# STx8NM60N

## N-channel 600 V, 0.56 Ω,7 A MDmesh™ II Power MOSFET TO-220, TO-220FP, IPAK, DPAK, D²PAK

## Features

| Type | $V_{DSS}$ (@Tjmax) | $R_{DS(on)}$ max | $I_D$ |
|---|---|---|---|
| STB8NM60N | 650 V | < 0.65 Ω | 7 A |
| STD8NM60N | 650 V | < 0.65 Ω | 7 A |
| STD8NM60N-1 | 650 V | < 0.65 Ω | 7 A |
| STF8NM60N | 650 V | < 0.65 Ω | 7 A(1) |
| STP8NM60N | 650 V | < 0.65 Ω | 7 A |

1. Limited only by maximum temperature allowed

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

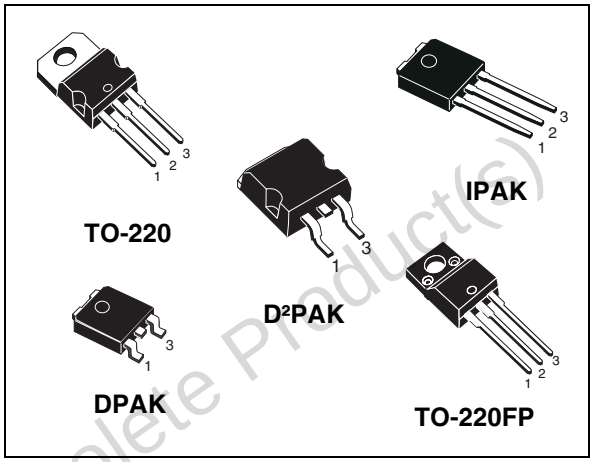
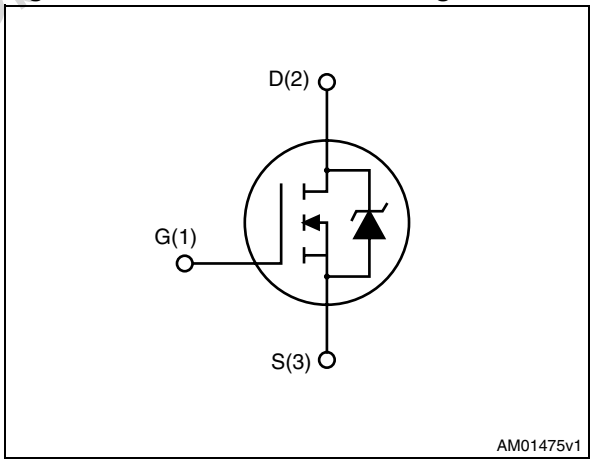



**Figure 1. Internal schematic diagram**




## Application

- Switching applications

## Description

This series of devices implements second generation 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.



**Table 1. Device summary**

| Order codes | Marking | Package | Packaging |
|---|---|---|---|
| STB8NM60N | B8NM60N | D²PAK | Tape and reel |
| STD8NM60N | D8NM60N | DPAK | Tape and reel |
| STD8NM60N-1 | D8NM60N | IPAK | Tube |
| STF8NM60N | F8NM60N | TO-220FP | Tube |
| STP8NM60N | P8NM60N | TO-220 | Tube |

# Contents

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | TO-220, IPAK, DPAK, D²PAK | TO-220FP | |
| $V_{DS}$ | Drain-source voltage ($V_{GS}$ = 0) | 600 | | V |
| $V_{GS}$ | Gate-source voltage | ± 25 | | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 7 | 7 (1) | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 4.3 | 4.3 (1) | A |
| $I_{DM}$ (2) | Drain current (pulsed) | 28 | 28 (1) | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 70 | 25 | W |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s;$T_C$ = 25 °C) | -- | 2500 | V |
| dv/dt (3) | Peak diode recovery voltage slope | 15 | | V/ns |
| $T_j$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature | -55 to 150 | | °C |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 7$ A, di/dt $\leq$ 400 A/µs, $V_{DD}$ = 80% $V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol | Parameter | Value | | | | | Unit |
|---|---|---|---|---|---|---|---|
| | | TO-220 | IPAK | DPAK | D²PAK | TO-220FP | |
| Rthj-case | Thermal resistance junction-case | 1.78 | | | | 5 | °C/W |
| Rthj-amb | Thermal resistance junction-amb | 62.5 | 100 | -- | 62.5 | | °C/W |
| $T_l$ | Maximum lead temperature for soldering purpose | 300 | | | | | °C |

**Table 4. Avalanche characteristics**

| Symbol | Parameter | Max value | Unit |
|---|---|---|---|
| $I_{AS}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by Tj max) | 2.5 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting Tj = 25 °C, $I_D = I_{AS}$, $V_{DD}$ = 50 V) | 200 | 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 | 600 | | | V |
| dv/dt(1) | Drain-source voltage slope | $V_{DD}$ = 480 V, $I_D$ = 7 A, $V_{GS}$ =10 V | | 38 | | V/ns |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = Max rating,<br>$V_{DS}$ = Max rating,Tc = 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 | $V_{GS}$ = 10V, $I_D$ = 3.5 A | | 0.56 | 0.65 | Ω |

1. Characteristics value at turn off on inductive load

**Table 6. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$(1) | Forward transconductance | $V_{DS}$ = 15 V, $I_D$= 3.5 A | | 15 | | 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 | | 560<br>37<br>2 | | pF<br>pF<br>pF |
| $C_{oss\ eq.}$(2) | Equivalent output capacitance | $V_{GS}$ = 0, $V_{DS}$ = 0 to 480 V | | 153 | | pF |
| $R_G$ | Gate input resistance | f = 1 MHz Gate DC Bias = 0<br>Test Signal Level = 20 mV<br>Open Drain | | 6 | | Ω |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$ = 480 V, $I_D$ = 7 A<br>$V_{GS}$ = 10 V<br>*(see Figure 19)* | | 19<br>3<br>10 | | nC<br>nC<br>nC |

1. Pulsed: pulse duration = 300µs, 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 | $V_{DD}$ = 300 V, $I_D$ = 3.5 A,<br>$R_G$ = 4.7 Ω, $V_{GS}$ = 10 V<br>*(see Figure 18),*<br>*(see Figure 23)* | | 10<br>12<br>40<br>10 | | ns<br>ns<br>ns<br>ns |

**Table 8. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$<br>$I_{SDM}$ (1) | Source-drain current<br>Source-drain current (pulsed) | | | | 7<br>28 | A<br>A |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$ = 7 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 | $I_{SD}$ = 7 A, di/dt = 100 A/µs, $V_{DD}$ = 30 V, Tj = 25 °C *(see Figure 20)* | | 310<br>2.40<br>15 | | ns<br>µC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$ = 7A, di/dt = 100 A/µs, $V_{DD}$ = 30 V, Tj=150°C *(see Figure 20)* | | 480<br>3.50<br>15 | | ns<br>µC<br>A |

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

## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area for TO-220, D²PAK**

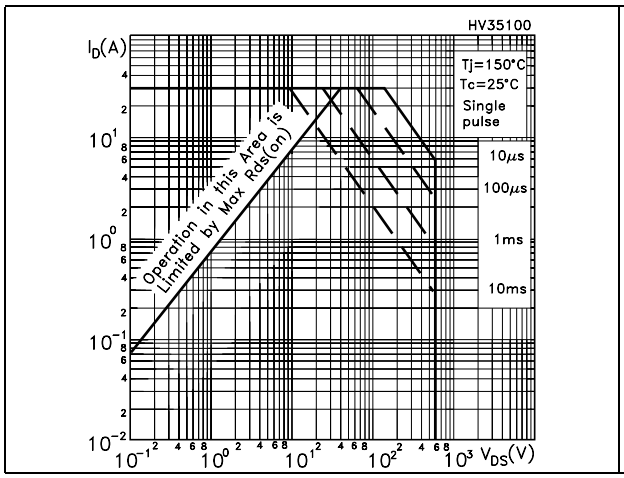



**Figure 3. Thermal impedance for TO-220, D²PAK**

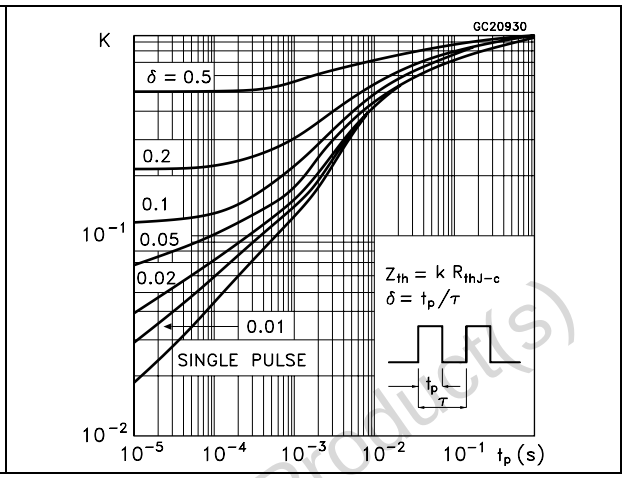



**Figure 4. Safe operating area for DPAK, IPAK**

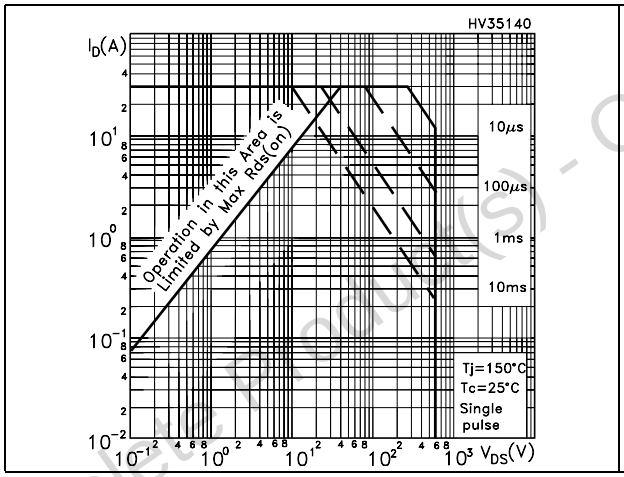



**Figure 5. Thermal impedance for DPAK, IPAK**

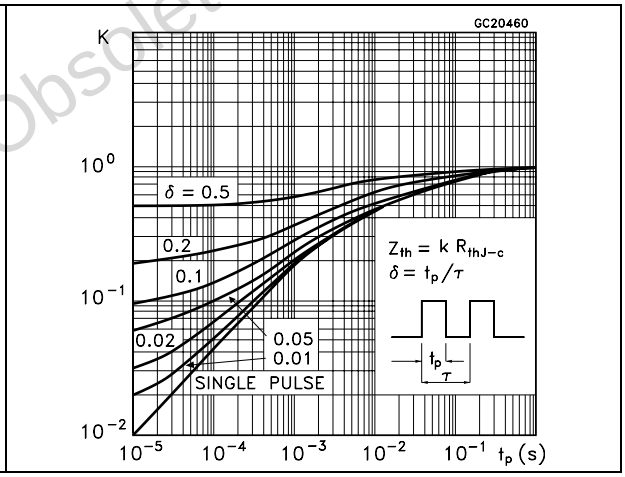



**Figure 6. Safe operating area for TO-220FP**

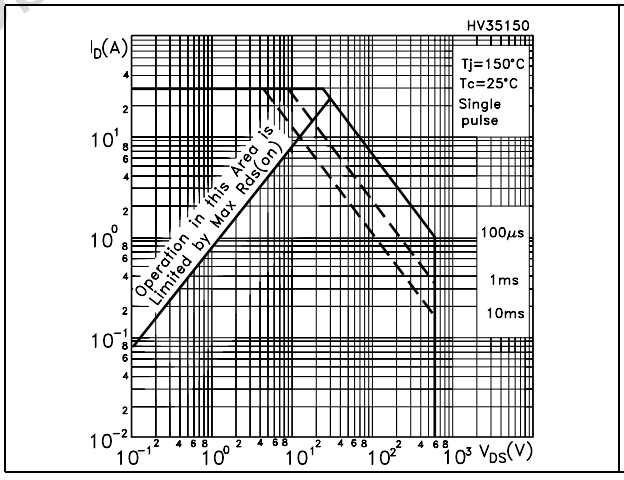



**Figure 7. Thermal impedance for TO-220FP**

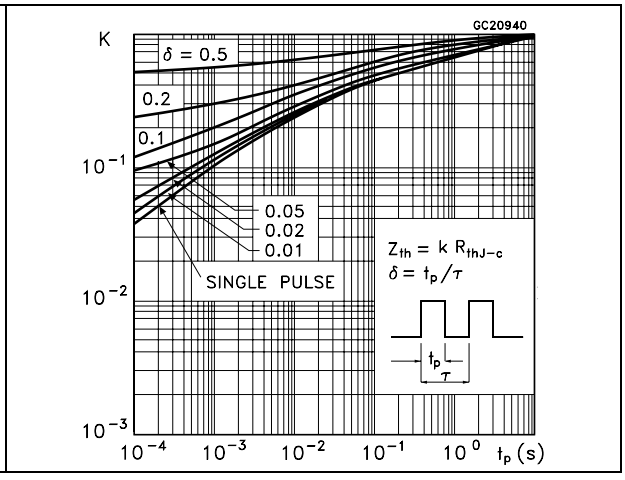


**Figure 8. Output characteristics**

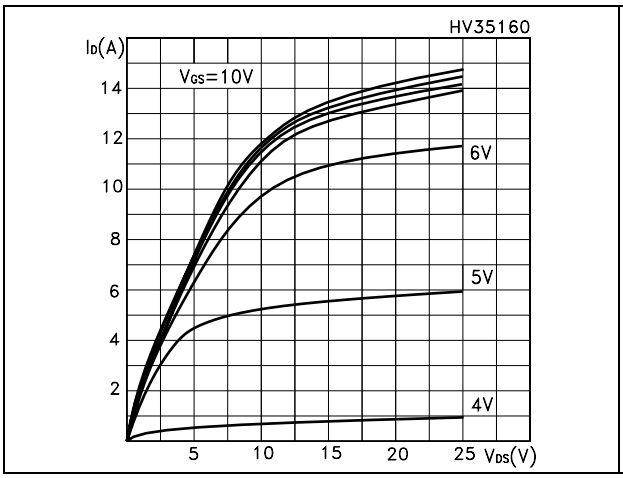



**Figure 9. Transfer characteristics**

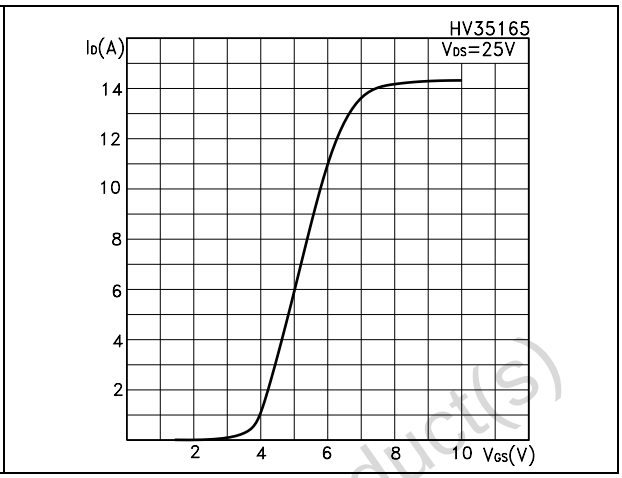



**Figure 10. Transconductance**

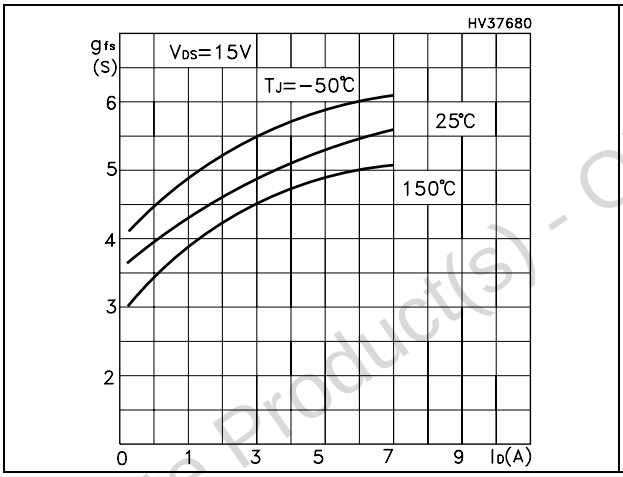



**Figure 11. Static-drain source on resistance**

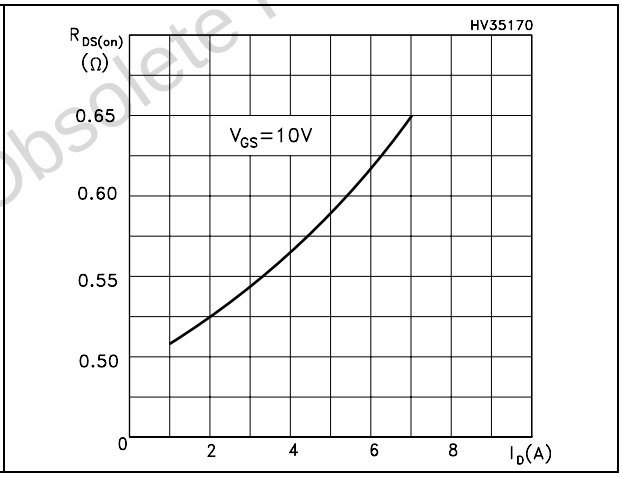



**Figure 12. Gate charge vs gate-source voltage**

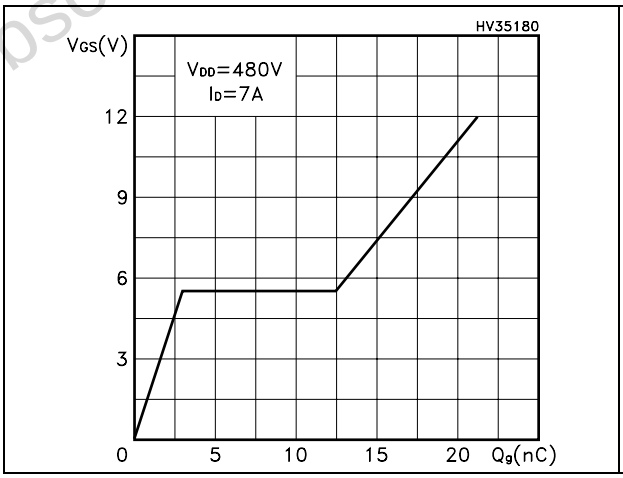



**Figure 13. Capacitance variations**

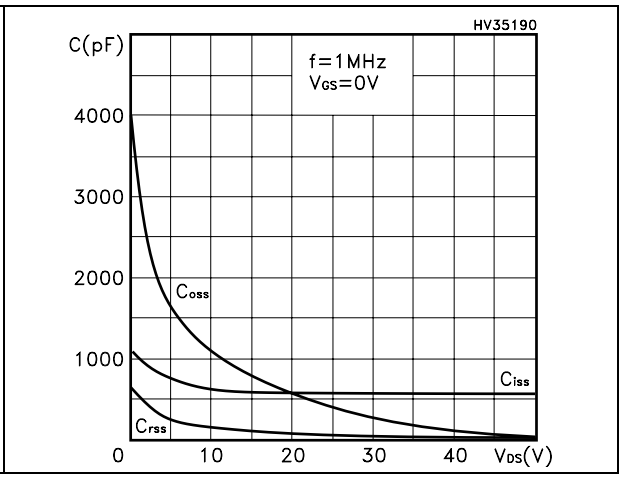


**Figure 14. Normalized gate threshold voltage vs temperature**

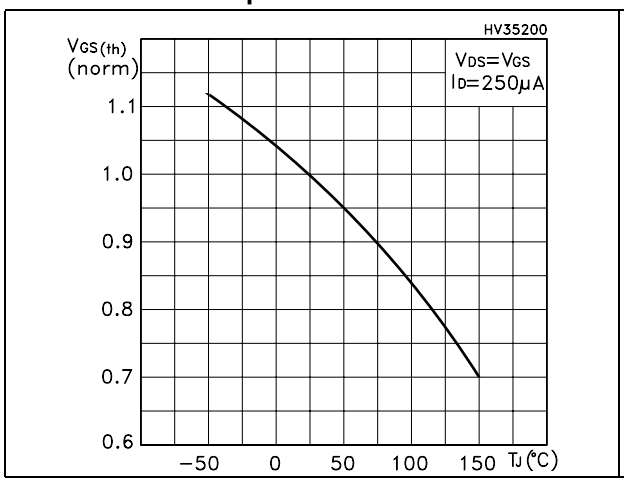



**Figure 15. Normalized on resistance vs temperature**

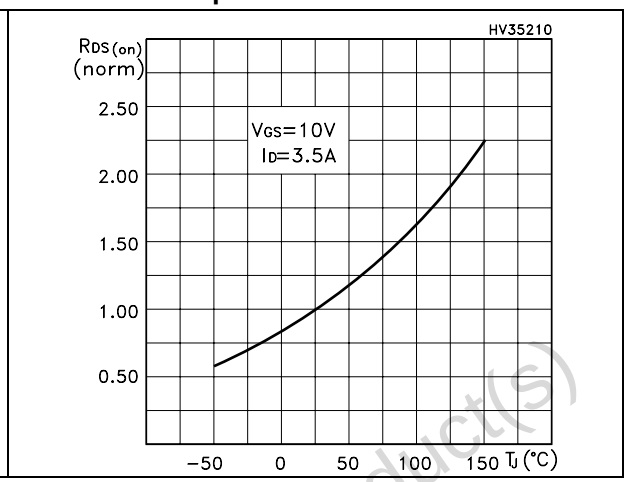



**Figure 16. Source-drain diode forward characteristics**

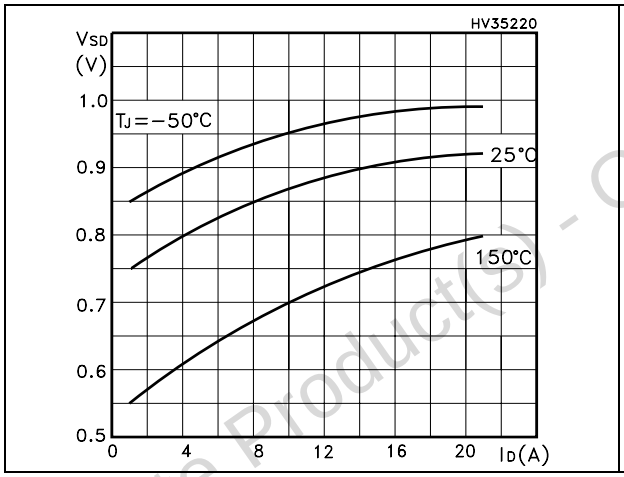
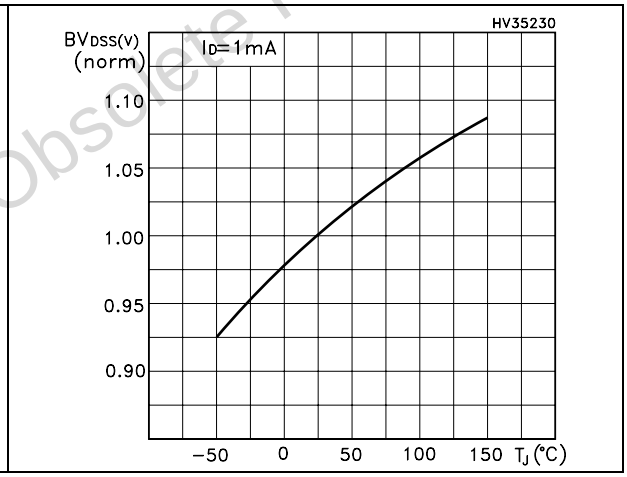



**Figure 17. Normalized $BV_{DSS}$ vs temperature**



# 3 Test circuit

**Figure 18. Switching times test circuit for resistive load**

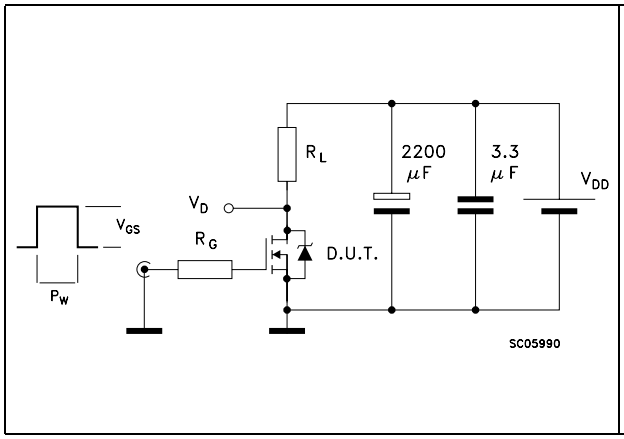



**Figure 19. Gate charge test circuit**

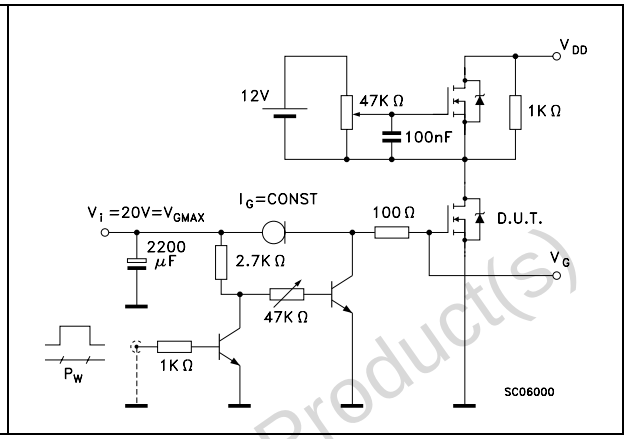



**Figure 20. Test circuit for inductive load switching and diode recovery times**

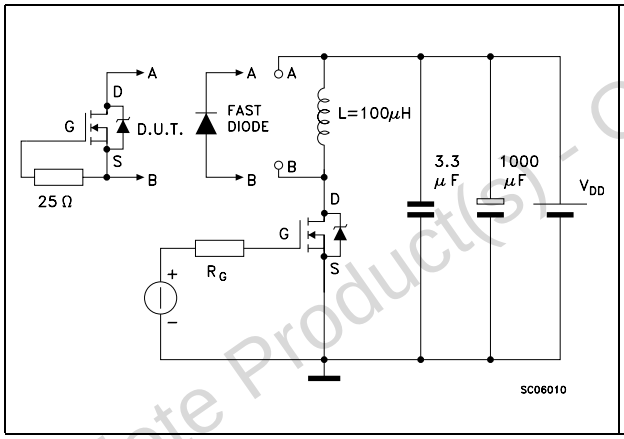



**Figure 21. Unclamped inductive load test circuit**

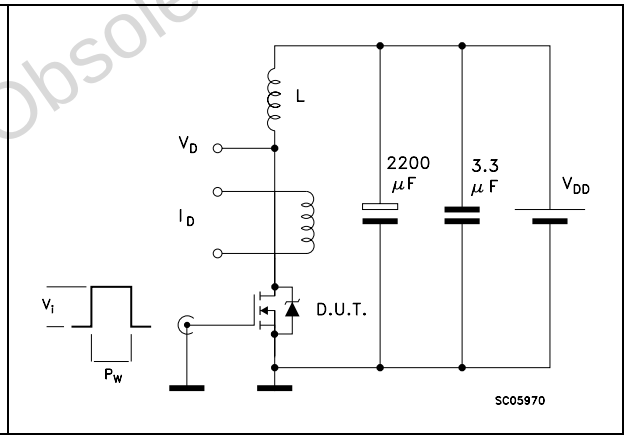



**Figure 22. Unclamped inductive waveform**

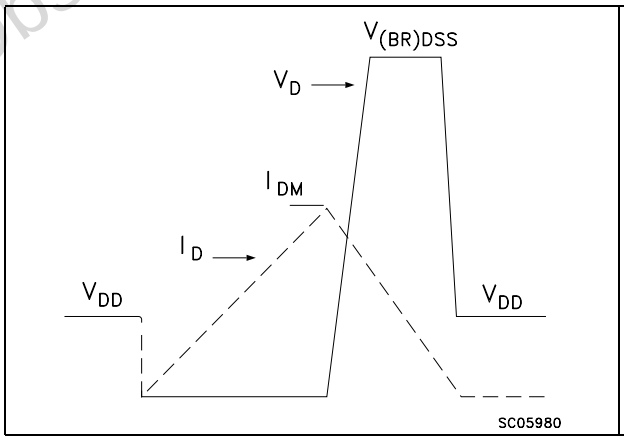
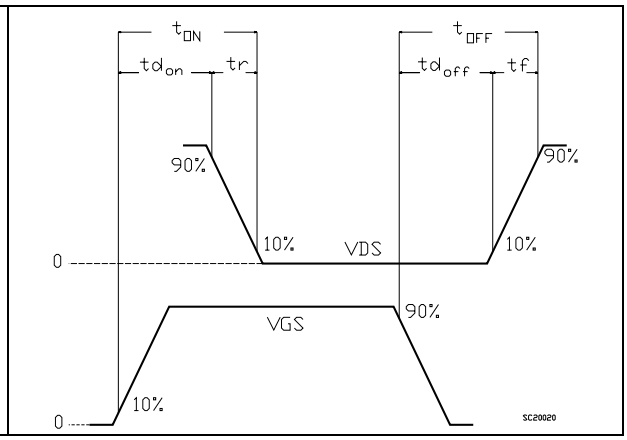



**Figure 23. Switching time waveform**

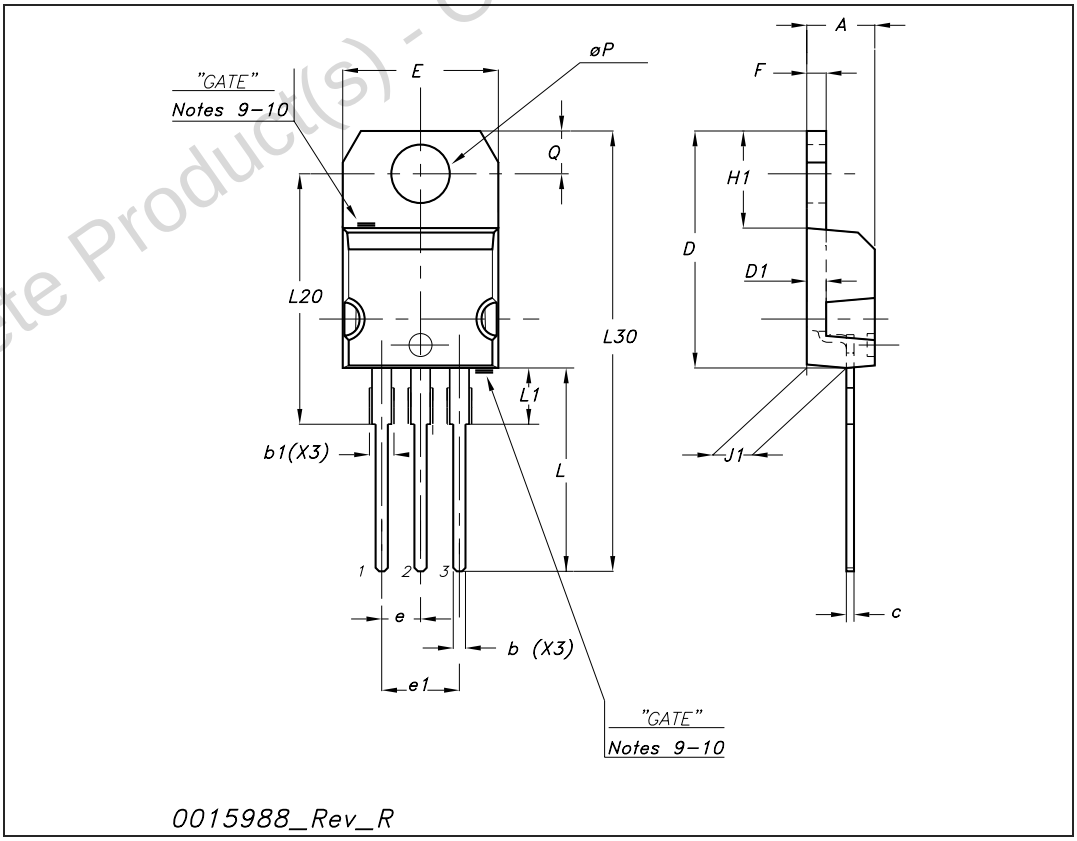


# 4 Package mechanical data

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*

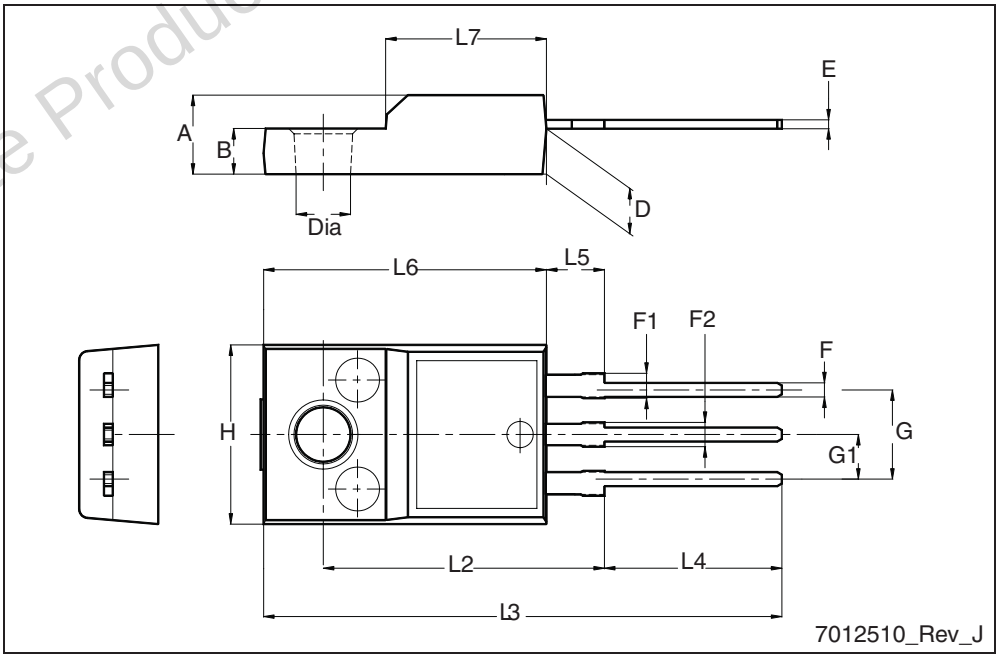
## TO-220 mechanical data

| 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 | |
| ∅P | 3.75 | | 3.85 | 0.147 | | 0.151 |
| Q | 2.65 | | 2.95 | 0.104 | | 0.116 |



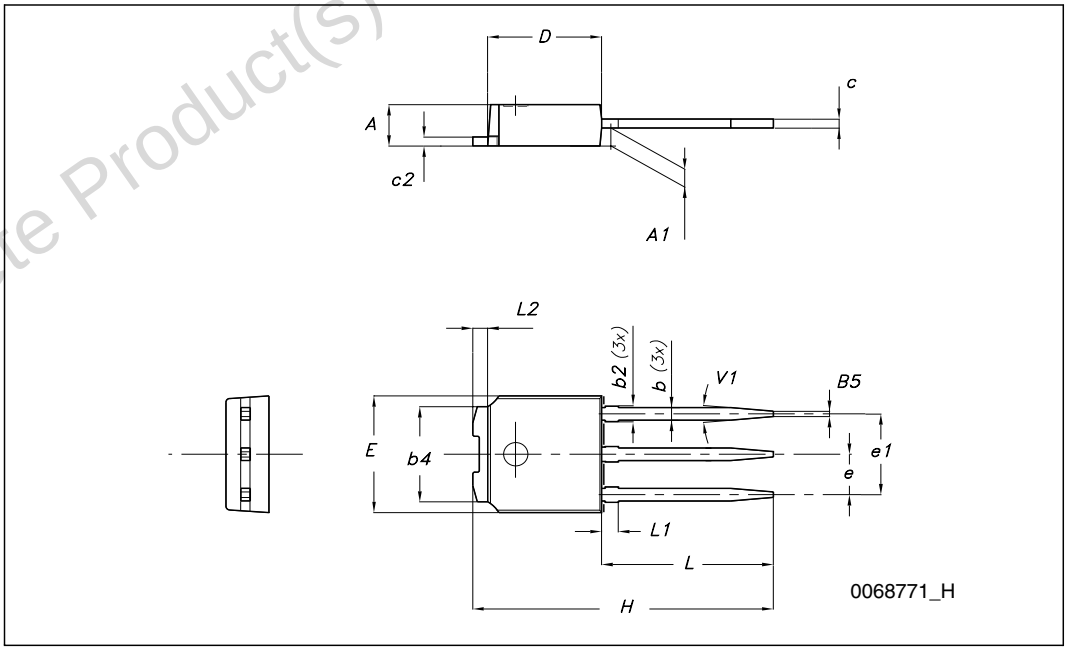
**TO-220FP mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.4 | | 4.6 |
| B | 2.5 | | 2.7 |
| D | 2.5 | | 2.75 |
| E | 0.45 | | 0.7 |
| F | 0.75 | | 1 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.5 |
| G | 4.95 | | 5.2 |
| G1 | 2.4 | | 2.7 |
| H | 10 | | 10.4 |
| L2 | | 16 | |
| L3 | 28.6 | | 30.6 |
| L4 | 9.8 | | 10.6 |
| L5 | 2.9 | | 3.6 |
| L6 | 15.9 | | 16.4 |
| L7 | 9 | | 9.3 |
| Dia | 3 | | 3.2 |



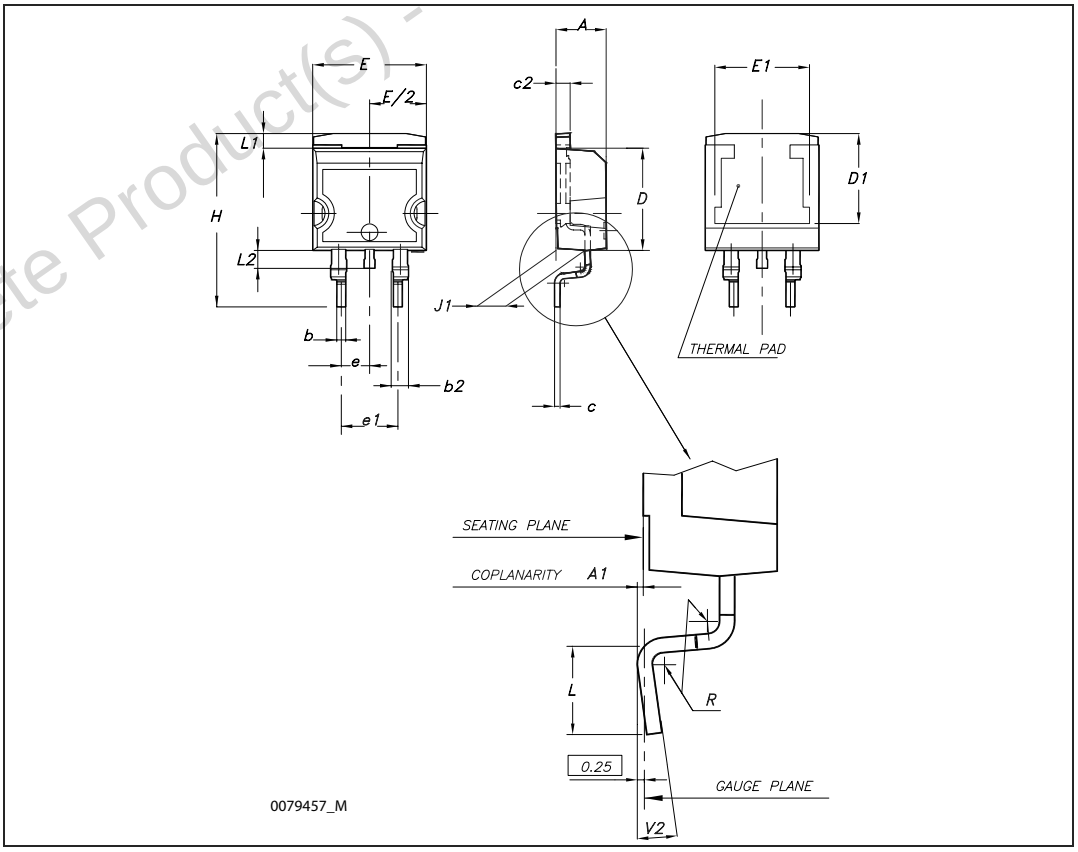
## TO-251 (IPAK) mechanical data

| DIM. | mm. | | |
|---|---|---|---|
| | min. | typ | max. |
| A | 2.20 | | 2.40 |
| A1 | 0.90 | | 1.10 |
| b | 0.64 | | 0.90 |
| b2 | | | 0.95 |
| b4 | 5.20 | | 5.40 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |
| E | 6.40 | | 6.60 |
| e | | 2.28 | |
| e1 | 4.40 | | 4.60 |
| H | | 16.10 | |
| L | 9.00 | | 9.40 |
| (L1) | 0.80 | | 1.20 |
| L2 | | 0.80 | |
| V1 | | 10 ° | |



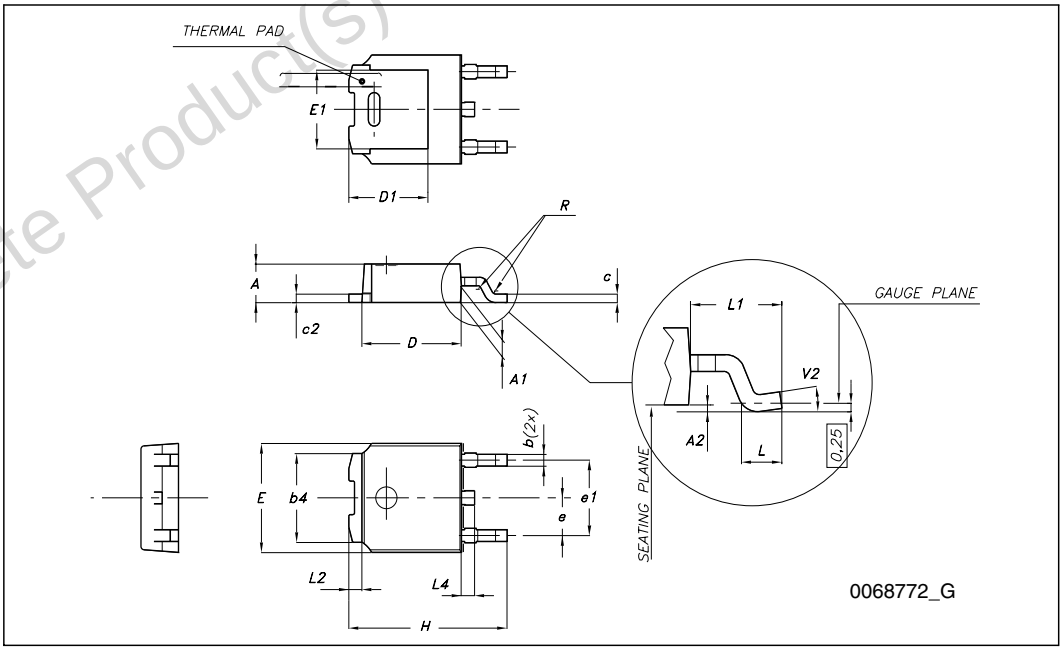
## D²PAK (TO-263) mechanical data

| 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° |



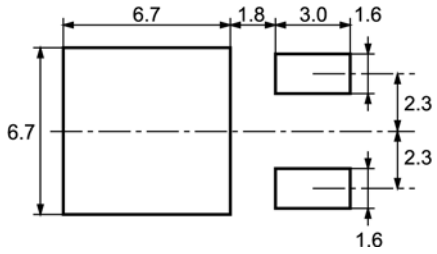
## TO-252 (DPAK) mechanical data

| 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 ° |



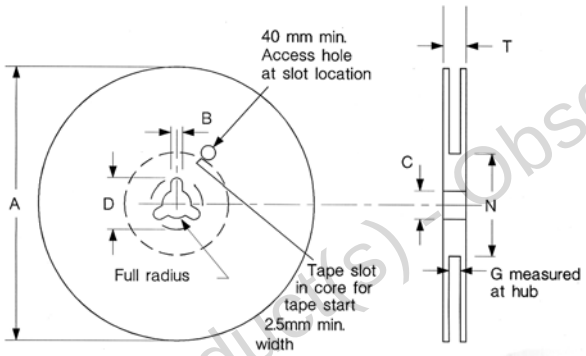
# 5 Packaging mechanical data

### DPAK FOOTPRINT




All dimensions are in millimeters

### TAPE AND REEL SHIPMENT



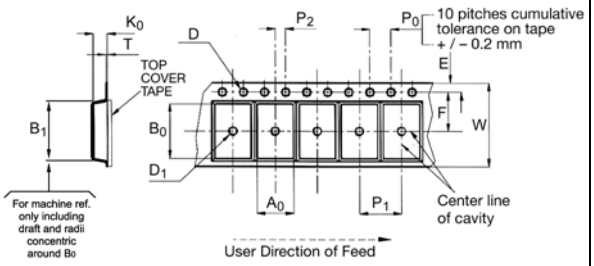

REEL MECHANICAL DATA

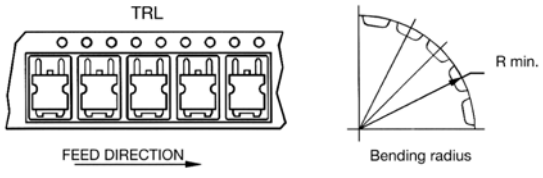
| DIM. | mm | | inch | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | | 330 | | 12.992 |
| B | 1.5 | | 0.059 | |
| C | 12.8 | 13.2 | 0.504 | 0.520 |
| D | 20.2 | | 0.795 | |
| G | 16.4 | 18.4 | 0.645 | 0.724 |
| N | 50 | | 1.968 | |
| T | | 22.4 | | 0.881 |

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

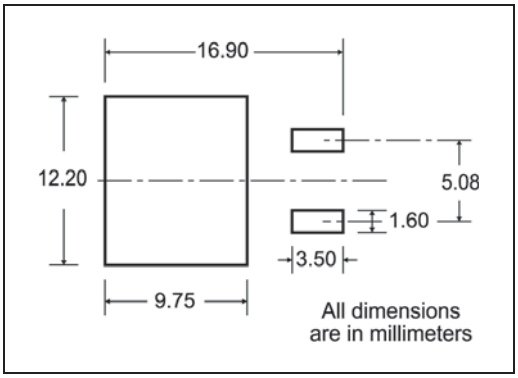
TAPE MECHANICAL DATA

| 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 |

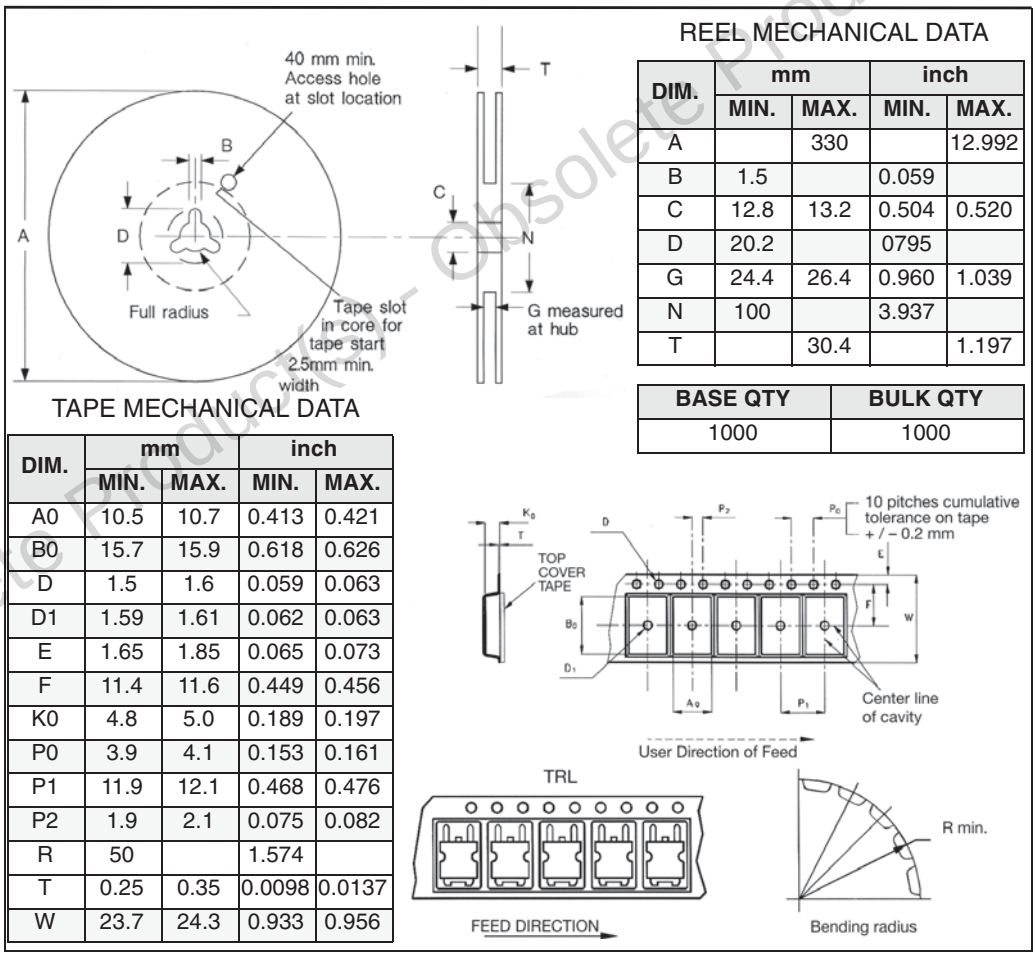


## D²PAK FOOTPRINT




## 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 |

# 6 Revision history

**Table 9. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 29-Aug-2007 | 1 | First release |
| 07-Jan-2008 | 2 | $I_{DSS}$ value has been corrected on *Table 5: On/off states* |
| 21-Nov-2008 | 3 | Added new package, mechanical data. |