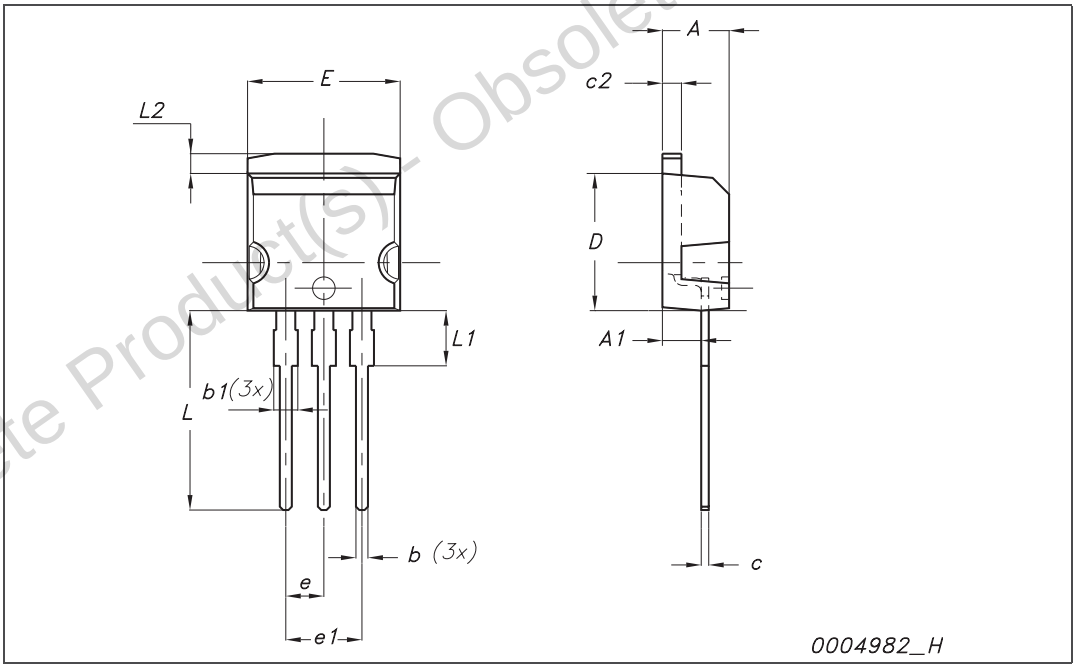
## TO-220FP mechanical data

| 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 |



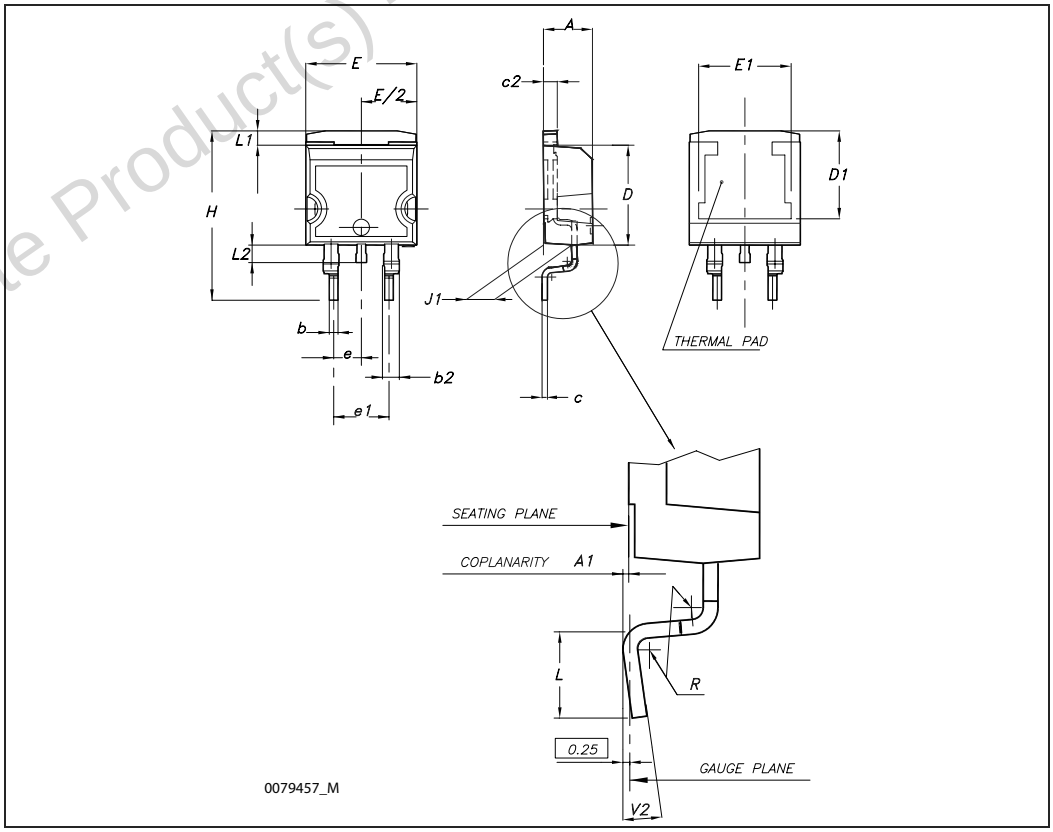
## I²PAK (TO-262) mechanical data

| Dim | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| A1 | 2.40 | | 2.72 | 0.094 | | 0.107 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| c2 | 1.23 | | 1.32 | 0.048 | | 0.052 |
| D | 8.95 | | 9.35 | 0.352 | | 0.368 |
| e | 2.40 | | 2.70 | 0.094 | | 0.106 |
| e1 | 4.95 | | 5.15 | 0.194 | | 0.202 |
| E | 10 | | 10.40 | 0.393 | | 0.410 |
| L | 13 | | 14 | 0.511 | | 0.551 |
| L1 | 3.50 | | 3.93 | 0.137 | | 0.154 |
| L2 | 1.27 | | 1.40 | 0.050 | | 0.055 |



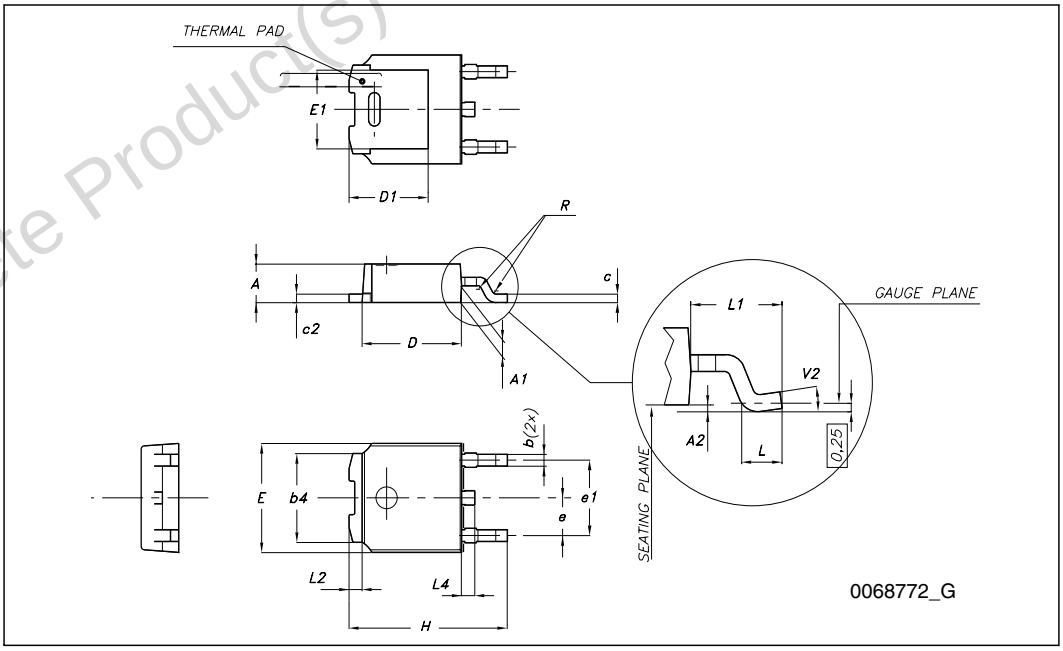
## D²PAK (TO-263) mechanical data

| 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° |



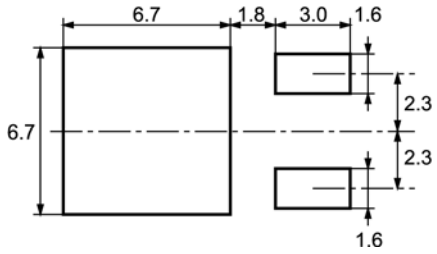
## TO-252 (DPAK) mechanical data

| 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 ° |



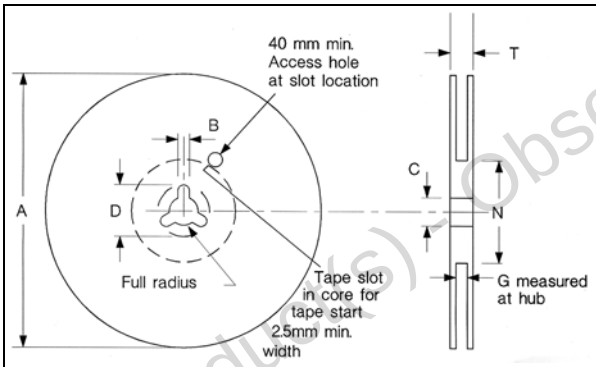
# 5 Packaging mechanical data

### DPAK FOOTPRINT




All dimensions are in millimeters

### TAPE AND REEL SHIPMENT



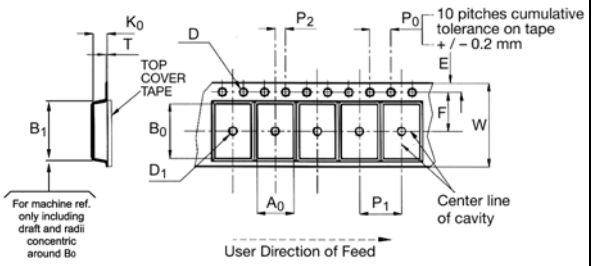

REEL MECHANICAL DATA

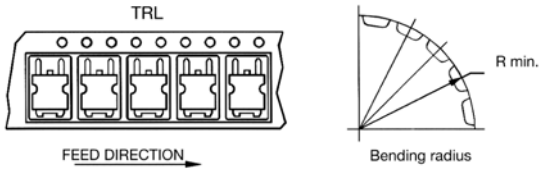
| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | | 330 | | 12.992 |
| B | 1.5 | | 0.059 | |
| C | 12.8 | 13.2 | 0.504 | 0.520 |
| D | 20.2 | | 0.795 | |
| G | 16.4 | 18.4 | 0.645 | 0.724 |
| N | 50 | | 1.968 | |
| T | | 22.4 | | 0.881 |

| BASE QTY | BULK QTY |
|---|---|
| 2500 | 2500 |

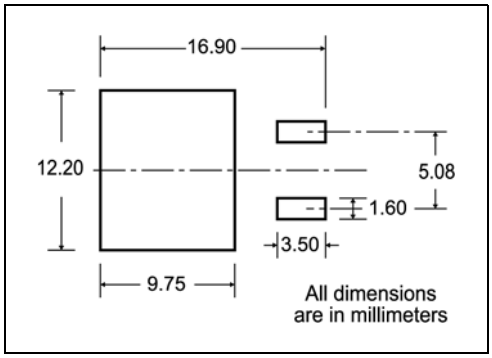
TAPE MECHANICAL DATA

| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A0 | 6.8 | 7 | 0.267 | 0.275 |
| B0 | 10.4 | 10.6 | 0.409 | 0.417 |
| B1 | | 12.1 | | 0.476 |
| D | 1.5 | 1.6 | 0.059 | 0.063 |
| D1 | 1.5 | | 0.059 | |
| E | 1.65 | 1.85 | 0.065 | 0.073 |
| F | 7.4 | 7.6 | 0.291 | 0.299 |
| K0 | 2.55 | 2.75 | 0.100 | 0.108 |
| P0 | 3.9 | 4.1 | 0.153 | 0.161 |
| P1 | 7.9 | 8.1 | 0.311 | 0.319 |
| P2 | 1.9 | 2.1 | 0.075 | 0.082 |
| R | 40 | | 1.574 | |
| W | 15.7 | 16.3 | 0.618 | 0.641 |

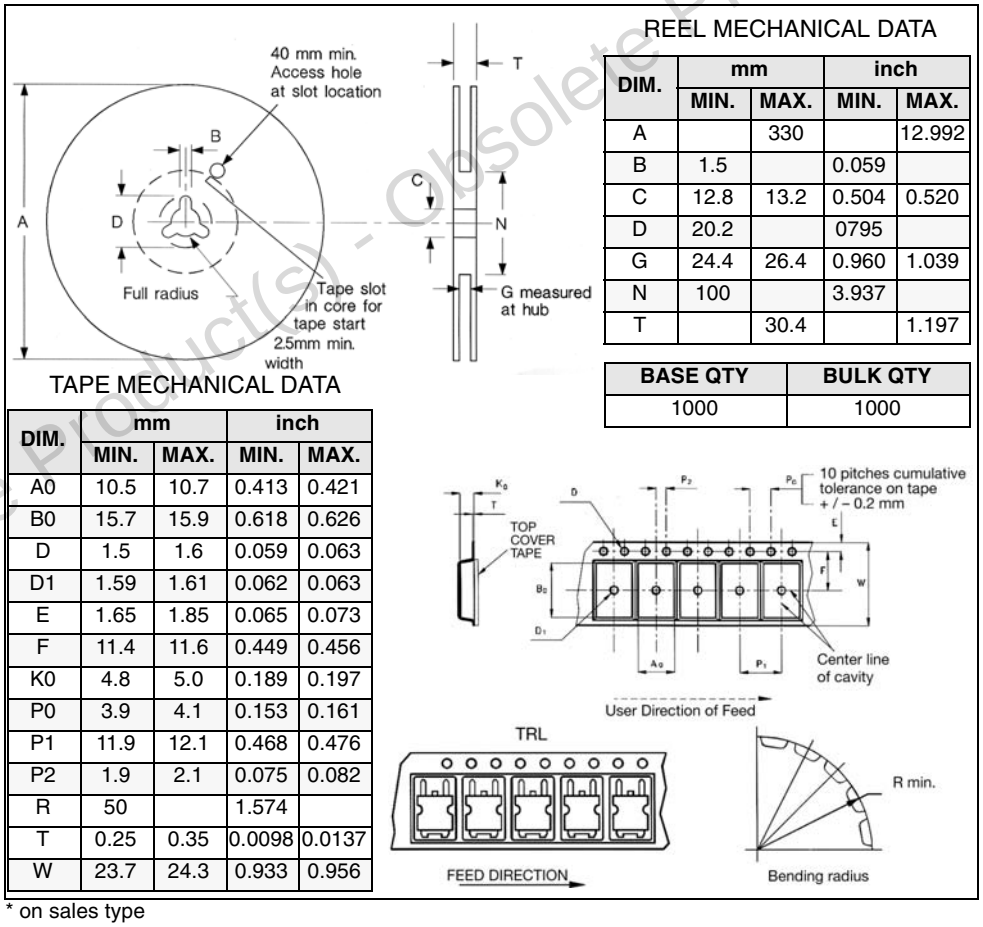


## D²PAK FOOTPRINT




## TAPE AND REEL SHIPMENT




REEL MECHANICAL DATA

| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | | 330 | | 12.992 |
| B | 1.5 | | 0.059 | |
| C | 12.8 | 13.2 | 0.504 | 0.520 |
| D | 20.2 | | 0795 | |
| G | 24.4 | 26.4 | 0.960 | 1.039 |
| N | 100 | | 3.937 | |
| T | | 30.4 | | 1.197 |

| BASE QTY | BULK QTY |
|---|---|
| 1000 | 1000 |

TAPE MECHANICAL DATA

| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A0 | 10.5 | 10.7 | 0.413 | 0.421 |
| B0 | 15.7 | 15.9 | 0.618 | 0.626 |
| D | 1.5 | 1.6 | 0.059 | 0.063 |
| D1 | 1.59 | 1.61 | 0.062 | 0.063 |
| E | 1.65 | 1.85 | 0.065 | 0.073 |
| F | 11.4 | 11.6 | 0.449 | 0.456 |
| K0 | 4.8 | 5.0 | 0.189 | 0.197 |
| P0 | 3.9 | 4.1 | 0.153 | 0.161 |
| P1 | 11.9 | 12.1 | 0.468 | 0.476 |
| P2 | 1.9 | 2.1 | 0.075 | 0.082 |
| R | 50 | | 1.574 | |
| T | 0.25 | 0.35 | 0.0098 | 0.0137 |
| W | 23.7 | 24.3 | 0.933 | 0.956 |

* on sales type

# 6 Revision history

**Table 9. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 24-May-2005 | 1 | Initial release |
| 10-Jun-2005 | 2 | Inserted new row in *Table 7.: Switching times* |
| 28-Sep-2005 | 3 | Document status promoted from preliminary data to datasheet. |
| 14-Oct-2005 | 4 | Modified *Figure 6*, *Figure 9* |
| 06-Mar-2006 | 5 | Modified *Figure 8* |
| 29-Mar-2006 | 6 | Modified value on *Table 5.* |
| 14-Nov-2006 | 7 | Document reformatted no content change |
| 24-Jul-2008 | 8 | – Added I²PAK;<br>– *Table 3: Thermal data* has been updated;<br>– *Figure 11: Capacitance variations* changed. |