# STB15NM60N - STF/I15NM60N
# STP15NM60N - STW15NM60N

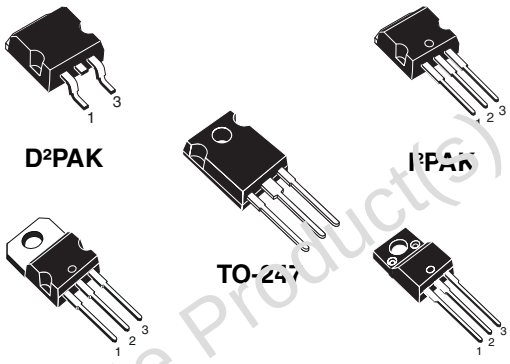
N-channel 600V - 0.270Ω - 14A - $D^2/I^2PAK$ - TO-220/FP - TO-247
Second generation MDmesh™ Power MOSFET

## Features

| Type | $V_{DSS}$ (@Tjmax) | $R_{DS(on)}$ | $I_D$ |
|---|---|---|---|
| STB15NM60N | 650V | < 0.299Ω | 14A |
| STI15NM60N | 650V | < 0.299Ω | 14A |
| STF15NM60N | 650V | < 0.299Ω | 14A (1) |
| STP15NM60N | 650V | < 0.299Ω | 14A |
| STW15NM60N | 650V | < 0.299Ω | 14A |

1. Limited only by maximum temperature allowed

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



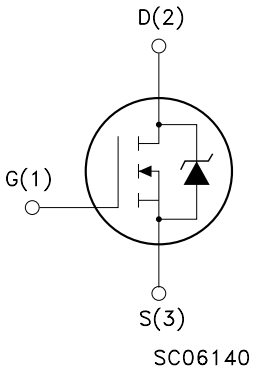

## Description

This series of devices implements 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

## Application

- Switching applications

## Internal schematic diagram




## Order codes

| Part number | Marking | Package | Packaging |
|---|---|---|---|
| STB15NM60N | B15NM60N | D²PAK | Tape & reel |
| STI15NM60N | I15NM60N | I²PAK | Tube |
| STF15NM60N | F15NM60N | TO-220FP | Tube |
| STP15NM60N | P15NM60N | TO-220 | Tube |
| STW15NM60N | W15NM60N | TO-247 | Tube |

Obsolete Product(s) - Obsolete Product(s)

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Obsolete Product(s) - Obsolete Product(s)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | D²PAK/I²PAK TO-220/TO-247 | 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 | 14 | 14 (1) | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100°C | 9 | 9 (1) | A |
| $I_{DM}$ (2) | Drain current (pulsed) | 56 | 56 (1) | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25°C | 125 | 30 | 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=1s;$T_C$=25°C) | -- | 2500 | V |
| $T_j$<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. $I_{SD}$ ≤14A, di/dt ≤400A/µs, $V_{DD}$ = 80% $V_{(BR)DSS}$

**Table 2. Thermal data**

| Symbol | Parameter | D²PAK/I²PAK TO-220/TO-247 | TO-220FP | Unit |
|---|---|---|---|---|
| Rthj-case | Thermal resistance junction-case max | 1 | 4.2 | °C/W |
| Rthj-amb | Thermal resistance junction-amb max | 62.5 | | °C/W |
| $T_l$ | Maximum lead temperature for soldering purposes | 300 | | °C |

**Table 3. Avalanche characteristics**

| Symbol | Parameter | Max value | Unit |
|---|---|---|---|
| $I_{AS}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by Tj max) | 6 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting Tj=25°C, $I_D$=$I_{AS}$, $V_{DD}$= 50V) | 300 | mJ |

Obsolete Product(s) - Obsolete Product(s)

# 2 Electrical characteristics

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

**Table 4. On/off states**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D$ = 1mA, $V_{GS}$= 0 | 600 | | | V |
| dv/dt(1) | Drain-source voltage slope | $V_{DD}$ = 480V,$I_D$ = 14A, $V_{GS}$ = 10V | | 30 | | 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) | $V_{GS}$ = ±20V | | | 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$= $V_{GS}$, $I_D$ = 250µA | 2 | 3 | 4 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$= 10V, $I_D$= 7A | | 0.270 | 0.299 | Ω |

1. Value measured at turn off under inductive load

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$(1) | Forward transconductance | $V_{DS}$ =15V, $I_D$= 7A | | 10 | | S |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS}$ = 50V, f =1MHz,<br>$V_{GS}$ = 0 | | 1250<br>100<br>10 | | pF<br>pF<br>pF |
| $C_{oss\ eq.}$(2) | Equivalent output capacitance | $V_{GS}$ = 0, $V_{DS}$ = 0V to 480V | | 137 | | pF |
| Rg | Gate input resistance | f=1MHz Gate DC Bias=0<br>Test signal level=20mV<br>open drain | | 6.0 | | Ω |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$ = 480V, $I_D$ = 14A<br>$V_{GS}$ = 10V<br>*(see Figure 18)* | | 37<br>6<br>18 | | 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% $V_{DSS}$

Obsolete Product(s) - Obsolete Product(s)

**Table 6. 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 | $V_{DD}$ = 300V, $I_D$ = 7A,<br>$R_G$ = 4.7Ω, $V_{GS}$ = 10V<br>*(see Figure 17)* | | 12<br>14<br>80<br>30 | | ns<br>ns<br>ns<br>ns |

**Table 7. 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) | | | | 14<br>56 | A<br>A |
| $V_{SD}$ (2) | Forward on voltage | $I_{SD}$ = 14A, $V_{GS}$=0 | | | 1.3 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$ =14A, di/dt =100A/µs,<br>$V_{DD}$ = 100V, Tj = 25°C<br>*(see Figure 19)* | | 390<br>5<br>25 | | ns<br>µC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $V_{DD}$ = 100V<br>di/dt =100A/µs, $I_{SD}$ = 14A<br>Tj = 150°C *(see Figure 19)* | | 500<br>7<br>25 | | ns<br>µC<br>A |

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

Obsolete Product(s) - Obsolete Product(s)

## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area for TO-220 / D²PAK / I²PAK**

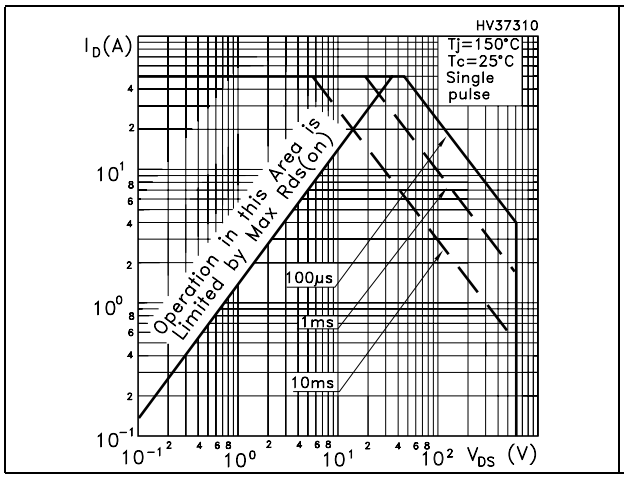



**Figure 2. Thermal impedance for TO-220 / D²PAK / I²PAK**

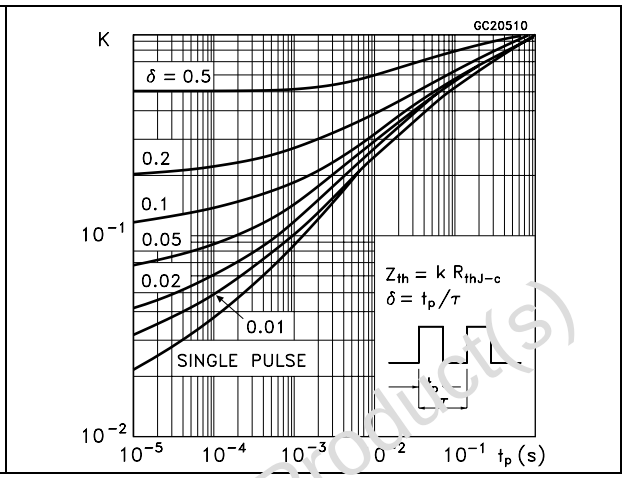



**Figure 3. Safe operating area for TO-220FP**

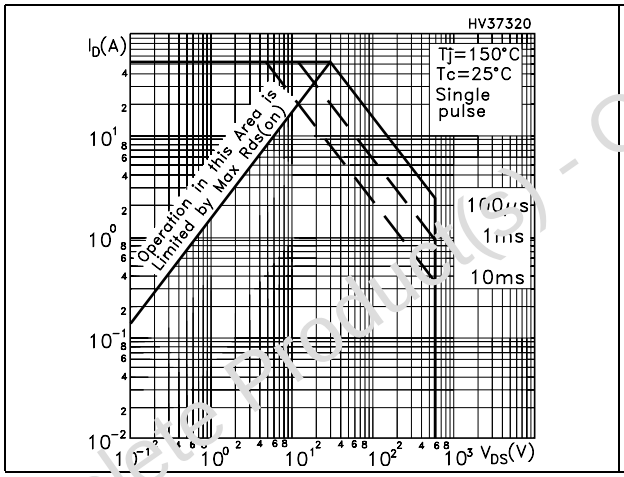



**Figure 4. Thermal impedance for TO-220FP**

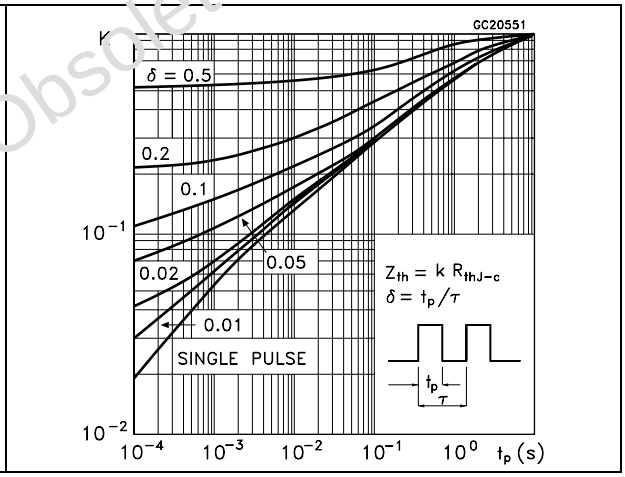



**Figure 5. Safe operating area for TO-247**

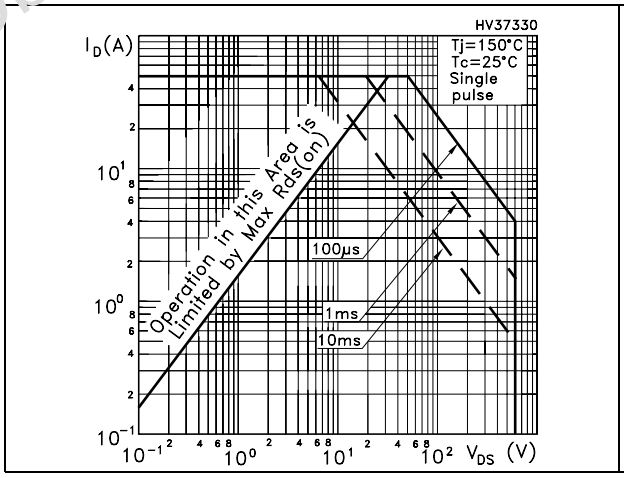
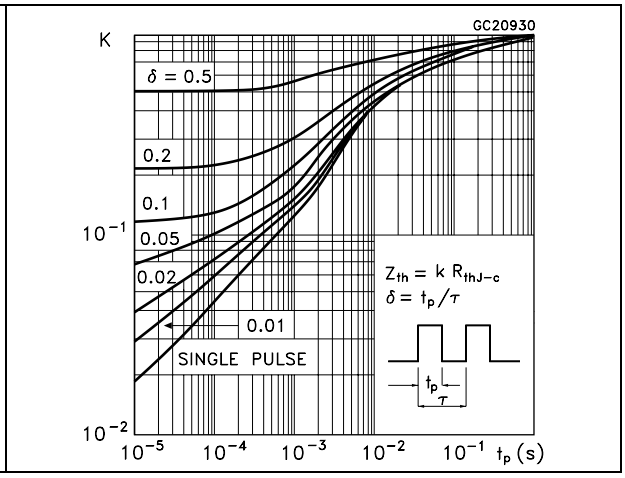



**Figure 6. Thermal impedance for TO-247**




Obsolete Product(s) - Obsolete Product(s)

**Figure 7. Output characteristics**

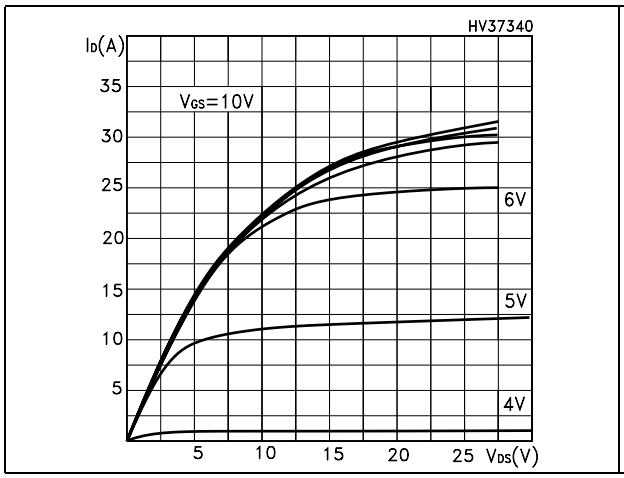



**Figure 8. Transfer characteristics**

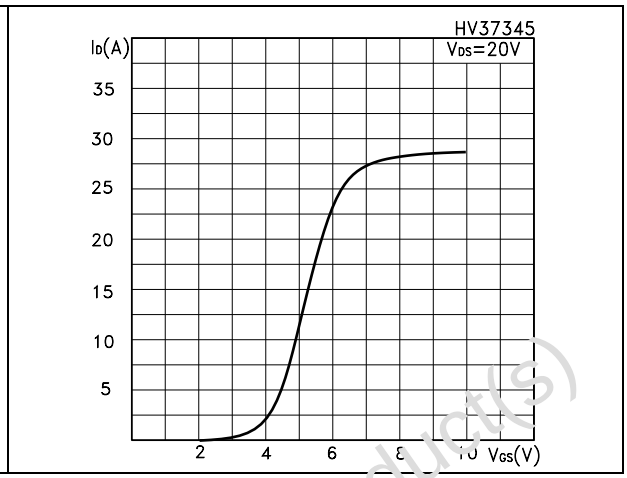



**Figure 9. Transconductance**

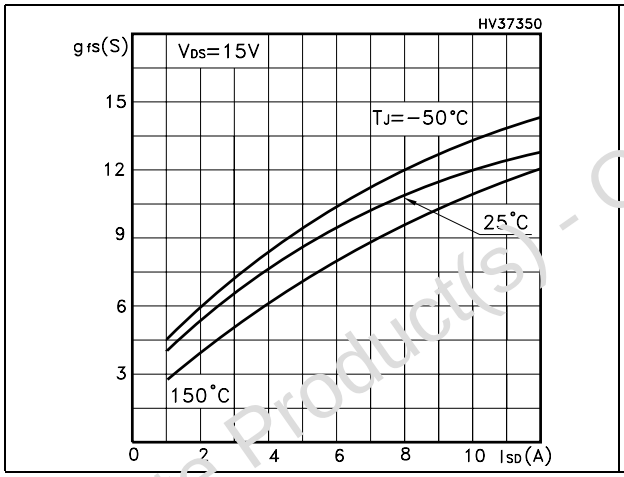



**Figure 10. Static drain-source on resistance**

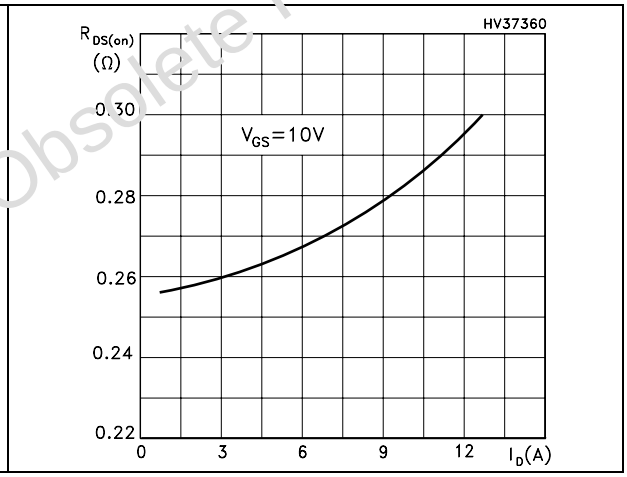



**Figure 11. Gate charge vs gate-source voltage**

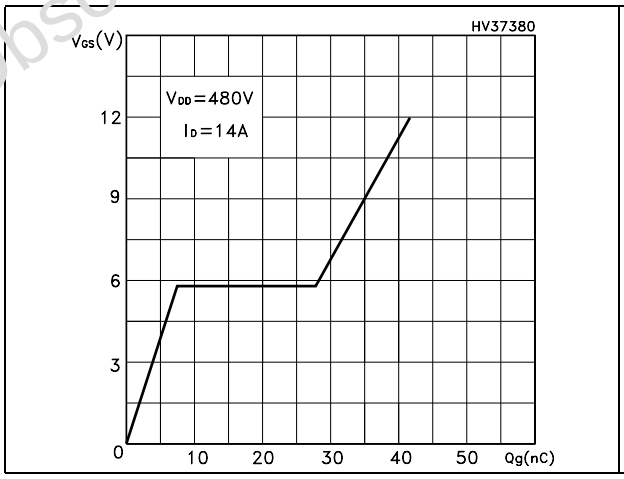
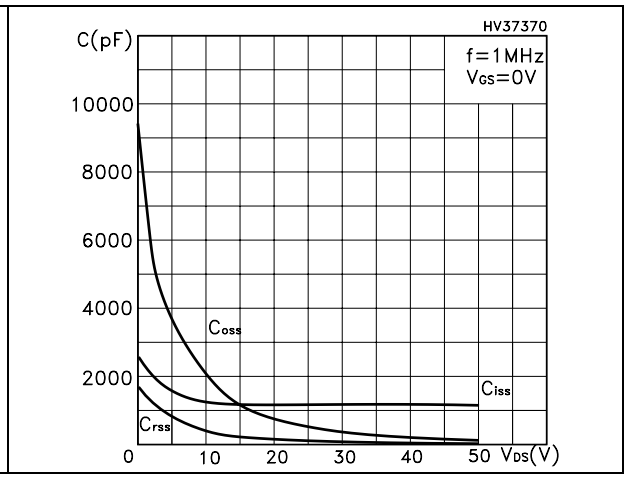



**Figure 12. Capacitance variations**




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**Figure 13. Normalized gate threshold voltage vs temperature**

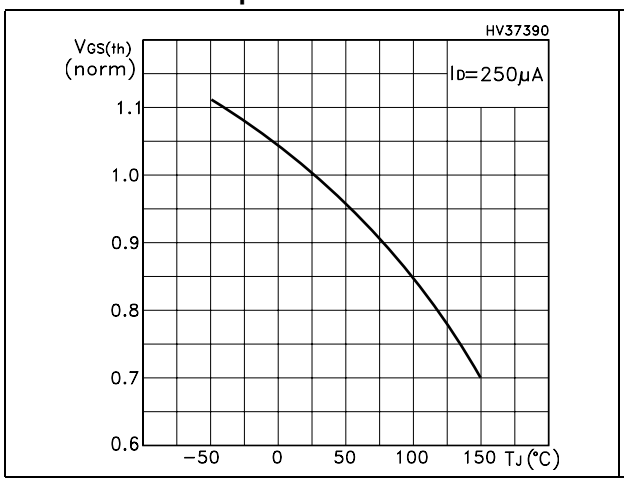



**Figure 14. Normalized on resistance vs temperature**

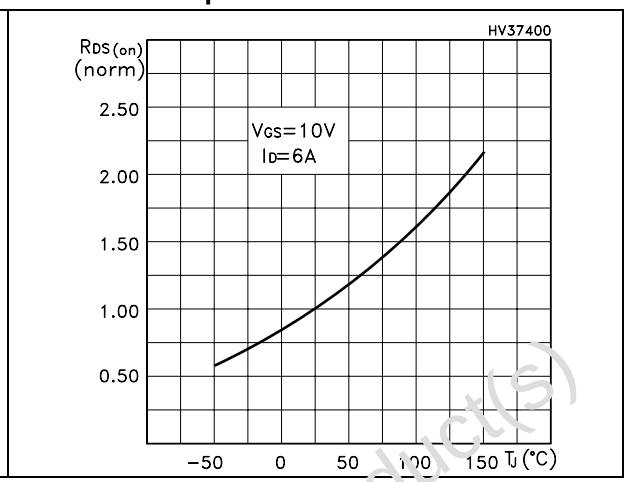



**Figure 15. Source-drain diode forward characteristics**

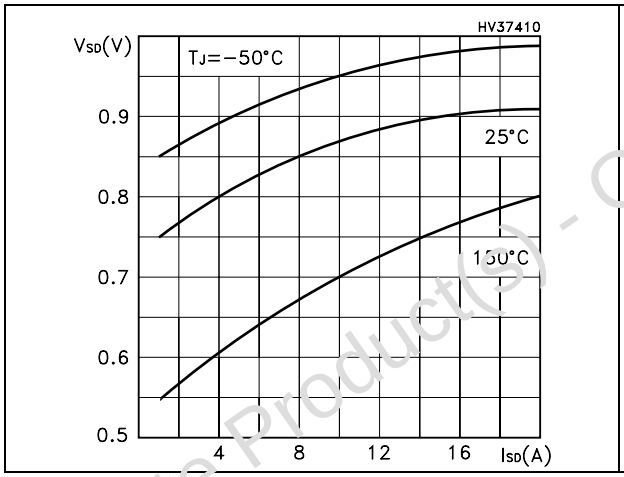
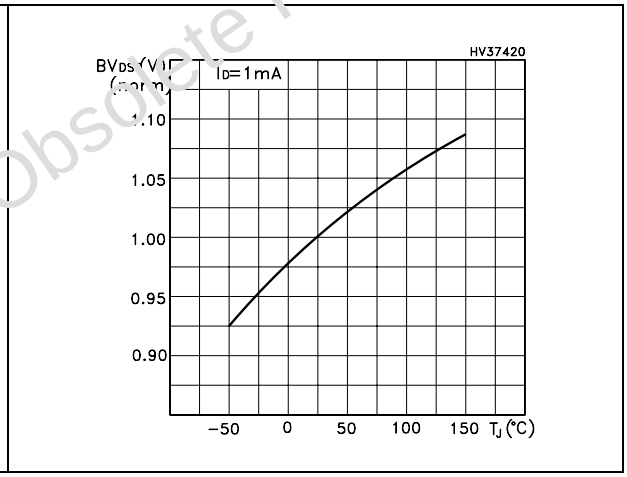



**Figure 16. Normalized $B_{VDSS}$ vs temperature**




Obsolete Product(s) - Obsolete Product(s)

# 3 Test circuit

**Figure 17. Switching times test circuit for resistive load**

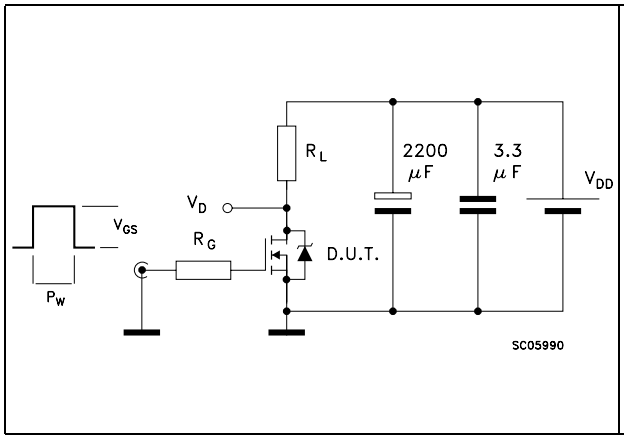



**Figure 18. Gate charge test circuit**

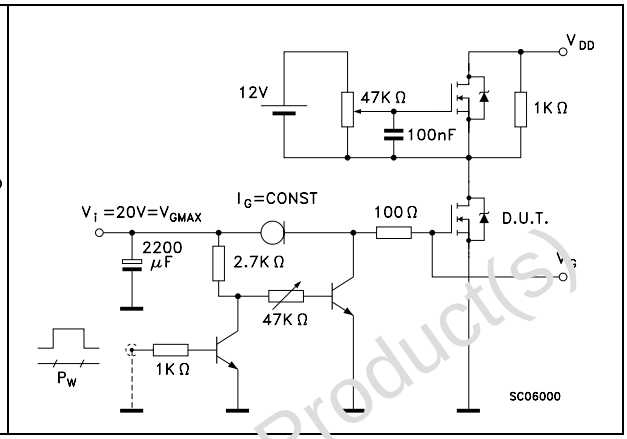



**Figure 19. Test circuit for inductive load switching and diode recovery times**

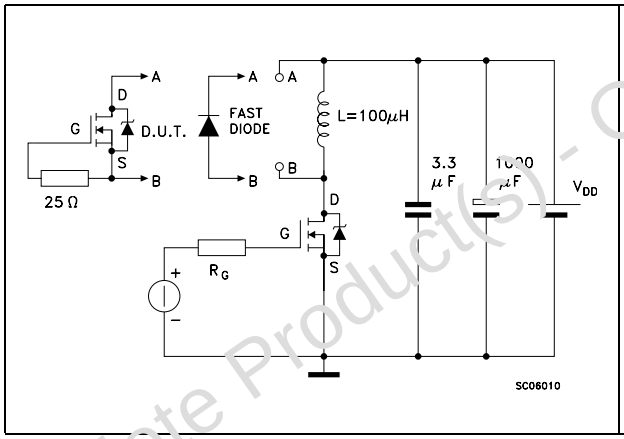



**Figure 20. Unclamped Inductive load test circuit**

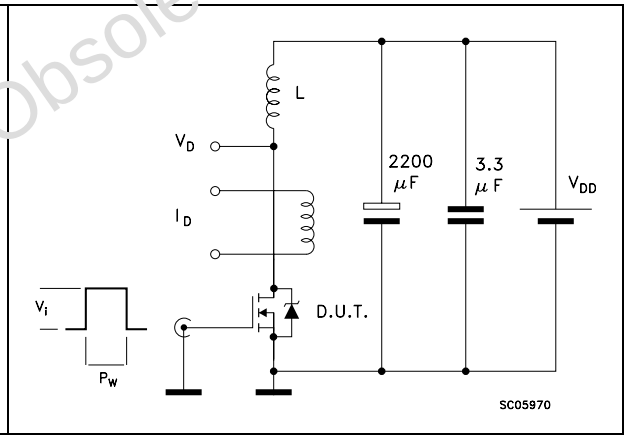



**Figure 21. Unclamped inductive waveform**

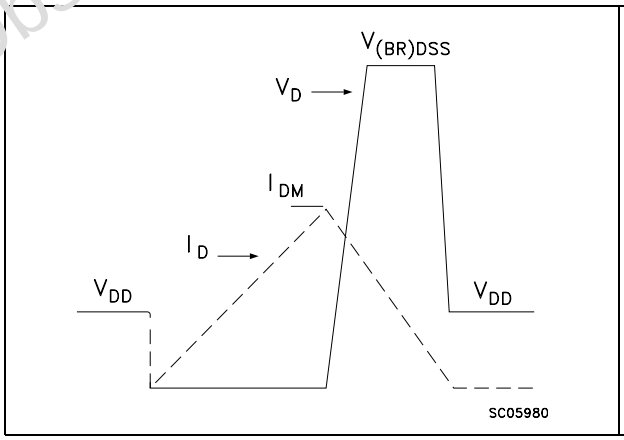
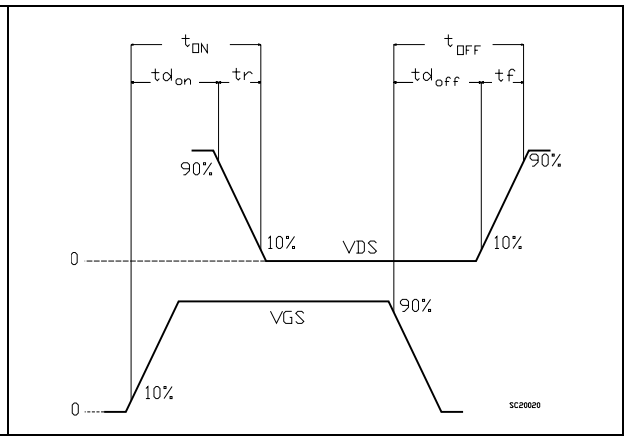



**Figure 22. Switching time waveform**




Obsolete Product(s) - Obsolete Product(s)

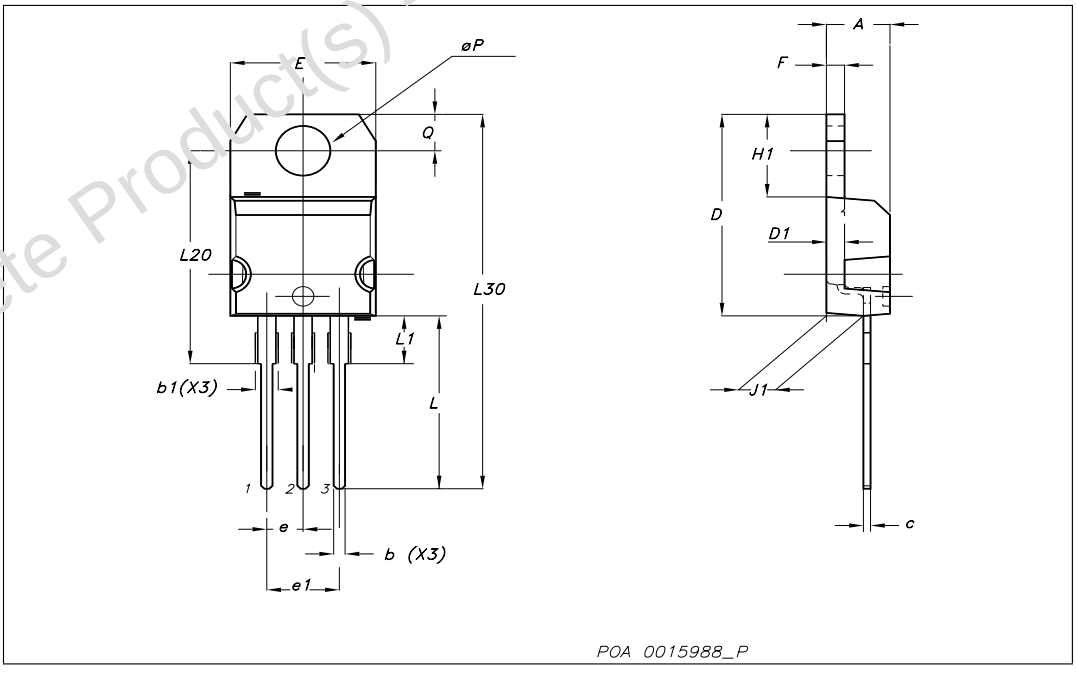
# 4 Package mechanical data

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*

Obsolete Product(s) - Obsolete Product(s)

## TO-220 mechanical data

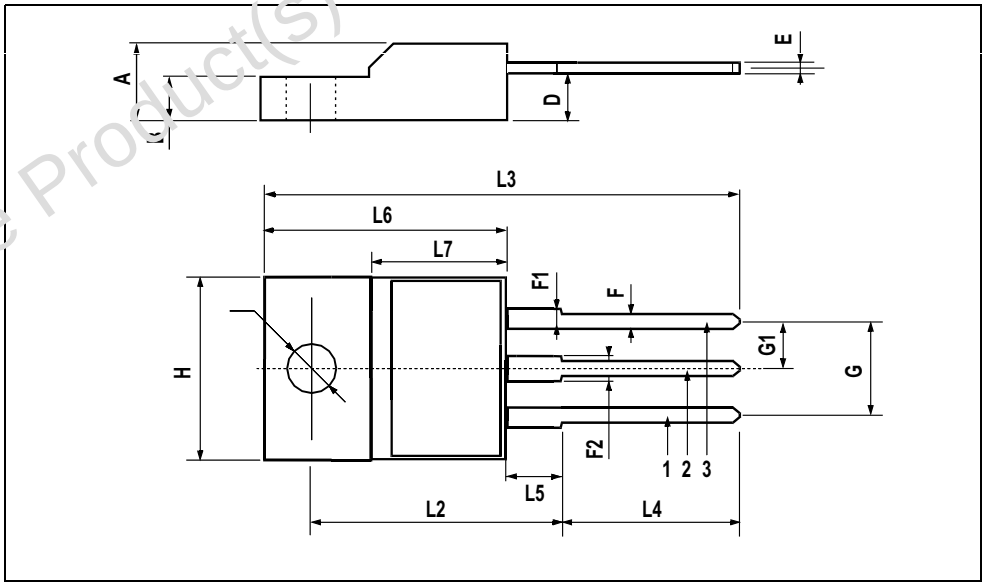
| Dim | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| D | 15.25 | | 15.75 | 0.6 | | 0.62 |
| D1 | | 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 |




Obsolete Product(s) - Obsolete Product(s)

## TO-220FP MECHANICAL DATA

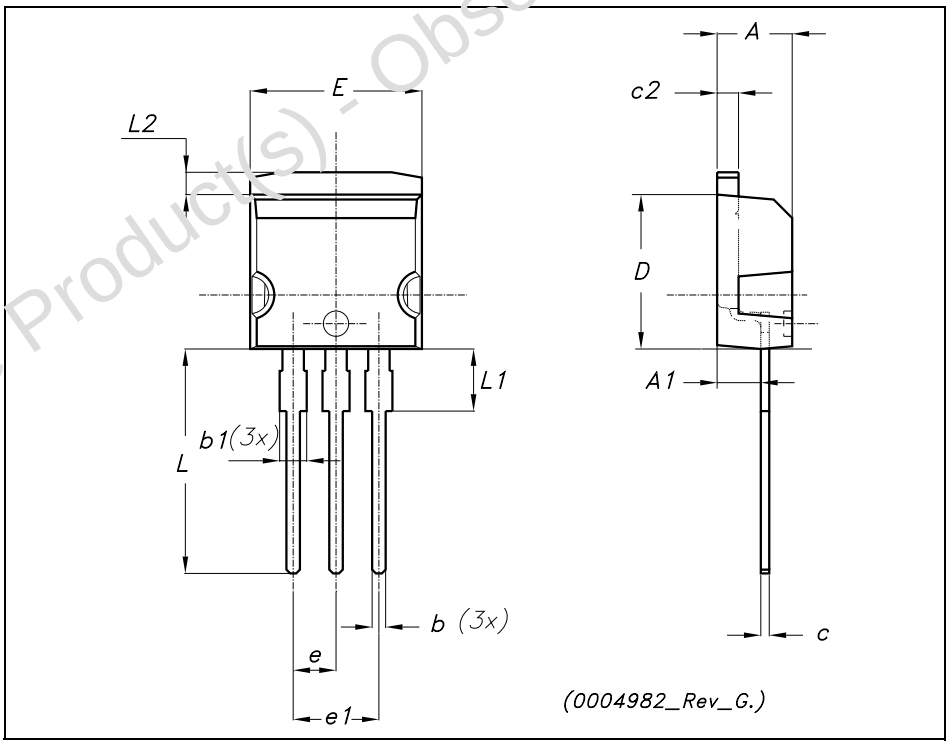
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.4 | | 4.6 | 0.173 | | 0.181 |
| B | 2.5 | | 2.7 | 0.098 | | 0.106 |
| D | 2.5 | | 2.75 | 0.098 | | 0.108 |
| E | 0.45 | | 0.7 | 0.017 | | 0.027 |
| F | 0.75 | | 1 | 0.030 | | 0.039 |
| F1 | 1.15 | | 1.7 | 0.045 | | 0.067 |
| F2 | 1.15 | | 1.7 | 0.045 | | 0.067 |
| G | 4.95 | | 5.2 | 0.195 | | 0.204 |
| G1 | 2.4 | | 2.7 | 0.094 | | 0.106 |
| H | 10 | | 10.4 | 0.393 | | 0.409 |
| L2 | | 16 | | | 0.630 | |
| L3 | 28.6 | | 30.6 | 1.126 | | 1.204 |
| L4 | 9.8 | | 10.6 | 0385 | | 0.417 |
| L5 | 2.9 | | 3.6 | 0.114 | | 0.141 |
| L6 | 15.9 | | 16.4 | 0.626 | | 0.645 |
| L7 | 9 | | 9.3 | 0.354 | | 0.366 |
| Ø | 3 | | 3.2 | 0.118 | | 0.126 |




Obsolete Product(s) - Obsolete Product(s)

## TO-262 ($I^2PAK$) MECHANICAL DATA

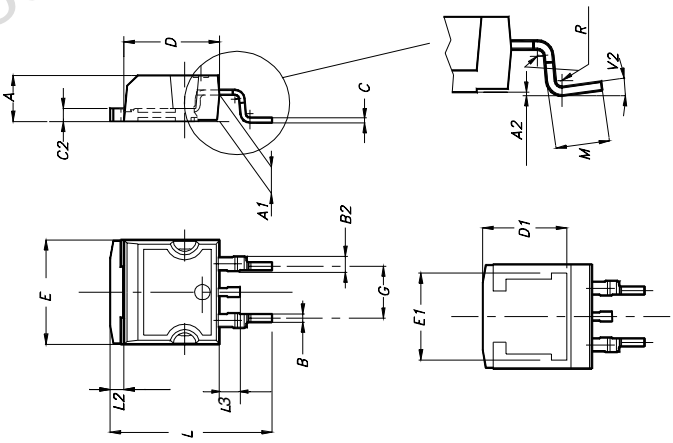
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| A1 | 2.40 | | 2.72 | 0.094 | | 0.107 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| 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 |




Obsolete Product(s) - Obsolete Product(s)

## $D^2PAK$ MECHANICAL DATA

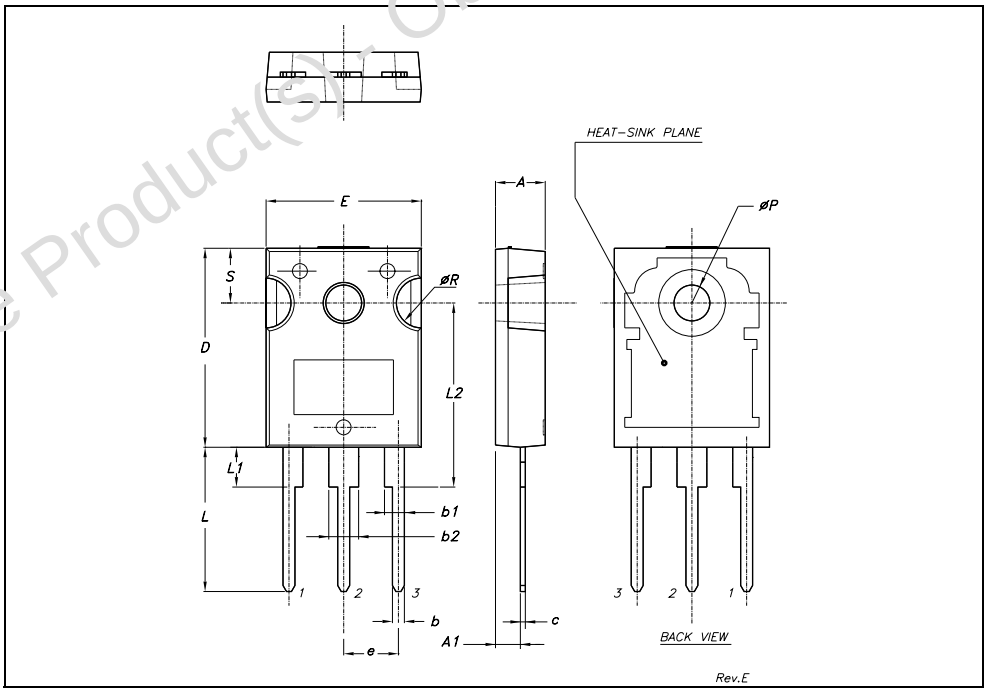
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.4 | | 4.6 | 0.173 | | 0.181 |
| A1 | 2.49 | | 2.69 | 0.098 | | 0.106 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| B | 0.7 | | 0.93 | 0.027 | | 0.036 |
| B2 | 1.14 | | 1.7 | 0.044 | | 0.067 |
| 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° | | | |




Obsolete Product(s) - Obsolete Product(s)

## TO-247 MECHANICAL DATA

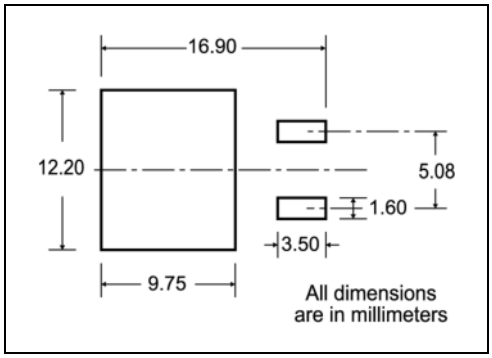
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.85 | | 5.15 | 0.19 | | 0.20 |
| A1 | 2.20 | | 2.60 | 0.086 | | 0.102 |
| b | 1.0 | | 1.40 | 0.039 | | 0.055 |
| b1 | 2.0 | | 2.40 | 0.079 | | 0.094 |
| b2 | 3.0 | | 3.40 | 0.118 | | 0.134 |
| c | 0.40 | | 0.80 | 0.015 | | 0.03 |
| D | 19.85 | | 20.15 | 0.781 | | 0.793 |
| E | 15.45 | | 15.75 | 0.608 | | 0.620 |
| e | | 5.45 | | | 0.214 | |
| L | 14.20 | | 14.80 | 0.560 | | 0.582 |
| L1 | 3.70 | | 4.30 | 0.14 | | 0.17 |
| L2 | | 18.50 | | | 0.728 | |
| øP | 3.55 | | 3.65 | 0.140 | | 0.143 |
| øR | 4.50 | | 5.50 | 0.177 | | 0.216 |
| S | | 5.50 | | | 0.216 | |



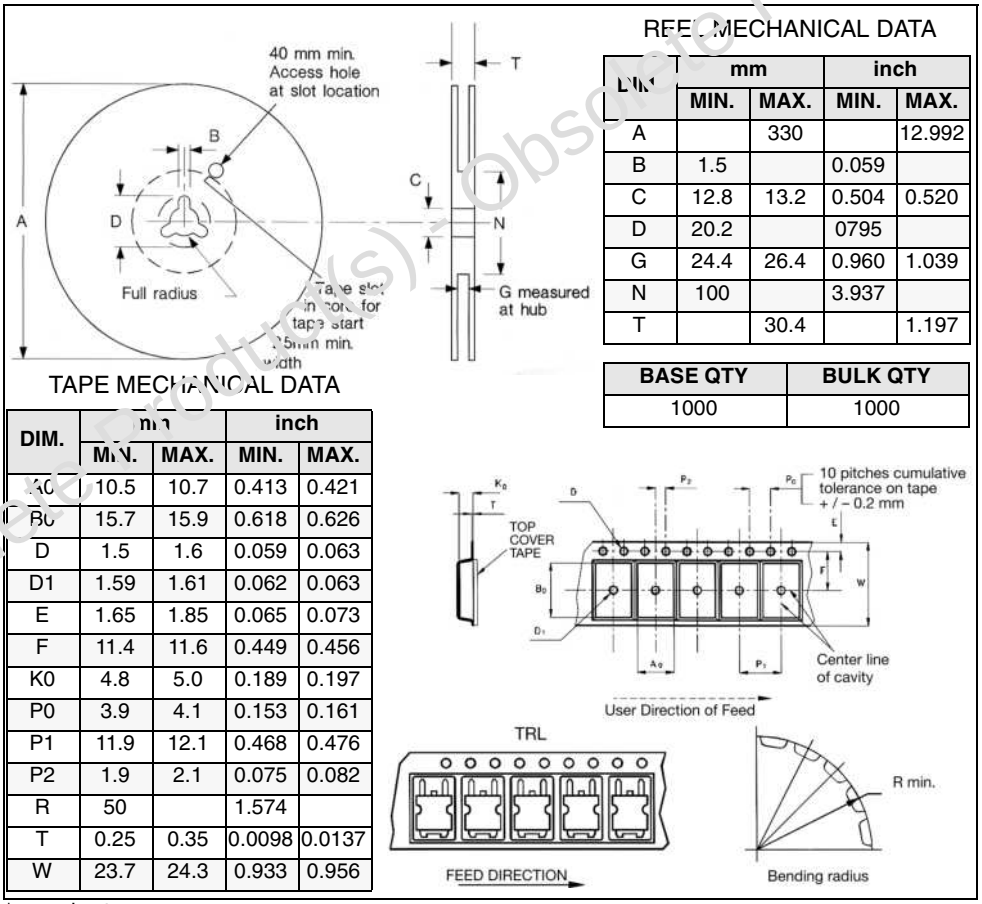

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# 5 Packaging mechanical data

## 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

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# 6 Revision history

**Table 8. Revision history**

| Date | Revision | Changes |
|---|---|---|
| 03-May-2007 | 1 | First release |

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