



STB5NK50Z/-1 - STD5NK50Z/-1 STP5NK50Z - STP5NK50ZFP

N-CHANNEL 500V - 1.22Ω - 4.4A TO-220/FP-D/IPAK-D²/I²PAK
Zener-Protected SuperMESH™ MOSFET

Table 1: General Features

| TYPE | V _{DSS} | R _{DS(on)} | I _D | P _w |
|-------------|------------------|---------------------|----------------|----------------|
| STB5NK50Z | 500 V | < 1.5 Ω | 4.4 A | 70 W |
| STB5NK50Z-1 | 500 V | < 1.5 Ω | 4.4 A | 70 W |
| STD5NK50Z | 500 V | < 1.5 Ω | 4.4 A | 70 W |
| STD5NK50Z-1 | 500 V | < 1.5 Ω | 4.4 A | 70 W |
| STP5K50Z | 500 V | < 1.5 Ω | 4.4 A | 70 W |
| STP5K50ZFP | 500 V | < 1.5 Ω | 4.4 A | 25 W |

- TYPICAL R_{DS(on)} = 1.22 Ω
- EXTREMELY HIGH dv/dt CAPABILITY
- IMPROVED ESD CAPABILITY
- 100% AVALANCHE RATED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY

DESCRIPTION

The SuperMESH™ series is obtained through an extreme optimization of ST's well established stripbased PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements ST full range of high voltage MOSFETs including revolutionary MDmesh™ products.

APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- IDEAL FOR OFF-LINE POWER SUPPLIES, ADAPTORS AND PFC
- LIGHTING

Table 2: Order Codes

| SALES TYPE | MARKING | PACKAGE | PACKAGING |
|-------------|-----------|--------------------|-------------|
| STB5NK50ZT4 | B5NK50Z | D ² PAK | TAPE & REEL |
| STB5NK50Z-1 | B5NK50Z | I ² PAK | TUBE |
| STD5NK50ZT4 | D5NK50Z | DPAK | TAPE & REEL |
| STD5NK50Z-1 | D5NK50Z | IPAK | TUBE |
| STP5NK50Z | P5NK50Z | TO-220 | TUBE |
| STP5NK50ZFP | P5NK50ZFP | TO-220FP | TUBE |

Figure 1: Package

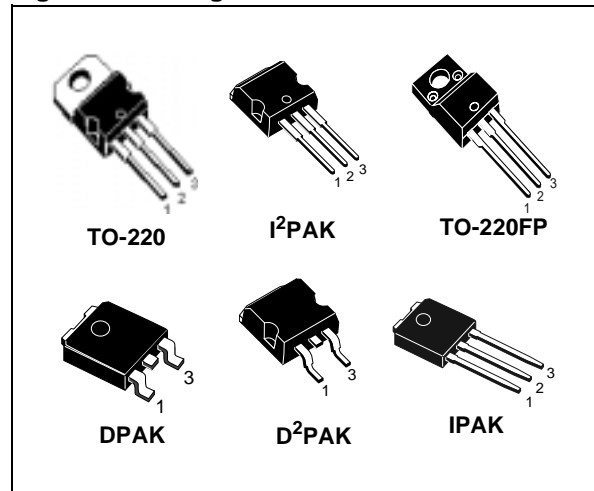
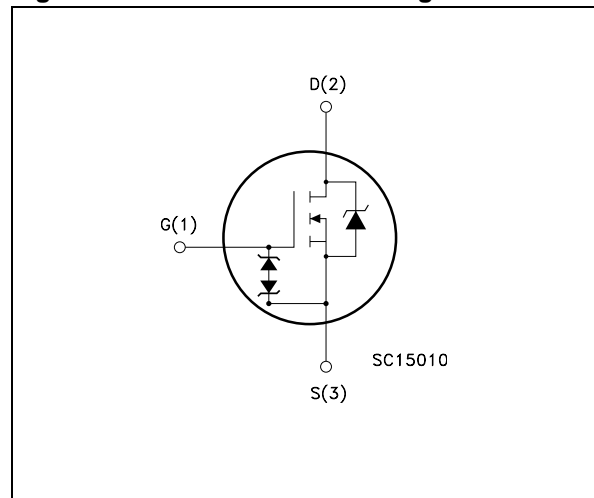


Figure 2: Internal Schematic Diagram



Rev. 4

STB5NK50Z/-1 - STD5NK50Z/-1 - STP5NK50Z - STP5NK50ZFP

Table 3: Absolute Maximum ratings

| Symbol | Parameter | Value | | | Unit |
|-----------------------|--|---------------------------|-------------|--------------------------|------|
| | | STP5NK50Z STB5NK50Z/-1 | STP5NK50ZFP | STD5NK50Z STD5NK50Z-1 | |
| V _{DS} | Drain-source Voltage (V _{GS} = 0) | 500 | | | V |
| V _{DGR} | Drain-gate Voltage (R _{GS} = 20 kΩ) | 500 | | | V |
| V _{GS} | Gate- source Voltage | ± 30 | | | V |
| I _D | Drain Current (continuous) at T _C = 25°C | 4.4 | 4.4 (*) | 4.4 | A |
| I _D | Drain Current (continuous) at T _C = 100°C | 2.7 | 2.7 (*) | 2.7 | A |
| I _{DM} (•) | Drain Current (pulsed) | 17.6 | 17.6 (*) | 17.6 | A |
| P _{TOT} | Total Dissipation at T _C = 25°C | 70 | 25 | 70 | W |
| | Derating Factor | 0.56 | 0.2 | 0.56 | W/°C |
| V _{ESD(G-S)} | Gate source ESD(HBM-C=100pF, R=1.5KΩ) | 3000 | | | V |
| dv/dt (1) | Peak Diode Recovery voltage slope | 4.5 | | | V/ns |
| V _{ISO} | Insulation Withstand Voltage (DC) | - | 2500 | - | V |
| T _j | Operating Junction Temperature | -55 to 150 | | | °C |
| T _{stg} | Storage Temperature | -55 to 150 | | | °C |

(•) Pulse width limited by safe operating area

(1) I_{SD} ≤ 4.4A, di/dt ≤ 200A/μs, V_{DD} ≤ V_{(BR)DSS}, T_j ≤ T_{JMAX}.

(*) Limited only by maximum temperature allowed

Table 4: Thermal Data

| | | TO-220 I ² PAK/D ² PAK | TO-220FP | DPAK | |
|-----------------------|--|---|----------|------|------|
| R _{thj-case} | Thermal Resistance Junction-case Max | 1.78 | 5 | 1.78 | °C/W |
| R _{thj-amb} | Thermal Resistance Junction-ambient Max | 62.5 | | | °C/W |
| T _I | Maximum Lead Temperature For Soldering Purpose | 300 | | | °C |

Table 5: Avalanche Characteristics

| Symbol | Parameter | Max Value | Unit |
|-----------------|--|-----------|------|
| I _{AR} | Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T _j max) | 4.4 | A |
| E _{AS} | Single Pulse Avalanche Energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V) | 130 | mJ |

Table 6: Gate-Source Zener Diode

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-------------------|-------------------------------|-------------------------------------|------|------|------|------|
| BV _{GSO} | Gate-Source Breakdown Voltage | I _{gs} =± 1mA (Open Drain) | 30 | | | V |

PROTECTION FEATURES OF GATE-TO-SOURCE ZENER DIODES

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

ELECTRICAL CHARACTERISTICS ($T_{CASE} = 25^{\circ}C$ UNLESS OTHERWISE SPECIFIED)

Table 7: On /Off

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---------------|--|--|------|------|----------|--------------------|
| $V_{(BR)DSS}$ | Drain-source Breakdown Voltage | $I_D = 1 \text{ mA}, V_{GS} = 0$ | 500 | | | V |
| I_{DSS} | Zero Gate Voltage Drain Current ($V_{GS} = 0$) | $V_{DS} = \text{Max Rating}$ $V_{DS} = \text{Max Rating}, T_C = 125^{\circ}C$ | | | 1 50 | μA μA |
| I_{GSS} | Gate-body Leakage Current ($V_{DS} = 0$) | $V_{GS} = \pm 20 \text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS} = V_{GS}, I_D = 50 \mu A$ | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static Drain-source On Resistance | $V_{GS} = 10 \text{ V}, I_D = 2.2 \text{ A}$ | | 1.22 | 1.5 | Ω |

Table 8: Dynamic

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|--|------|----------------------|------|----------------------|
| g_{fs} (1) | Forward Transconductance | $V_{DS} = 15 \text{ V}, I_D = 2.2 \text{ A}$ | | 3.1 | | S |
| C_{iss} C_{oss} C_{rss} | Input Capacitance Output Capacitance Reverse Transfer Capacitance | $V_{DS} = 25 \text{ V}, f = 1 \text{ MHz}, V_{GS} = 0$ | | 535 75 17 | | pF pF pF |
| $C_{OSS \text{ eq}}$ (3). | Equivalent Output Capacitance | $V_{GS} = 0 \text{ V}, V_{DS} = 0 \text{ to } 400 \text{ V}$ | | 45 | | pF |
| $t_{d(on)}$ t_r $t_{d(off)}$ t_f | Turn-on Delay Time Rise Time Turn-off-Delay Time Fall Time | $V_{DD} = 250 \text{ V}, I_D = 2.2 \text{ A},$ $R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$ (see Figure 19) | | 15 10 32 15 | | ns ns ns ns |
| Q_g Q_{gs} Q_{gd} | Total Gate Charge Gate-Source Charge Gate-Drain Charge | $V_{DD} = 400 \text{ V}, I_D = 4.4 \text{ A},$ $V_{GS} = 10 \text{ V}$ (see Figure 22) | | 20 4 10 | 28 | nC nC nC |

Table 9: Source Drain Diode

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------------------------------|--|--|------|--------------------|-------------|---------------|
| I_{SD} I_{SDM} (2) | Source-drain Current Source-drain Current (pulsed) | | | | 4.4 17.6 | A A |
| V_{SD} (1) | Forward On Voltage | $I_{SD} = 4.4 \text{ A}, V_{GS} = 0$ | | | 1.6 | V |
| t_{rr} Q_{rr} I_{RRM} | Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current | $I_{SD} = 4.4 \text{ A}, di/dt = 100 \text{ A}/\mu s$ $V_{DD} = 30V, T_j = 150^{\circ}C$ (see Figure 20) | | 310 1425 9.2 | | ns nC A |

(1) Pulsed: Pulse duration = 300 μs , duty cycle 1.5 %.

(2) Pulse width limited by safe operating area.

(3) $C_{OSS \text{ eq}}$ 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} .

Figure 3: Safe Operating Area For DPAK/IPAK/
D²PAK/I²PAK/TO-220

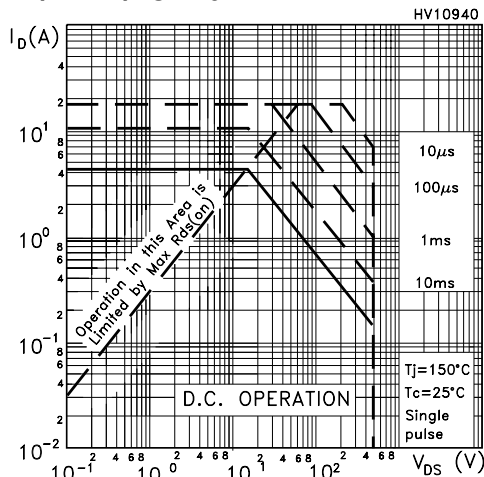


Figure 4: Thermal Impedance For DPAK/IPAK/
D²PAK/I²PAK/TO-220

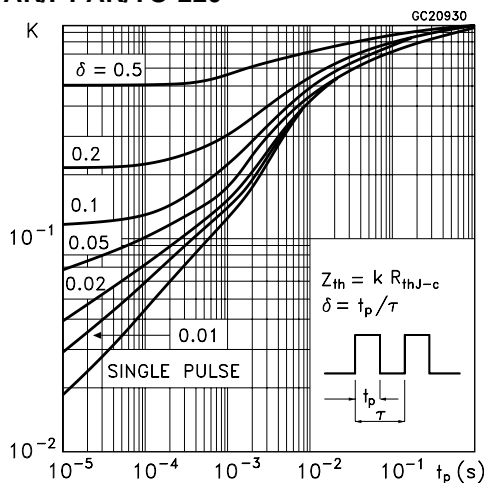


Figure 5: Output Characteristics

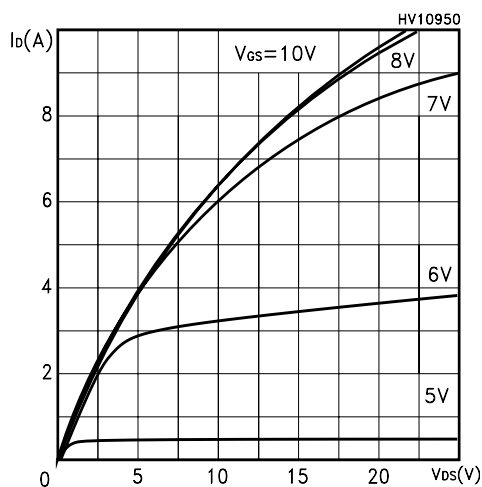


Figure 6: Safe Operating Area For TO-220FP

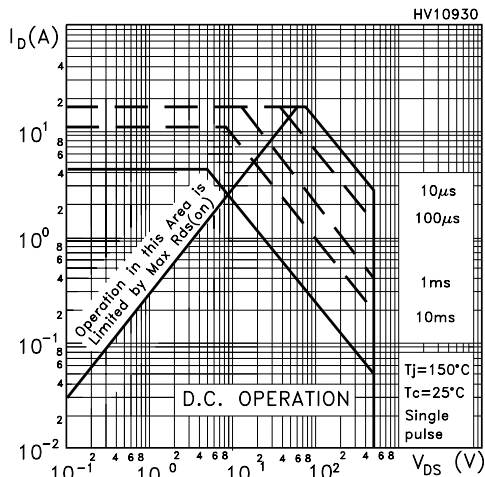


Figure 7: Thermal Impedance For TO-220FP

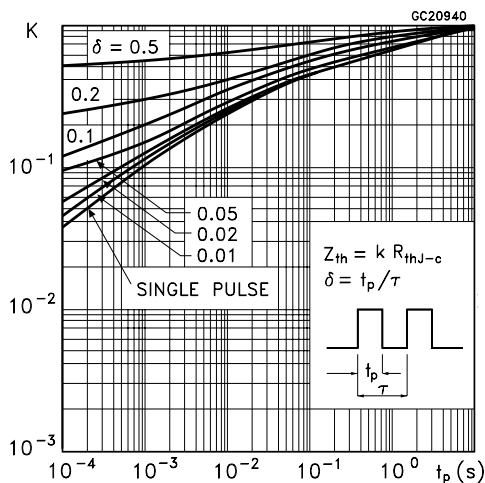


Figure 8: Transfer Characteristics

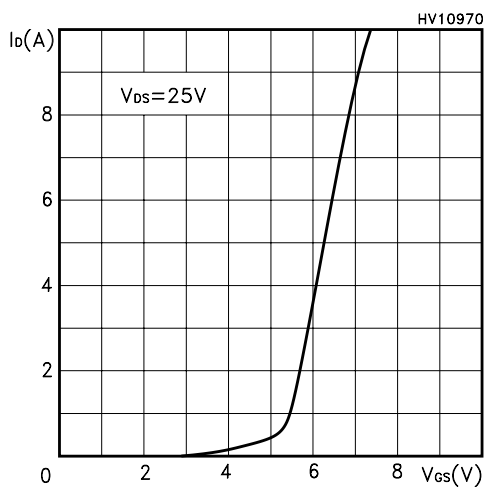


Figure 9: Transconductance

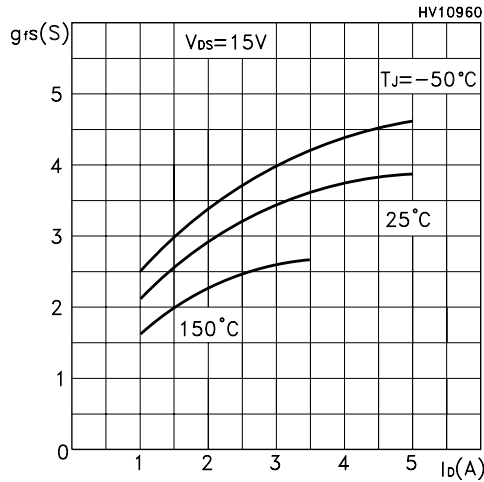


Figure 10: Gate Charge vs Gate-source Voltage

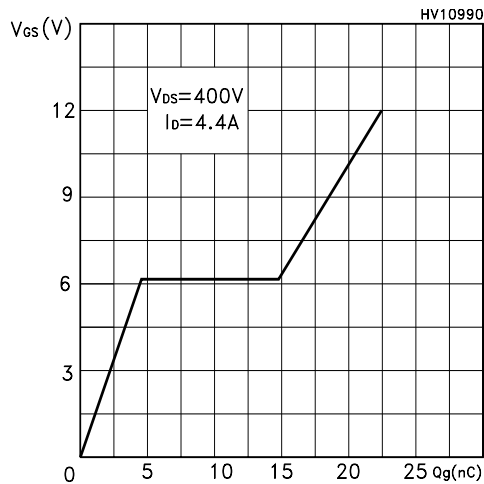


Figure 11: Normalized Gate Threshold Voltage vs Temperature

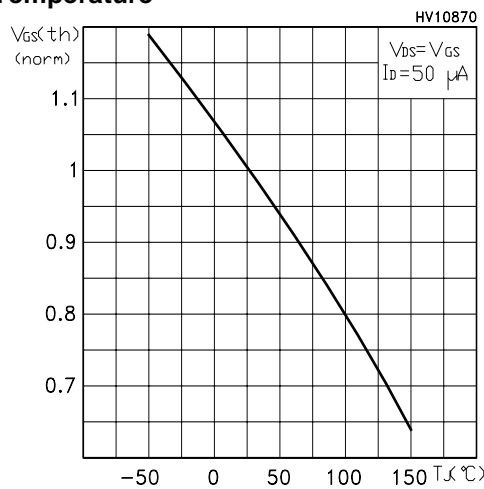


Figure 12: Static Drain-Source On Resistance

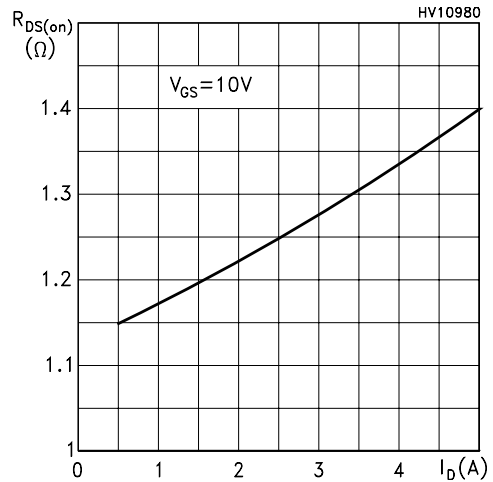


Figure 13: Capacitance Variations

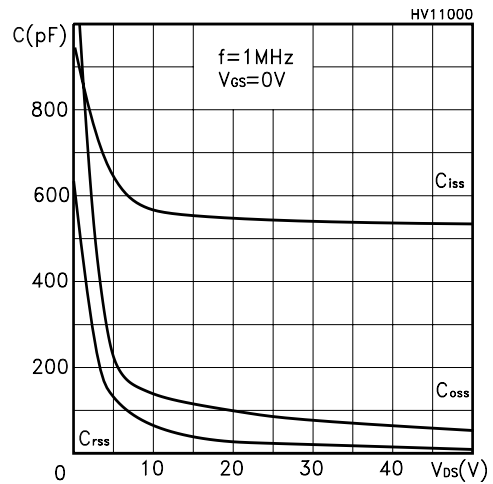


Figure 14: Normalized On Resistance vs Temperature

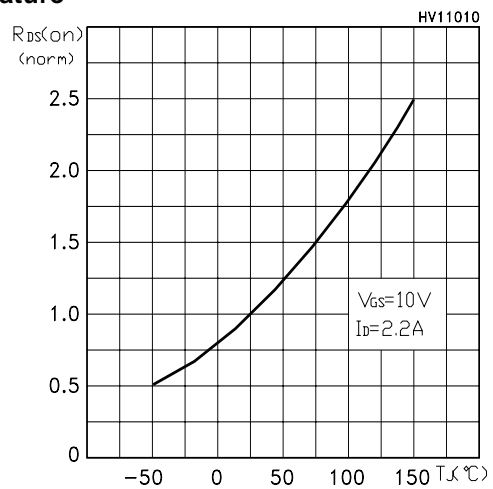


Figure 15: Source-Drain Forward Characteristics

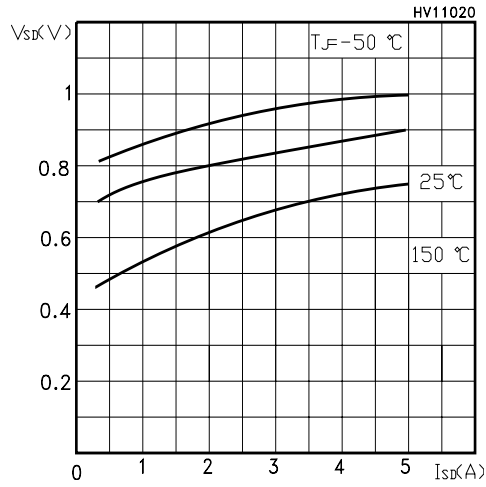


Figure 17: Normalized BV_{DSS} vs Temperature

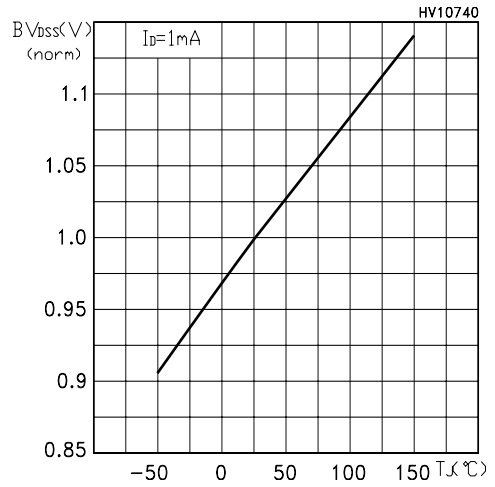


Figure 16: Maximum Avalanche Energy vs Temperature

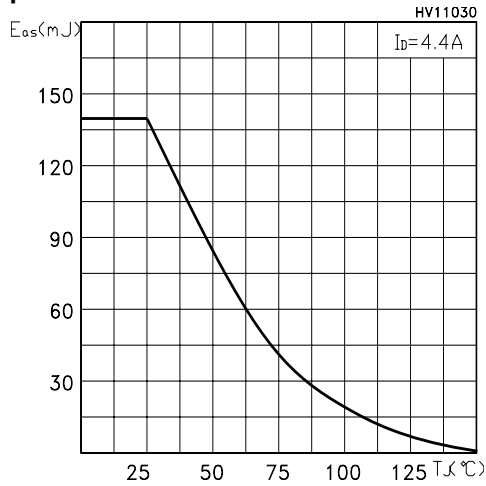


Figure 18: Unclamped Inductive Load Test Circuit

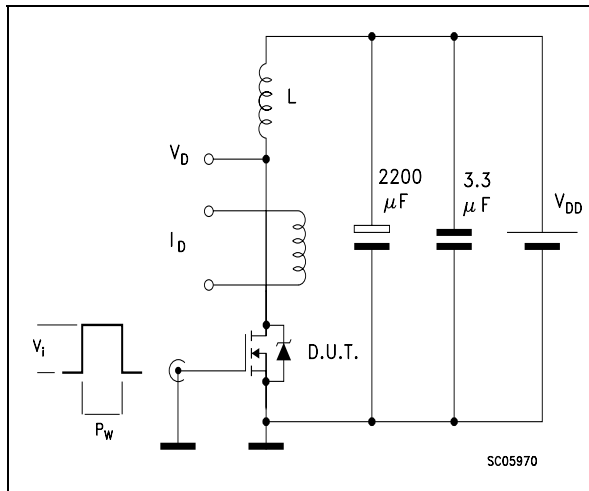


Figure 19: Switching Times Test Circuit For Resistive Load

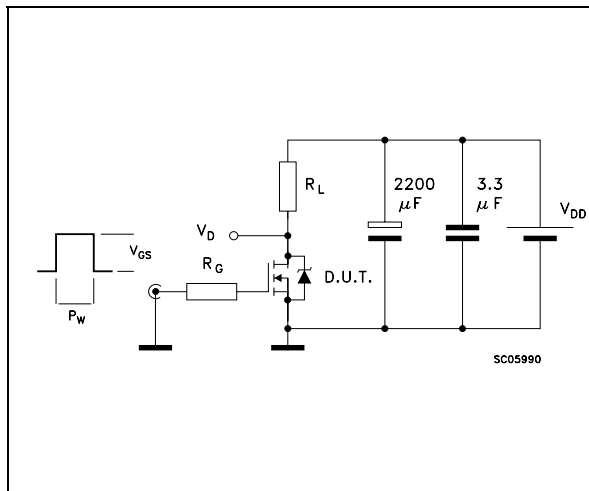


Figure 20: Test Circuit For Inductive Load Switching and Diode Recovery Times

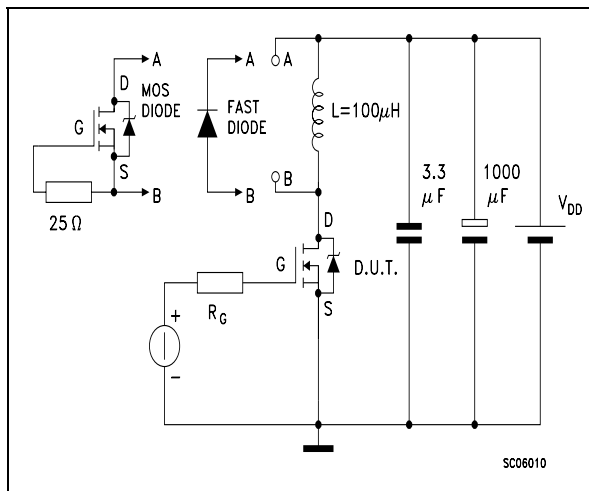


Figure 21: Unclamped Inductive Waform

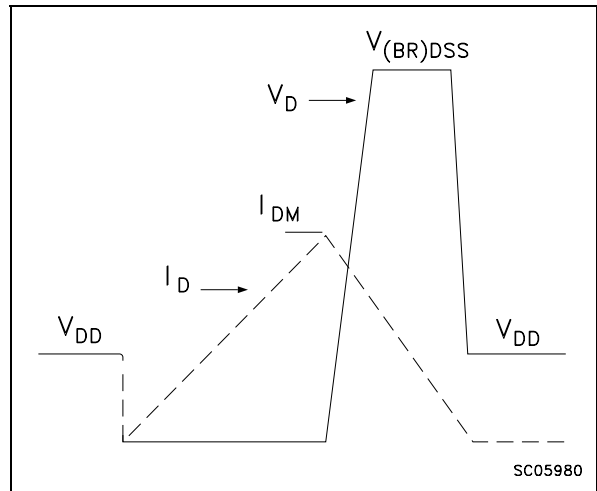
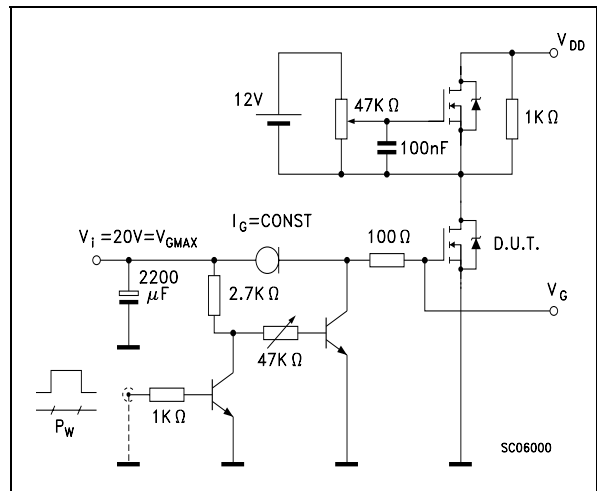
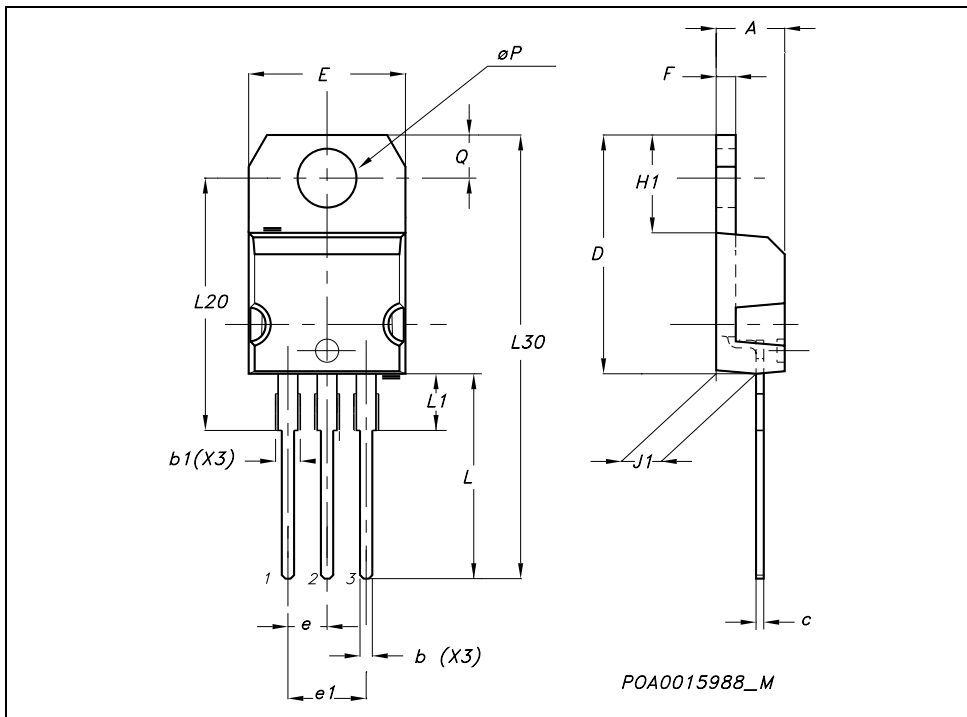


Figure 22: Gate Charge Test Circuit



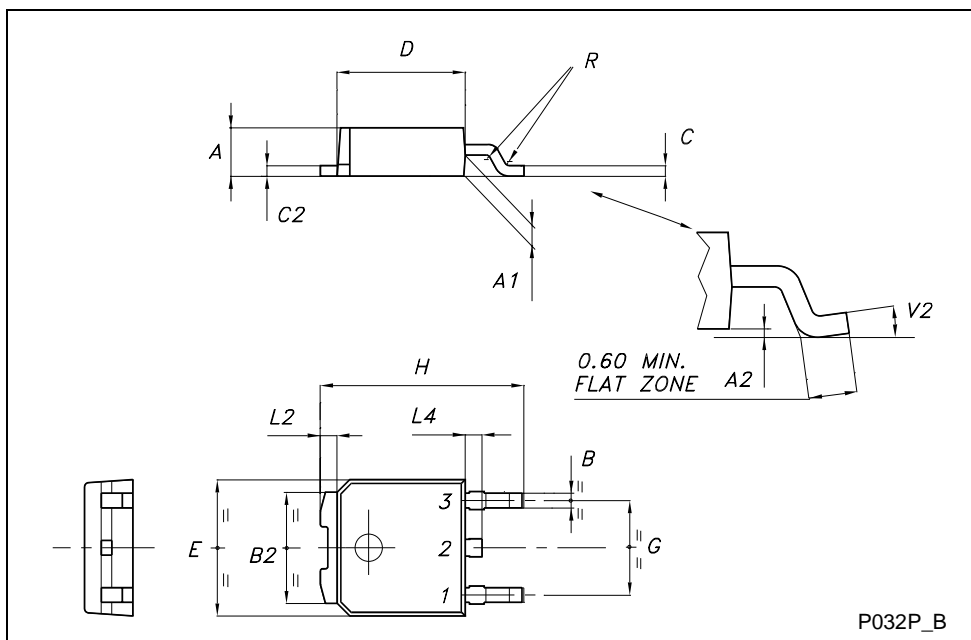
TO-220 MECHANICAL DATA

| 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 | 1.15 | | 1.70 | 0.045 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| D | 15.25 | | 15.75 | 0.60 | | 0.620 |
| 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 | | 0.052 |
| 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 |



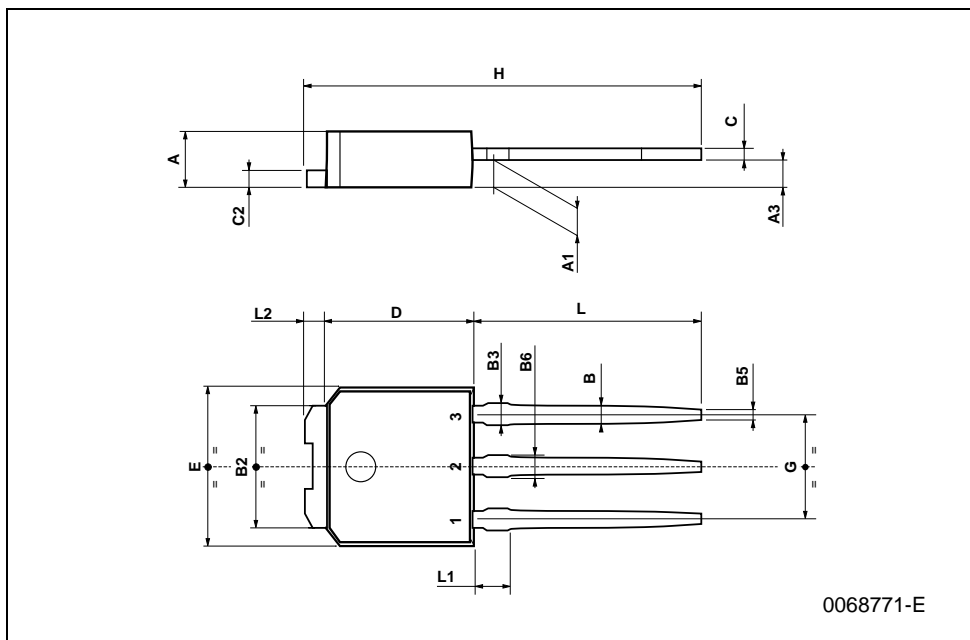
TO-252 (DPAK) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.20 | | 2.40 | 0.087 | | 0.094 |
| A1 | 0.90 | | 1.10 | 0.035 | | 0.043 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| B | 0.64 | | 0.90 | 0.025 | | 0.035 |
| B2 | 5.20 | | 5.40 | 0.204 | | 0.213 |
| C | 0.45 | | 0.60 | 0.018 | | 0.024 |
| C2 | 0.48 | | 0.60 | 0.019 | | 0.024 |
| D | 6.00 | | 6.20 | 0.236 | | 0.244 |
| E | 6.40 | | 6.60 | 0.252 | | 0.260 |
| G | 4.40 | | 4.60 | 0.173 | | 0.181 |
| H | 9.35 | | 10.10 | 0.368 | | 0.398 |
| L2 | | 0.8 | | | 0.031 | |
| L4 | 0.60 | | 1.00 | 0.024 | | 0.039 |
| V2 | 0° | | 8° | 0° | | 0° |



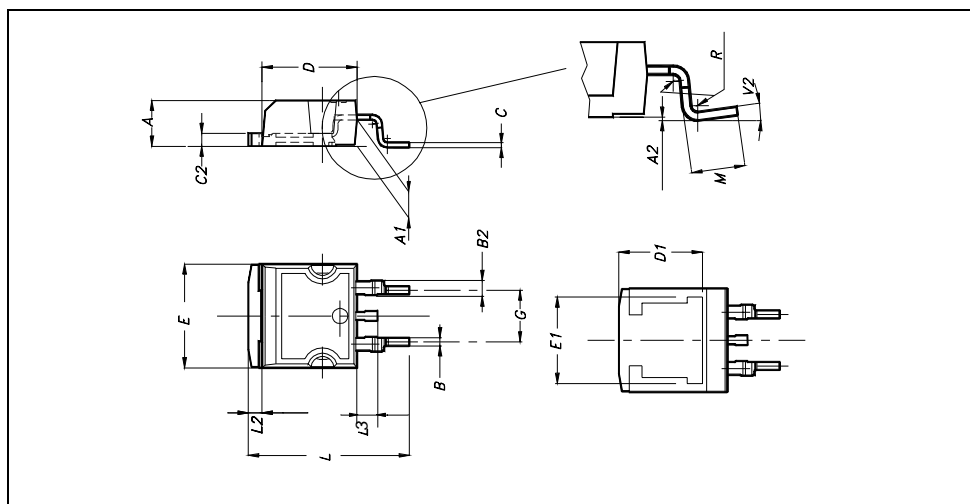
TO-251 (IPAK) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A3 | 0.7 | | 1.3 | 0.027 | | 0.051 |
| B | 0.64 | | 0.9 | 0.025 | | 0.031 |
| B2 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| B3 | | | 0.85 | | | 0.033 |
| B5 | | 0.3 | | | 0.012 | |
| B6 | | | 0.95 | | | 0.037 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 0.48 | | 0.6 | 0.019 | | 0.023 |
| D | 6 | | 6.2 | 0.236 | | 0.244 |
| E | 6.4 | | 6.6 | 0.252 | | 0.260 |
| G | 4.4 | | 4.6 | 0.173 | | 0.181 |
| H | 15.9 | | 16.3 | 0.626 | | 0.641 |
| L | 9 | | 9.4 | 0.354 | | 0.370 |
| L1 | 0.8 | | 1.2 | 0.031 | | 0.047 |
| L2 | | 0.8 | 1 | | 0.031 | 0.039 |



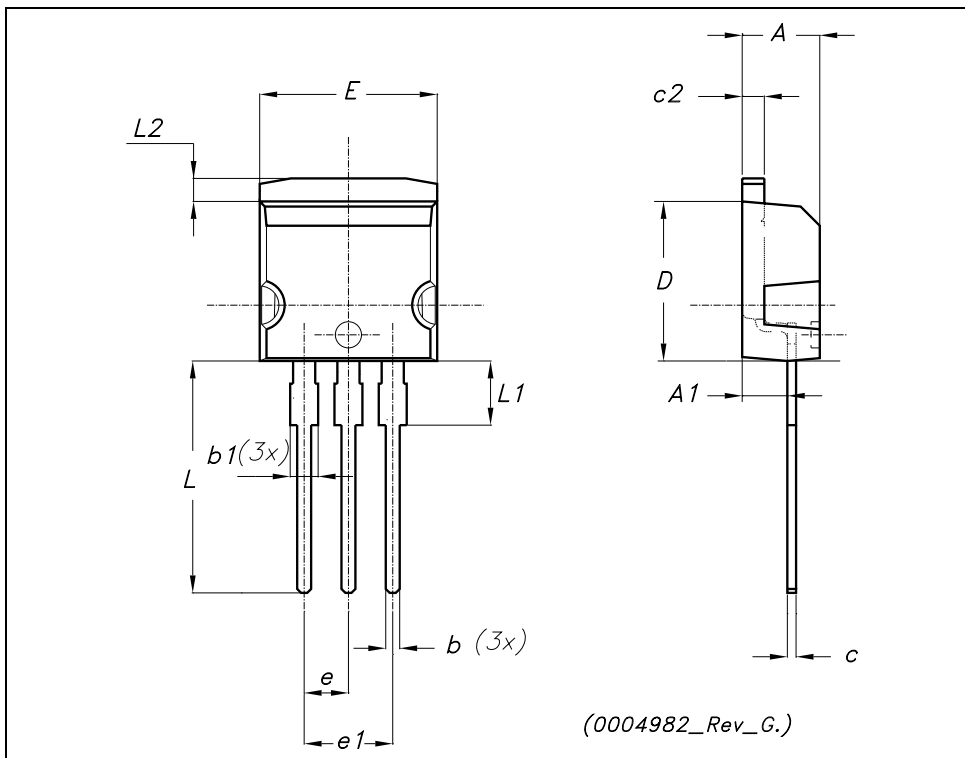
D²PAK MECHANICAL DATA

| 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° | | | |

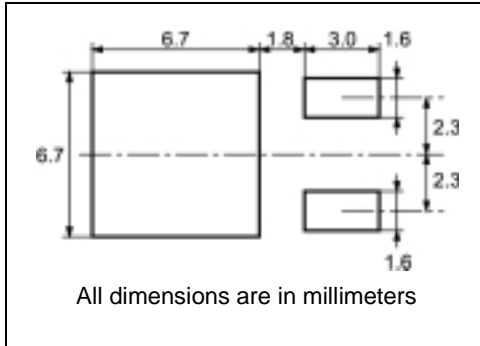


TO-262 (I²PAK) MECHANICAL DATA

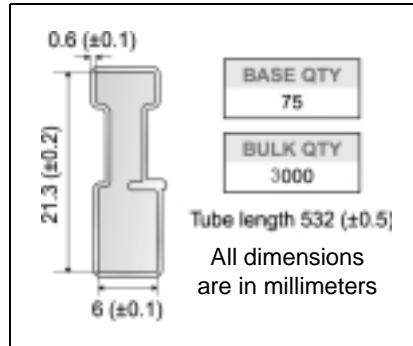
| DIM. | mm. | | | inch | | |
|------|------|------|-------|-------|------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| A1 | 2.40 | | 2.72 | 0.094 | | 0.107 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49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



DPAK FOOTPRINT



TUBE SHIPMENT (no suffix)*



TAPE AND REEL SHIPMENT (suffix "T4")*

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 |

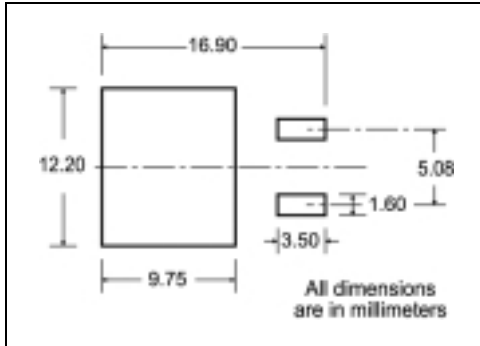
| BASE QTY | BULK QTY |
|----------|----------|
| 2500 | 2500 |

TAPE MECHANICAL DATA

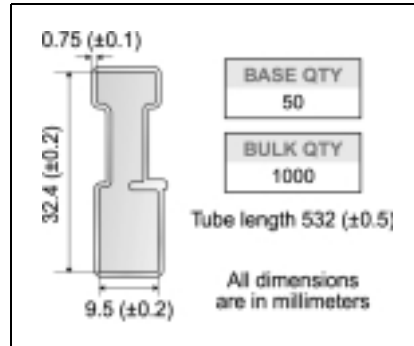
| DIM. | mm | | inch | |
|------|------|------|-------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A0 | 6.8 | 7 | 0.267 | 0.275 |
| B0 | 10.4 | 10.6 | 0.409 | 0.417 |
| B1 | | 12.1 | | 0.476 |
| D | 1.5 | 1.6 | 0.059 | 0.063 |
| D1 | 1.5 | | 0.059 | |
| E | 1.65 | 1.85 | 0.065 | 0.073 |
| F | 7.4 | 7.6 | 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 |

* on sales type

D²PAK FOOTPRINT



TUBE SHIPMENT (no suffix)*



TAPE AND REEL SHIPMENT (suffix "T4")*

40 mm min. Access hole at slot location
Full radius
Tape slot in core for tape start 2.5mm min. width
G measured at hub

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 |

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 | 24.4 | 26.4 | 0.960 | 1.039 |
| N | 100 | | 3.937 | |
| T | | 30.4 | | 1.197 |

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

TOP COVER TAPE
Center line of cavity
User Direction of Feed
Feeding radius
10 pitches cumulative tolerance on tape +/- 0.2 mm

* on sales type

Table 10: Revision History

| Date | Revision | Description of Changes |
|--------------|-----------------|--|
| 16-June-2004 | 1 | D ² PAK Included. New Stylesheet. |

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