



STD5NM60 STB8NM60 - STP8NM60

N-channel 650 V @ Tjmax, 0.9 Ω, 8 A MDmesh™ Power MOSFET
TO-220, TO-220FP, D²PAK, DPAK, IPAK

Features

| Type | V _{DSS} | R _{DS(on)} | I _D | P _w |
|------------|------------------|---------------------|--------------------|----------------|
| STD5NM60 | 650 V | < 1 Ω | 5 A | 96 W |
| STD5NM60-1 | 650 V | < 1 Ω | 5 A | 96 W |
| STB8NM60 | 650 V | < 1 Ω | 5 A | 100 W |
| STP8NM60 | 650 V | < 1 Ω | 8 A | 100 W |
| STP8NM60FP | 650 V | < 1 Ω | 8 A ⁽¹⁾ | 30 W |

- 100% avalanche tested
- High dv/dt and avalanche capabilities
- Low input capacitance and gate charge
- Low gate input resistance

Application

- Switching applications

Description

The MDmesh™ is a new revolutionary Power MOSFET technology that associates the multiple drain process with the company's PowerMESH™ horizontal layout. The resulting product has an outstanding low on-resistance, impressively high dv/dt and excellent avalanche characteristics. The adoption of the company's proprietary strip technique yields overall dynamic performance that is significantly better than that of similar competition's products.

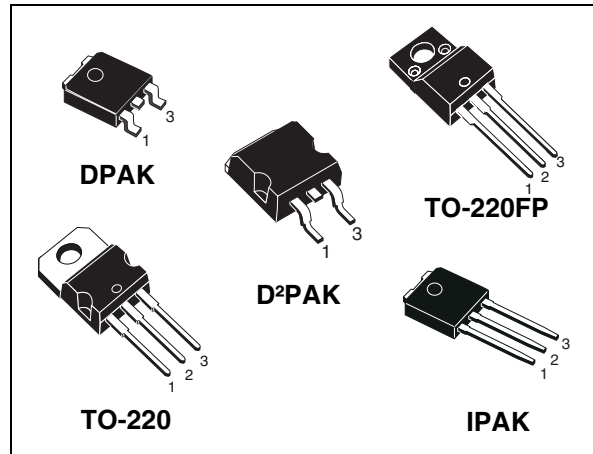


Figure 1. Internal schematic diagram

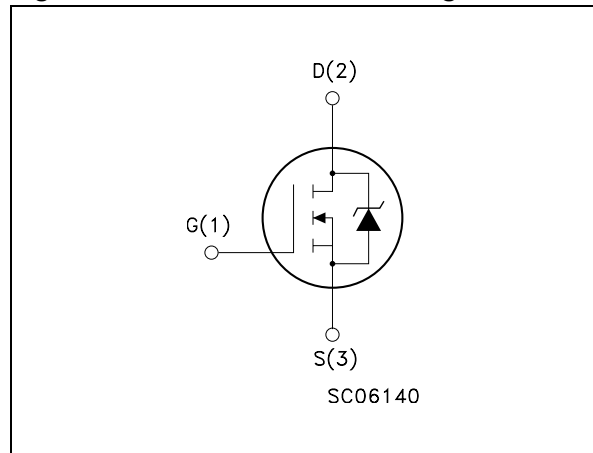


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|----------|--------------------|-------------|
| STD5NM60-1 | D5NM60 | IPAK | Tube |
| STD5NM60T4 | D5NM60 | DPAK | Tape & reel |
| STB8NM60T4 | B8NM60 | D ² PAK | Tape & reel |
| STP8NM60 | P8NM60 | TO-220 | Tube |
| STP8NM60FP | P8NM60FP | TO-220FP | Tube |

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | | | Unit |
|------------------------------------|--|------------------------------|-------------------|--------------------|------|
| | | TO-220 D ² PAK | TO-220FP | IPAK DPAK | |
| V _{GS} | Gate-source voltage | ± 30 | | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 8 | 8 ⁽¹⁾ | 5 | A |
| I _D | Drain current (continuous) at T _C =100 °C | 5 | 5 ⁽¹⁾ | 3.1 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 32 | 32 ⁽¹⁾ | 20 ⁽¹⁾ | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 100 | 30 | 96 | W |
| | Derating factor | 0.8 | 0.24 | 0.0.4 | W/°C |
| 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 _J T _{stg} | Operating junction temperature Storage temperature | -55 to 150 | | | °C |

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} ≤ 5 A, di/dt ≤ 400 A/μs, V_{DD} = 80%V_{(BR)DSS}

Table 2. Thermal resistance

| Symbol | Parameter | Value | | | Unit |
|-----------------------|--|------------------------------|--------------|----------|------|
| | | TO-220 D ² PAK | IPAK DPAK | TO-220FP | |
| R _{thj-case} | Thermal resistance junction-case max | 1.25 | 1.3 | 4.16 | °C/W |
| R _{thj-a} | Thermal resistance junction-ambient max | 62.5 | | | °C/W |
| T _l | Maximum lead temperature for soldering purpose | 300 | | | °C |

Table 3. Avalanche data

| Symbol | Parameter | Value | Unit |
|-----------------|---|-------|------|
| I _{AS} | Avalanche current, repetitive or not-repetitive (pulse width limited by T _J Max) | 2.5 | A |
| E _{AS} | Single pulse avalanche energy (starting T _J =25 °C, I _D =I _{AS} , V _{DD} =50 V) | 200 | mJ |

2 Electrical characteristics

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

Table 4. On/off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|---|------|------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 250\ \mu\text{A}$, $V_{GS} = 0$ | 600 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = \text{max rating}$, $V_{DS} = \text{max rating @ } 125\text{ °C}$ | | | 1 10 | μA μA |
| I_{GSS} | Gate body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 20\text{ V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 250\ \mu\text{A}$ | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10\text{ V}$, $I_D = 2.5\text{ A}$ | | 0.9 | 1 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------------|-------------------------------|---|------|------|------|------|
| g_{fs} | Forward transconductance | $V_{DS} = I_{D(on)} \times R_{DS(on)max}$, $I_D = 2.5\text{ A}$ | | 2.4 | | S |
| C_{iss} | Input capacitance | $V_{DS} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | | 400 | | pF |
| C_{oss} | Output capacitance | | | 100 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 10 | | pF |
| $C_{oss\ eq}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0$, $V_{DS} = 0\text{ to } 480\text{ V}$ | | 50 | | pF |
| Q_g | Total gate charge | $V_{DD} = 400\text{ V}$, $I_D = 5\text{ A}$ | | 13 | 18 | nC |
| Q_{gs} | Gate-source charge | $V_{GS} = 10\text{ V}$ | | 5 | | nC |
| Q_{gd} | Gate-drain charge | (see Figure 12) | | 6 | | nC |

1. $C_{oss\ eq}$ 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 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------|---|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}= 300\text{ V}$, $I_D= 2.5\text{ A}$, $R_G= 4.7\ \Omega$, $V_{GS}=10\text{ V}$ <i>(see Figure 17)</i> | | 14 | | ns |
| t_r | Rise time | | | 10 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 23 | | ns |
| t_f | Fall time | | | 10 | | ns |
| $t_{r(Voff)}$ | Off-voltage rise time | $V_{DD}= 480\text{ V}$, $I_D= 5\text{ A}$, $R_G= 4.7\ \Omega$, $V_{GS}=10\text{ V}$ | | 7 | | ns |
| t_f | Fall time | | | 10 | | ns |
| t_c | Cross-over time | | | 17 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | | | 8 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 32 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 5\text{ A}$, $V_{GS}=0$ | | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 5\text{ A}$, $V_{DD}=100\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, <i>(see Figure 22)</i> | | 300 | | ns |
| Q_{rr} | Reverse recovery charge | | | 1.95 | | μC |
| I_{RRM} | Reverse recovery current | | | 13 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 5\text{ A}$, $V_{DD} = 100\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, $T_j=150\text{ }^\circ\text{C}$ <i>(see Figure 22)</i> | | 445 | | ns |
| Q_{rr} | Reverse recovery charge | | | 3.00 | | μC |
| I_{RRM} | Reverse recovery current | | | 13.5 | | 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/D²PAK

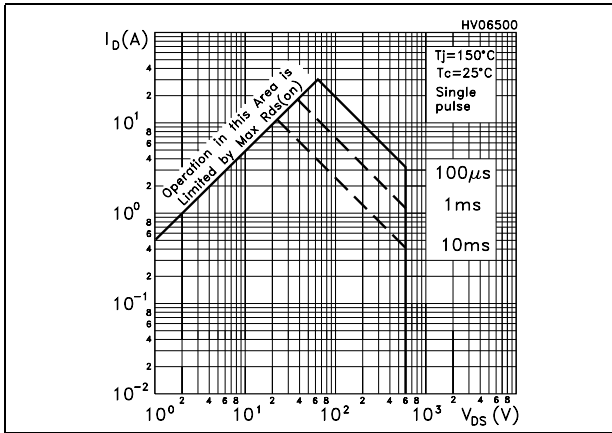


Figure 3. Thermal impedance for TO-220/D²PAK

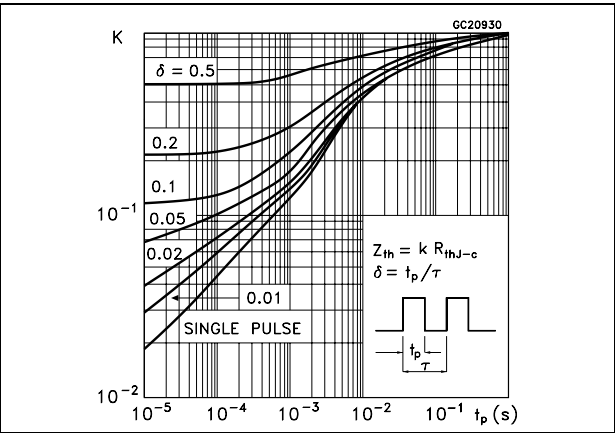


Figure 4. Safe operating area for TO-220FP

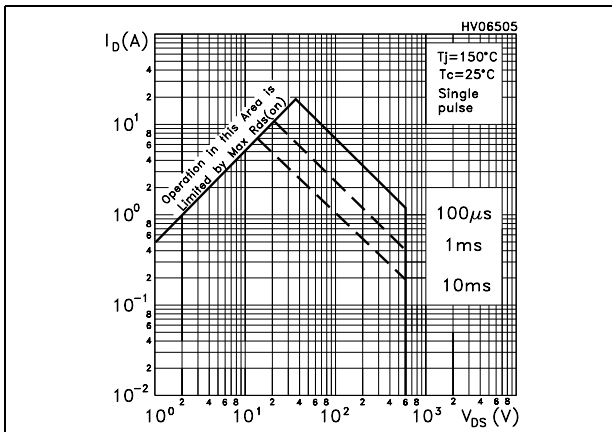


Figure 5. Thermal impedance for TO-220FP

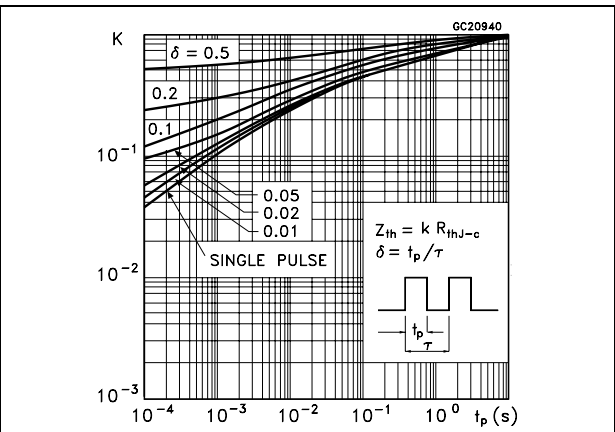


Figure 6. Safe operating area for DPAK/IPAK

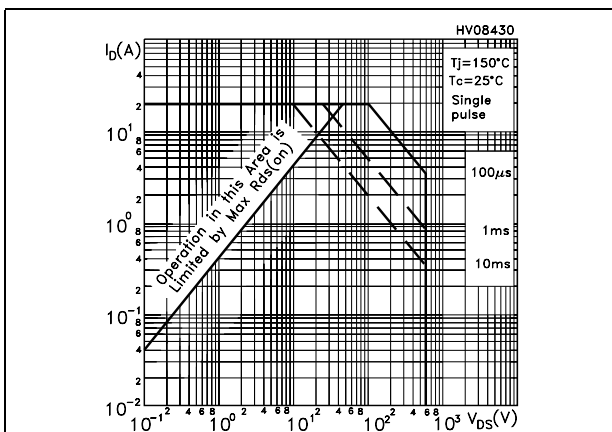


Figure 7. Thermal impedance for DPAK/IPAK

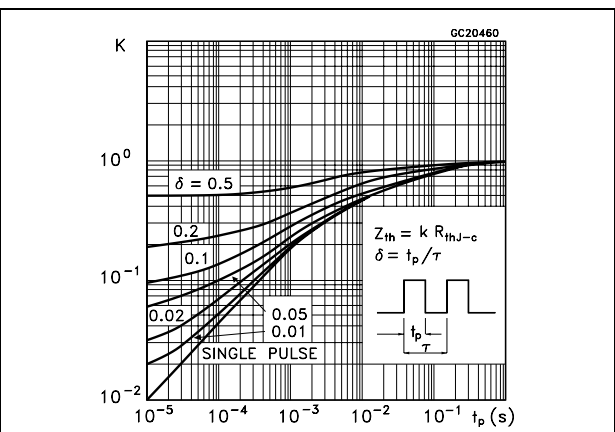


Figure 8. Output characteristics

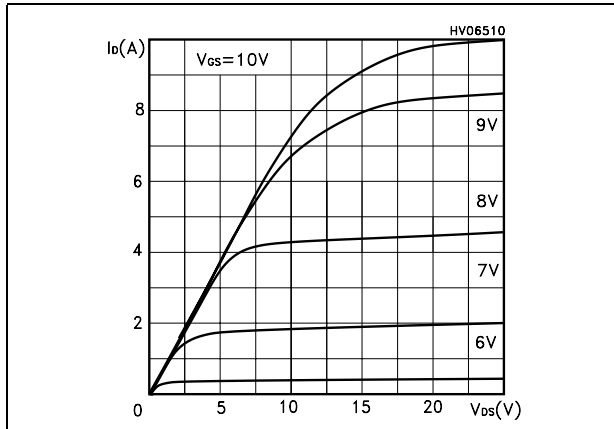


Figure 9. Transfer characteristics

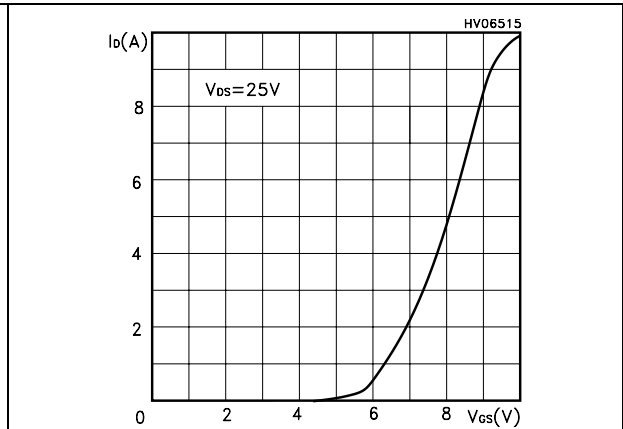


Figure 10. Transconductance

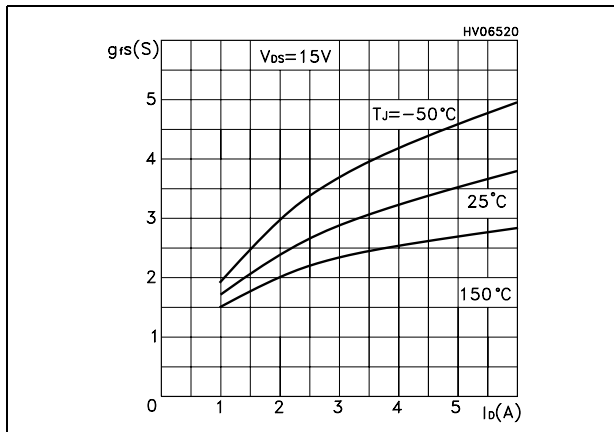


Figure 11. Static drain-source on resistance

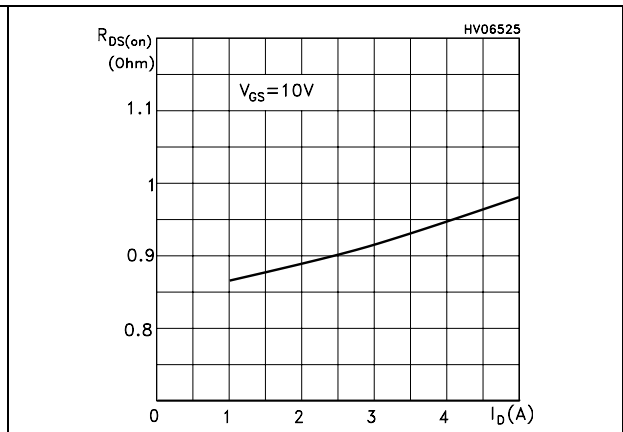


Figure 12. Gate charge vs gate-source voltage

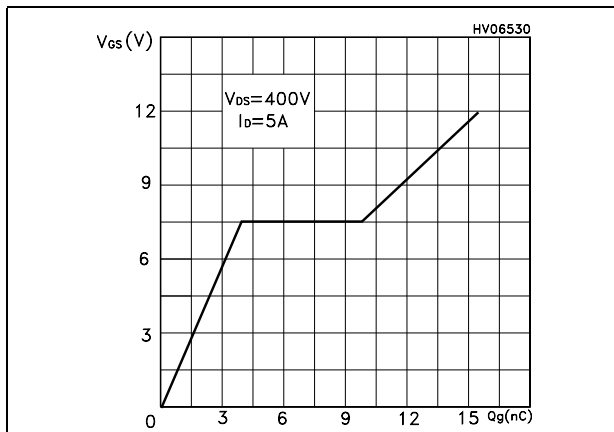


Figure 13. Capacitance variations

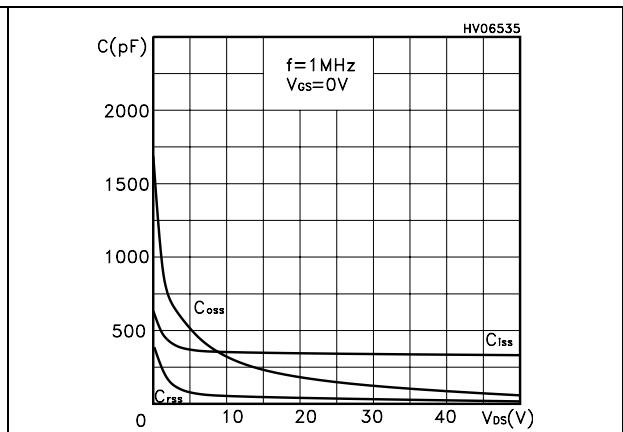


Figure 14. Normalized gate threshold voltage vs temperature

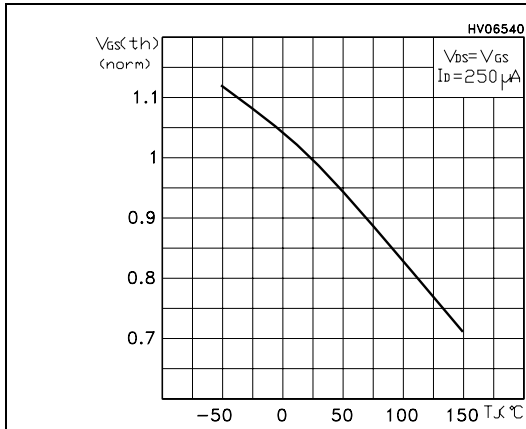


Figure 15. Normalized on resistance vs temperature

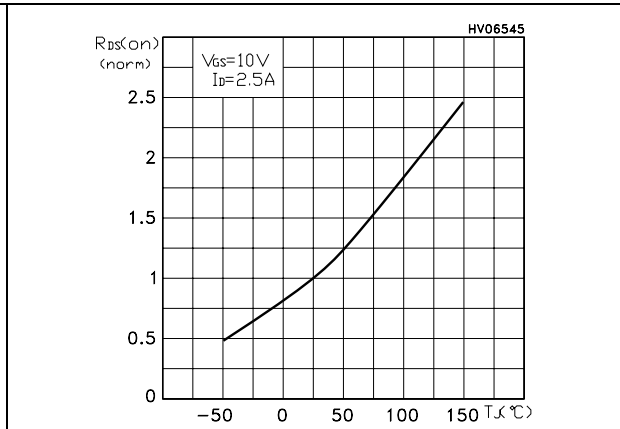
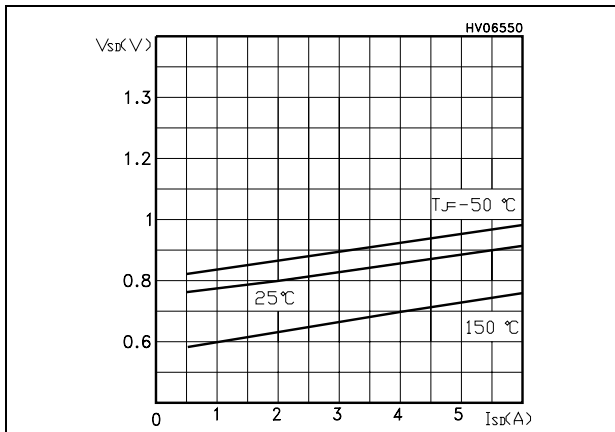


Figure 16. Source-drain diode forward characteristics



3 Test circuit

Figure 17. Switching times test circuit for resistive load

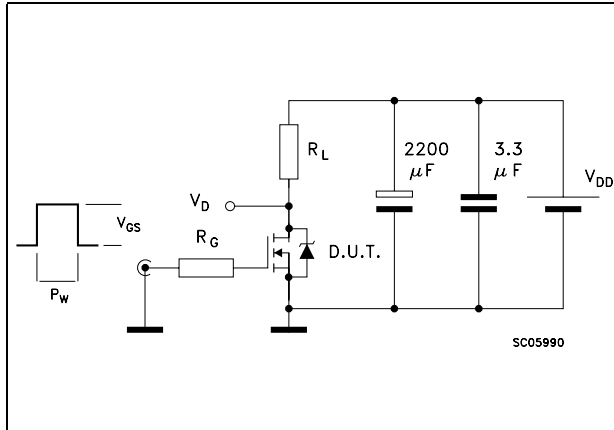


Figure 18. Gate charge test circuit

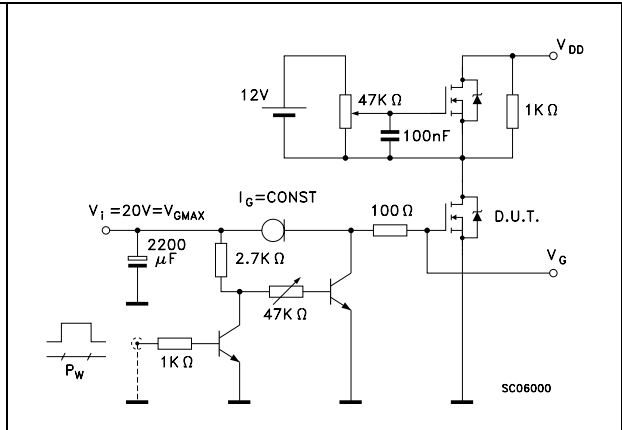


Figure 19. Test circuit for inductive load switching and diode recovery times

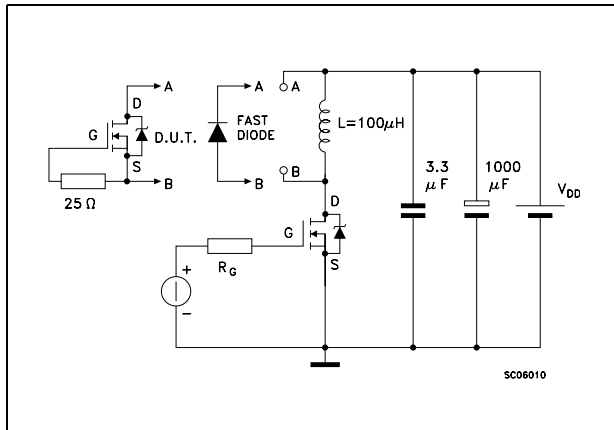


Figure 20. Unclamped inductive load test circuit

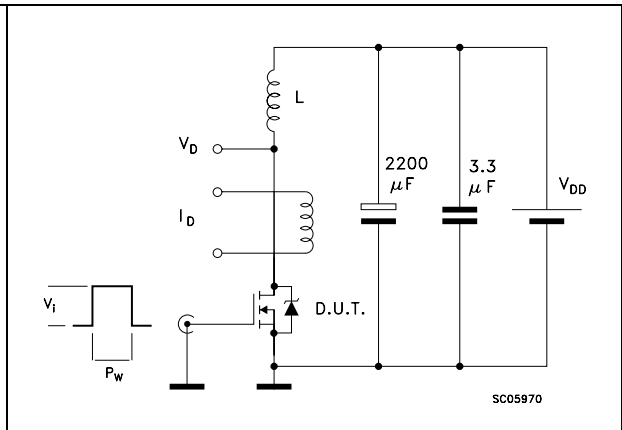


Figure 21. Unclamped inductive waveform

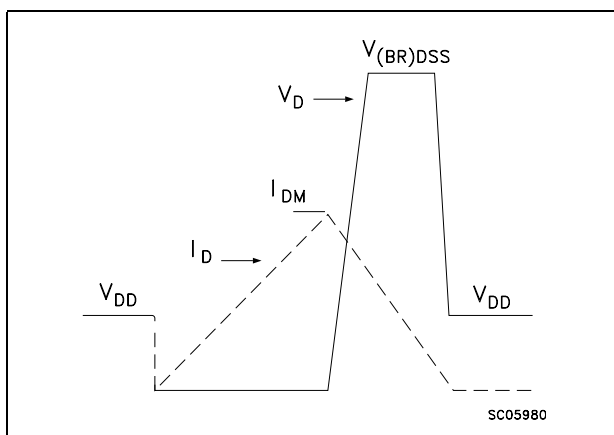
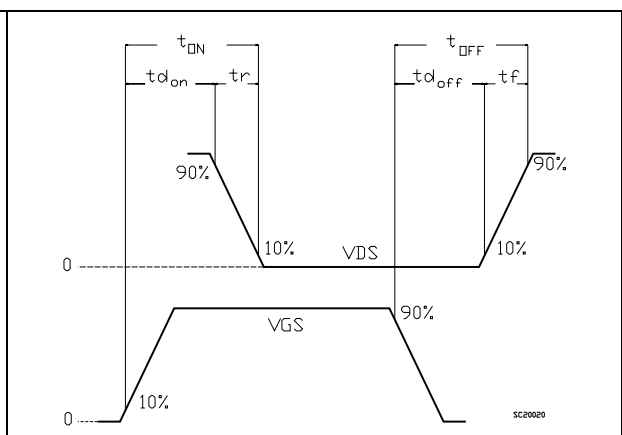


Figure 22. Switching time waveform

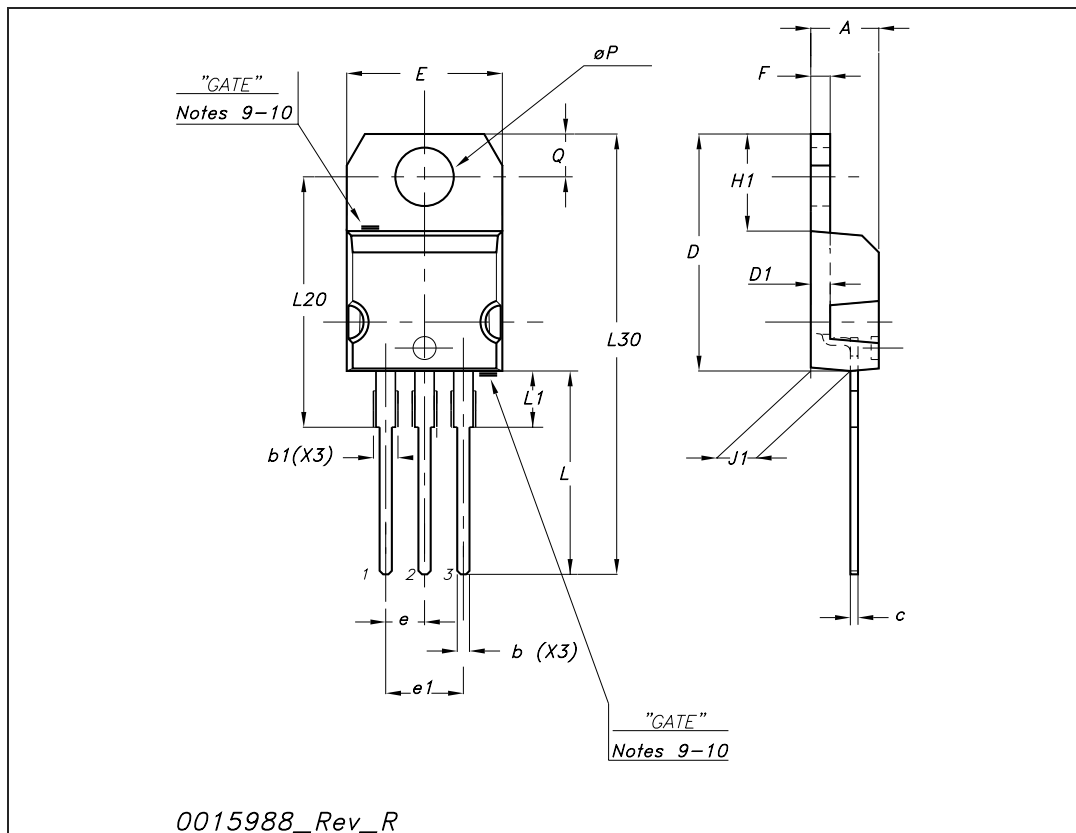


4 Package mechanical data

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

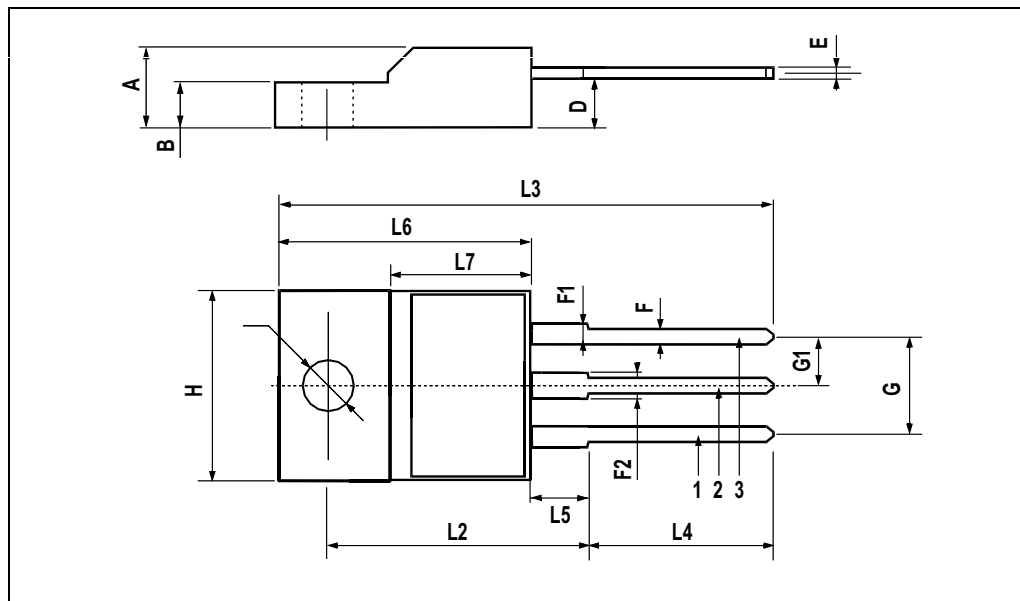
TO-220 mechanical data

| 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 |



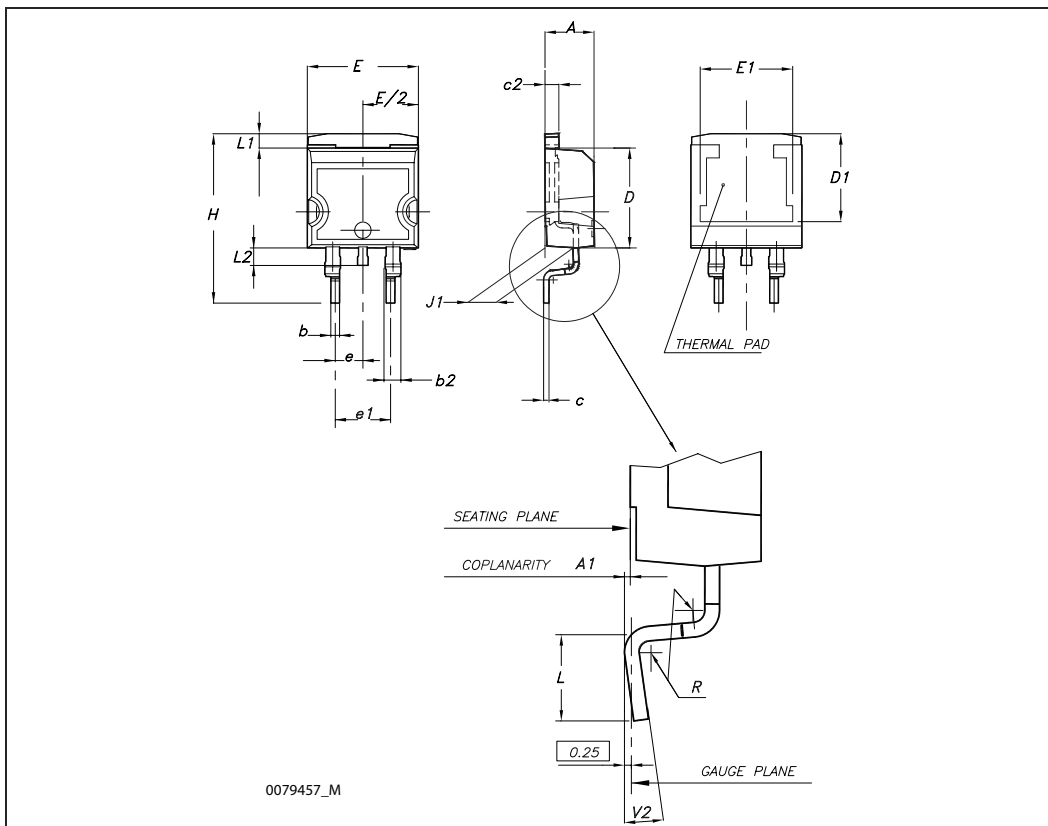
TO-220FP MECHANICAL DATA

| DIM. | mm. | | | 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 |



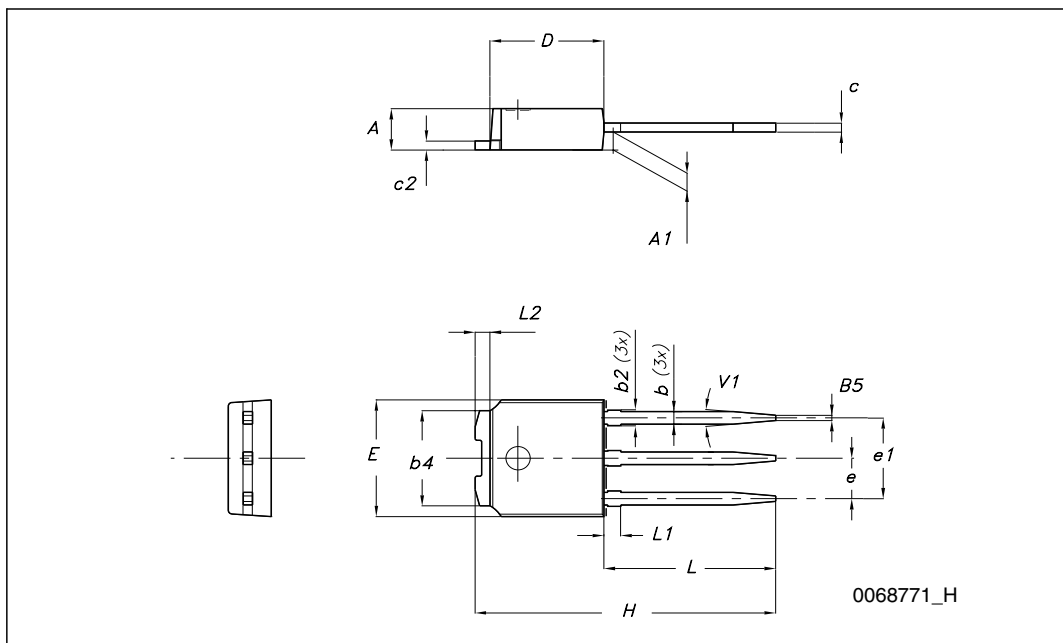
D²PAK (TO-263) mechanical data

| 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° |



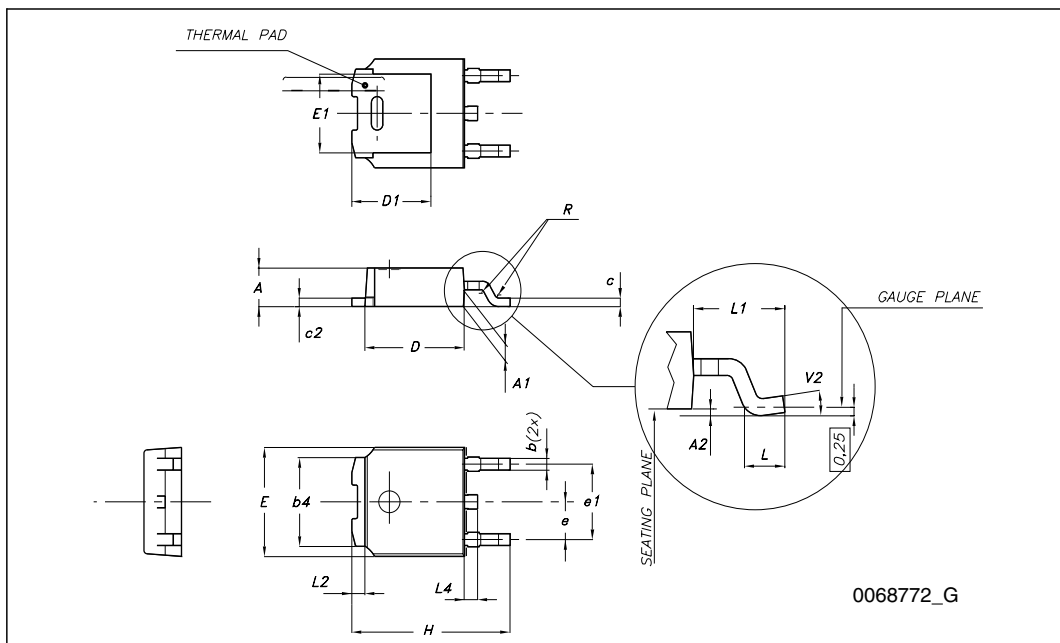
TO-251 (IPAK) mechanical data

| 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° | |



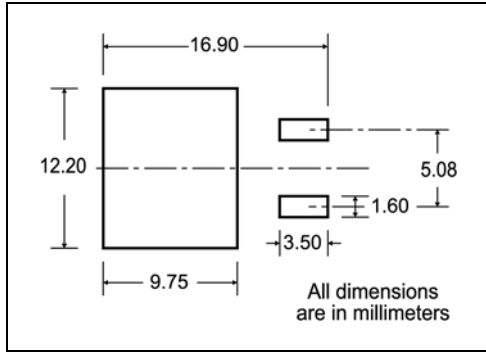
TO-252 (DPAK) mechanical data

| 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

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT

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 |

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

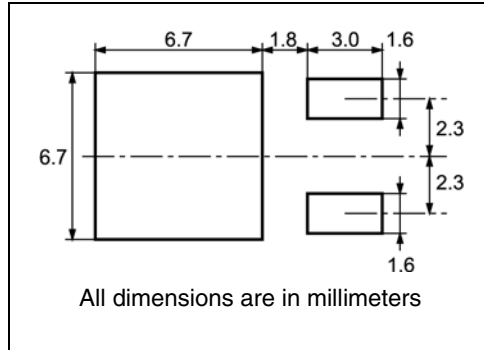
FEED DIRECTION

TRL

Bending radius R min.

* on sales type

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT

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 |

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 |

6 Revision history

Table 8. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 14-Apr-2004 | 11 | Title changed |
| 11-Apr-2005 | 12 | Inserted D ² PAK |
| 21-Feb-2006 | 13 | New template |
| 08-Sep-2006 | 14 | Modified order codes |
| 14-Sep-2006 | 15 | Corrected Figure 6.: Safe operating area for DPAK/IPAK |
| 09-Jul-2007 | 16 | Qrr value in Table 7.: Source drain diode has been updated |
| 01-Oct-2008 | 17 | 4: Package mechanical data updated |

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