



STD4NK50ZD - STD4NK50ZD-1 STF4NK50ZD - STP4NK50ZD

N-channel 500V - 2.4Ω - 3A - TO-220 - TO-220FP- DPAK - IPAK
Fast diode SuperMESH™ Power MOSFET

General features

| Type | V _{DSS} | R _{DS(on)} | I _D | P _w |
|--------------|------------------|---------------------|----------------|----------------|
| STD4NK50ZD-1 | 500V | <2.7Ω | 3A | 45W |
| STD4NK50ZD | 500V | <2.7Ω | 3A | 45W |
| STF4NK50ZD | 500V | <2.7Ω | 3A | 20W |
| STP4NK50ZD | 500V | <2.7Ω | 3A | 45W |

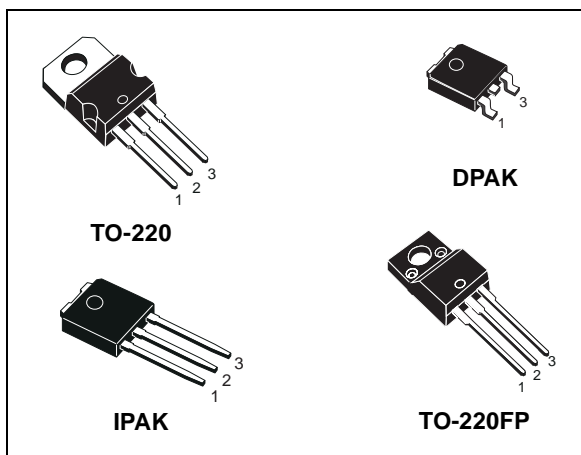
- 100% avalanche tested
- Extremely high dv/dt capability
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeability

Description

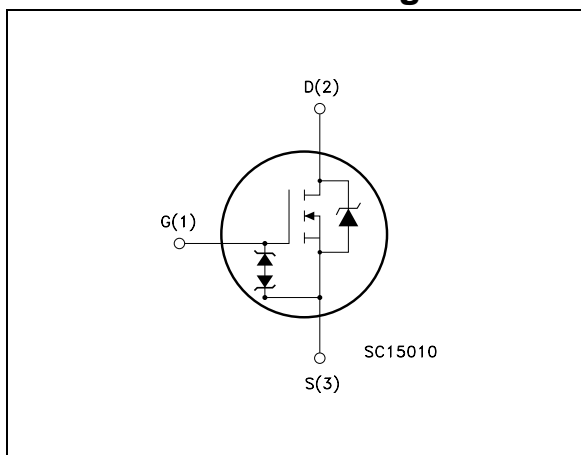
The fast SuperMESH™ series associates all advantages of reduced on-resistance, zener gate protection and outstanding dc/dt capability with a Fast body-drain recovery diode. Such series complements the FDmesh™ advanced technology.

Applications

- Switching application



Internal schematic diagram



Order codes

| Part number | Marking | Package | Packaging |
|--------------|------------|----------|-------------|
| STD4NK50ZD-1 | D4NK50ZD-1 | IPAK | Tube |
| STD4NK50ZD | D4NK50ZD | DPAK | Tape & reel |
| STF4NK50ZD | F4NK50ZD | TO-220FP | Tube |
| STP4NK50ZD | P4NK50ZD | TO-220 | Tube |

Contents

| | | |
|----------|---|-----------|
| 1 | Electrical ratings | 3 |
| 2 | Electrical characteristics | 5 |
| | 2.1 Electrical characteristics (curves) | 6 |
| 3 | Test circuit | 10 |
| 4 | Package mechanical data | 11 |
| 5 | Packaging mechanical data | 16 |
| 6 | Revision history | 17 |

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | | | Unit |
|--------------------|---|------------|--------------------|--------------------|------|
| | | TO-220 | IPAK/DPAK | TO-220FP | |
| V_{DS} | Drain-source voltage ($V_{GS} = 0$) | 500 | | | V |
| V_{DGR} | Drain-gate voltage ($R_{GS} = 20K\Omega$) | 500 | | | V |
| V_{GS} | Gate-source voltage | ± 30 | | | V |
| I_D | Drain current (continuous) at $T_C = 25^\circ C$ | 3 | 3 ⁽¹⁾ | 3 ⁽¹⁾ | A |
| I_D | Drain current (continuous) at $T_C = 100^\circ C$ | 1.9 | 1.9 ⁽¹⁾ | 1.9 ⁽¹⁾ | A |
| $I_{DM}^{(2)}$ | Drain current (pulsed) | 12 | 12 ⁽¹⁾ | 12 ⁽¹⁾ | A |
| P_{TOT} | Total dissipation at $T_C = 25^\circ C$ | 45 | | 20 | W |
| | Derating factor | 0.36 | | 0.16 | W/°C |
| $V_{ESD(G-D)}$ | Gate source ESD(HBM-C=100pF, R=1.5KΩ) | 2800 | | | V |
| $dv/dt^{(3)}$ | Peak diode recovery voltage slope | 15 | | | V/ns |
| V_{ISO} | Insulation withstand voltage (DC) | -- | -- | 2500 | V |
| T_J T_{stg} | Operating junction temperature Storage temperature | -55 to 150 | | | °C |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 3A$, $di/dt \leq 200A/\mu s$, $V_{DD} = 80\%V_{(BR)DSS}$

Table 2. Thermal resistance

| Symbol | Parameter | Value | | | Unit |
|----------------|--|--------|-----------|----------|------|
| | | TO-220 | IPAK/DPAK | TO-220FP | |
| $R_{thj-case}$ | Thermal resistance junction-case Max | 2.78 | | 6.25 | °C/W |
| R_{thj-a} | Thermal resistance junction-ambient Max | 62.5 | 100 | 62.5 | °C/W |
| T_I | Maximum lead temperature for soldering purpose | 300 | | | °C |

Table 3. Avalanche data

| Symbol | Parameter | Value | Unit |
|----------|--|-------|------|
| I_{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_J Max) | 3 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_J = 25^\circ C$, $I_d = I_{AR}$, $V_{DD} = 50V$) | 120 | mJ |

2 Electrical characteristics

($T_{CASE}=25^{\circ}C$ unless otherwise specified)

Table 4. On/off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|--|------|------|----------|--------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1mA, V_{GS} = 0$ | 500 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = \text{Max rating},$ $V_{DS} = \text{Max rating} @ 125^{\circ}C$ | | | 1 50 | μA μA |
| I_{GSS} | Gate body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 20V$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 50\mu A$ | 2.5 | 3.5 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10V, I_D = 1.5A$ | | 2.3 | 2.7 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|--|------|------|------|------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} = 15V, I_D = 1.5A$ | | 1.5 | | S |
| C_{iss} | Input capacitance | $V_{DS} = 25V, f = 1 \text{ MHz},$ $V_{GS} = 0$ | | 310 | | pF |
| C_{oss} | Output capacitance | | | 49 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 10 | | pF |
| $C_{oss \text{ eq}}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0V \text{ to } 400V$ | | 33 | | pF |
| Q_g | Total gate charge | $V_{DD} = 400V, I_D = 3A$ $V_{GS} = 10V$ (see Figure 11) | | 12 | | nC |
| Q_{gs} | Gate-source charge | | | 3 | | nC |
| Q_{gd} | Gate-drain charge | | | 7 | | nC |

1. Pulsed: pulse duration=300 μs , duty cycle 1.5%

2. $C_{oss \text{ eq}}$ 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}

Table 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit | |
|--------------|---------------------|---|------|------|------|------|----|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 250 \text{ V}, I_D = 1.5A,$ $R_G = 4.7\Omega, V_{GS} = 10V$ (see Figure 18) | | 9.5 | | ns | |
| t_r | Rise time | | | 15.5 | | ns | |
| $t_{d(off)}$ | Turn-off delay time | | | | 23 | | ns |
| t_f | Fall time | | | | 22 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|-----------------|-------------------------------|--|-----|------|-----|------|
| I_{SD} | Source-drain current | | | | 3 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 12 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 3A, V_{GS}=0$ | | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 3A,$ $di/dt = 100A/\mu s,$ $V_{DD} = 34V, T_j = 25^\circ C$ | | 73 | | ns |
| Q_{rr} | Reverse recovery charge | | | 140 | | nC |
| I_{RRM} | Reverse recovery current | | | 3.82 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 3A,$ $di/dt = 100A/\mu s,$ $V_{DD} = 34V, T_j = 150^\circ C$ | | 118 | | ns |
| Q_{rr} | Reverse Recovery Charge | | | 260 | | nC |
| I_{RRM} | Reverse recovery current | | | 4.4 | | A |

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

Table 8. Gate-source zener diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max | Unit |
|------------------|-------------------------------|---------------------------------|------|------|-----|------|
| $BV_{GSO}^{(1)}$ | Gate-source braekdown voltage | $I_{GS} = \pm 1mA$ (open drain) | 30 | | | V |

1. 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.

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220

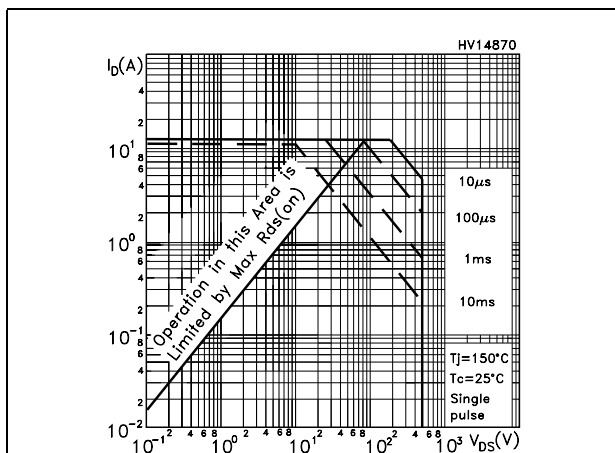


Figure 2. Thermal impedance for TO-220

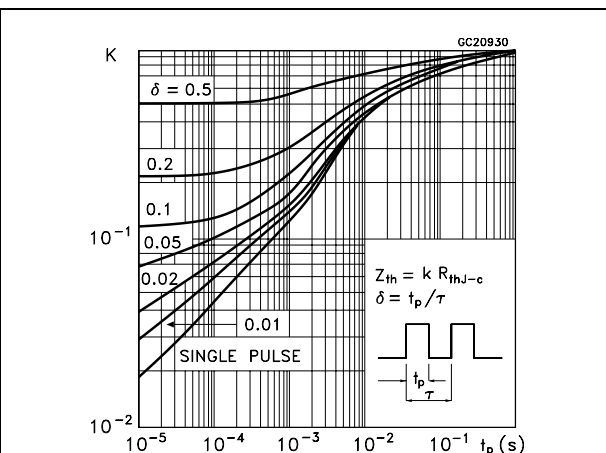


Figure 3. Safe operating area for TO-220FP

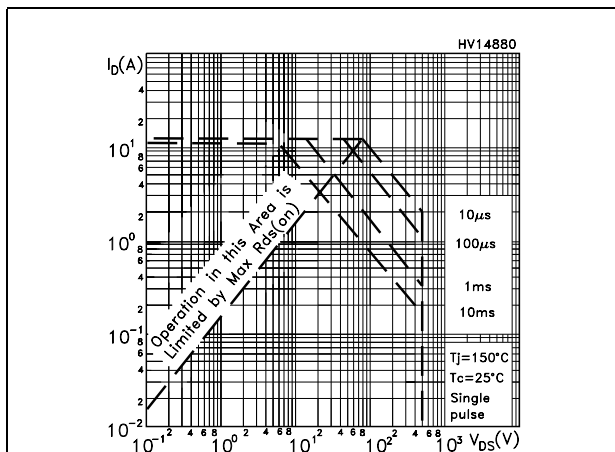


Figure 4. Thermal impedance for TO-220FP

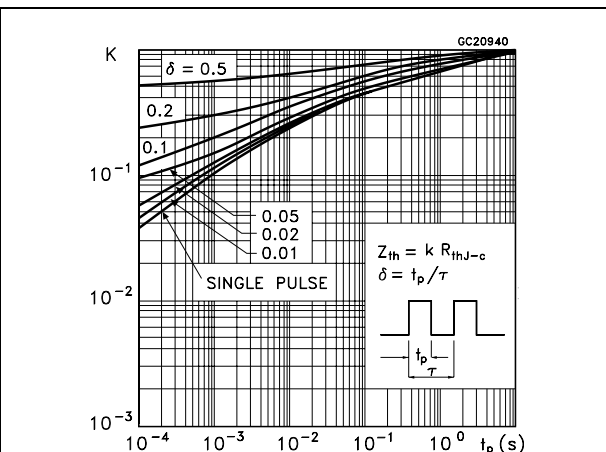


Figure 5. Safe operating area for DPAK/IPAK

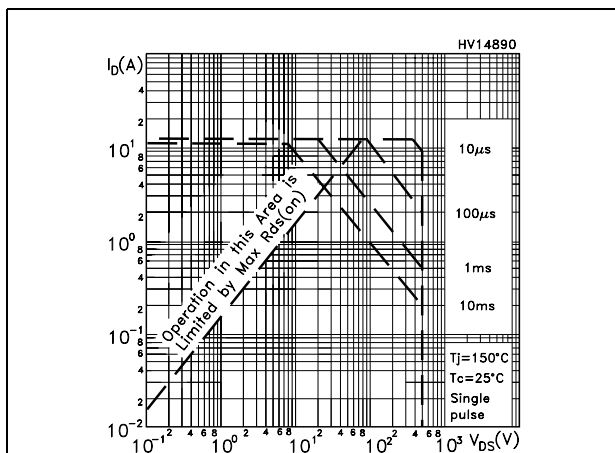


Figure 6. Thermal impedance for DPAK/IPAK

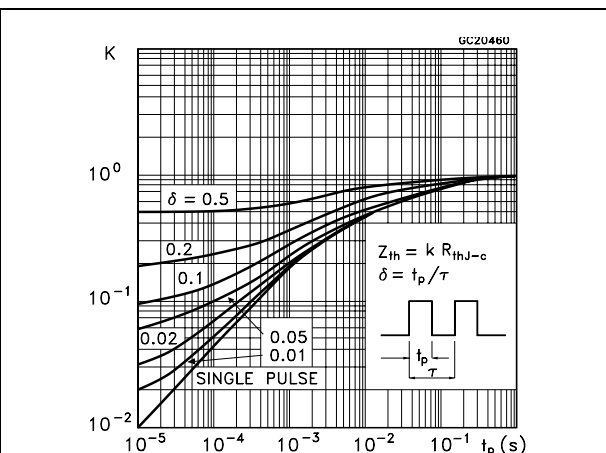


Figure 7. Output characteristics

Figure 8. Transfer characteristics

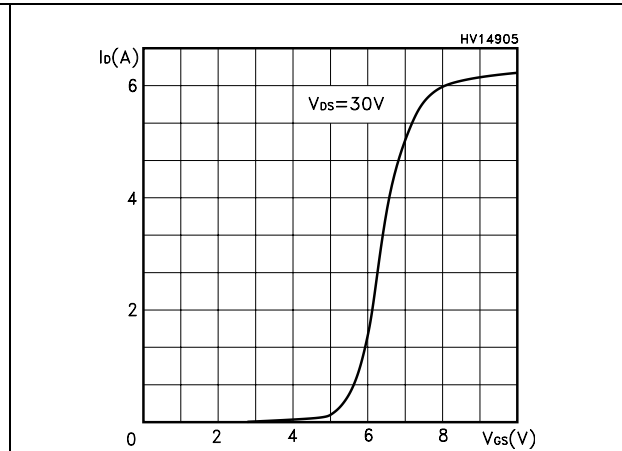
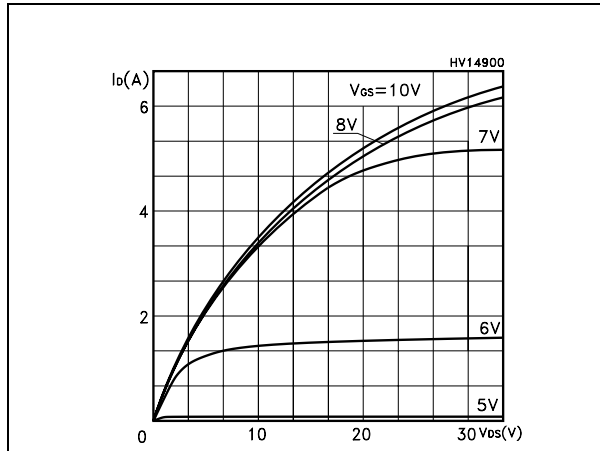


Figure 9. Transconductance

Figure 10. Static drain-source on resistance

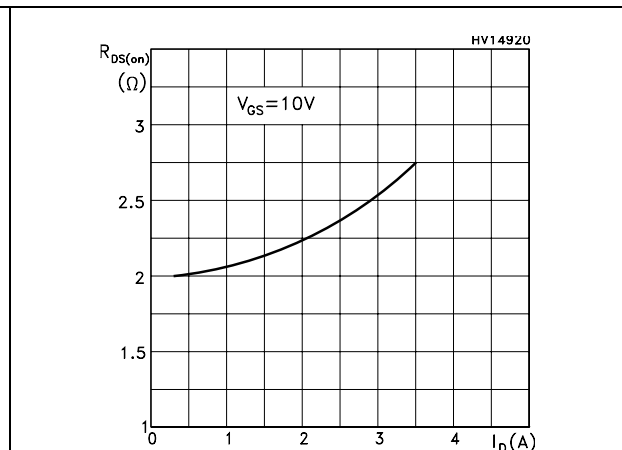
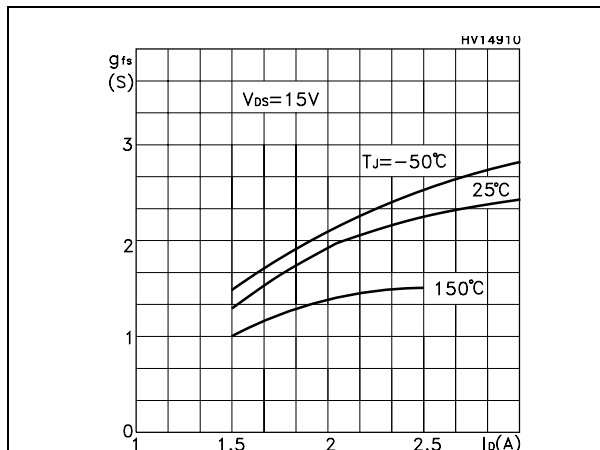


Figure 11. Gate charge vs gate-source voltage Figure 12. Capacitance variations

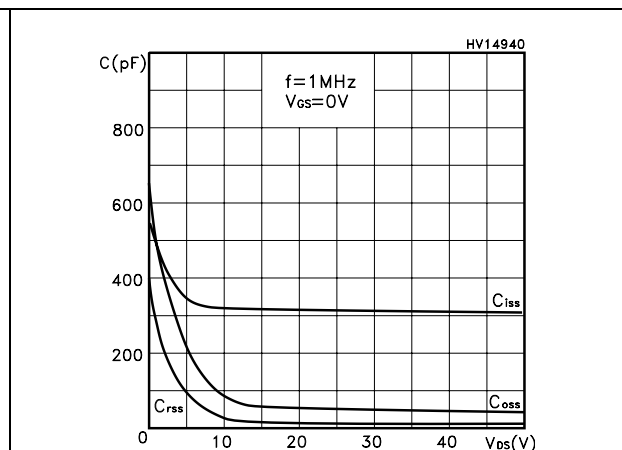
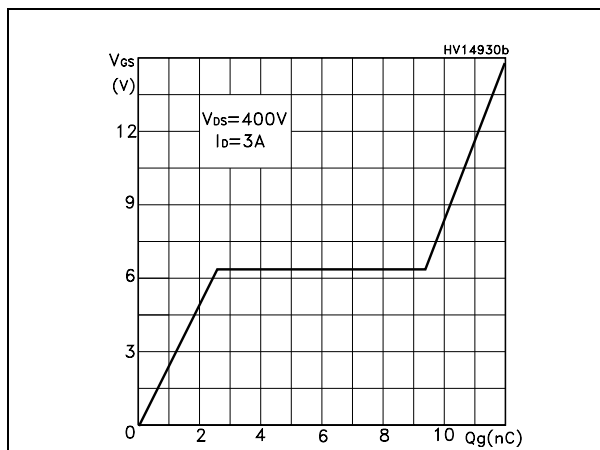


Figure 13. Normalized gate threshold voltage vs temperature

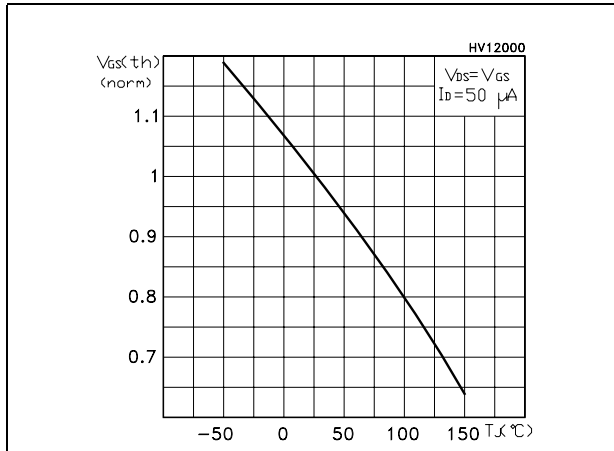


Figure 14. Normalized on resistance vs temperature

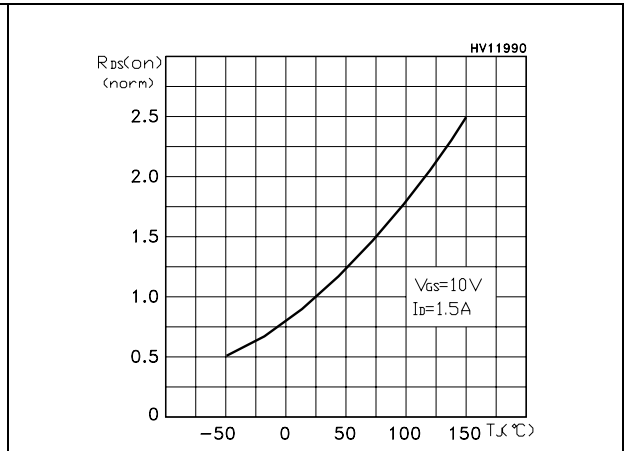


Figure 15. Source-drain diode forward characteristics

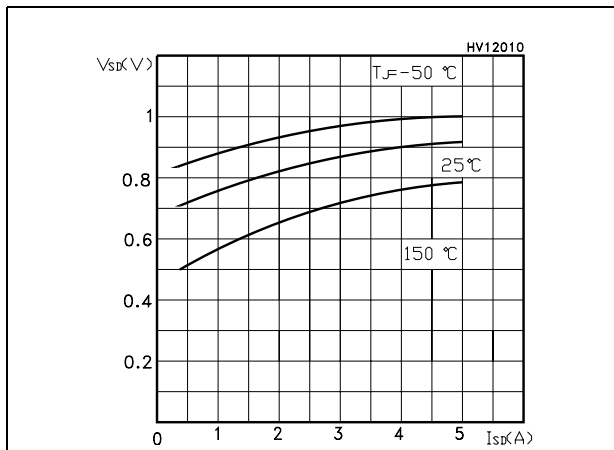


Figure 16. Normalized B_VDSS vs temperature

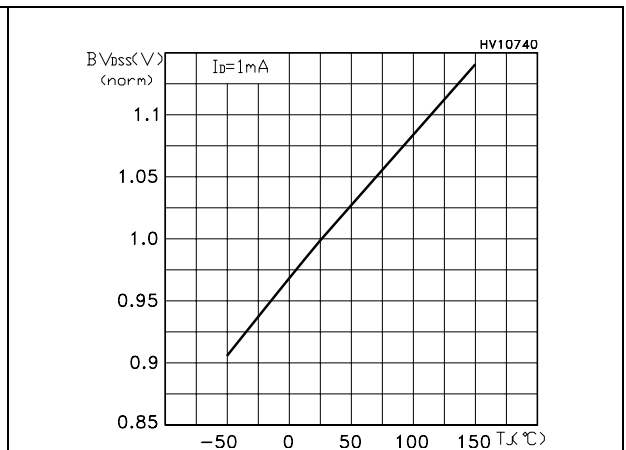
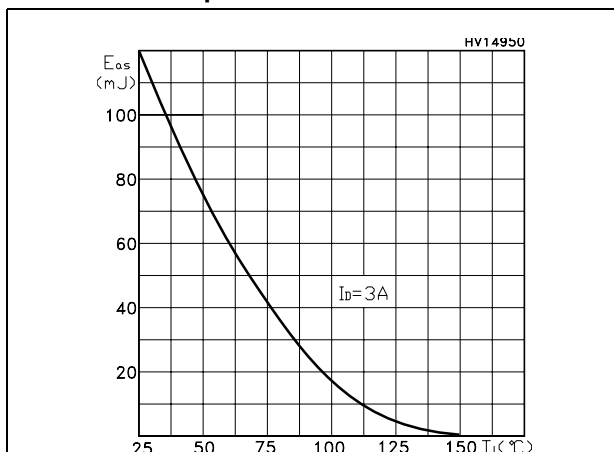


Figure 17. Maximum avalanche energy vs temperature



3 Test circuit

Figure 18. Switching times test circuit for resistive load

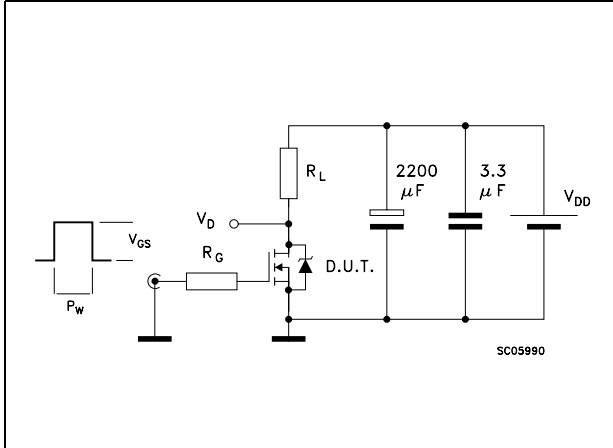


Figure 19. Gate charge test circuit

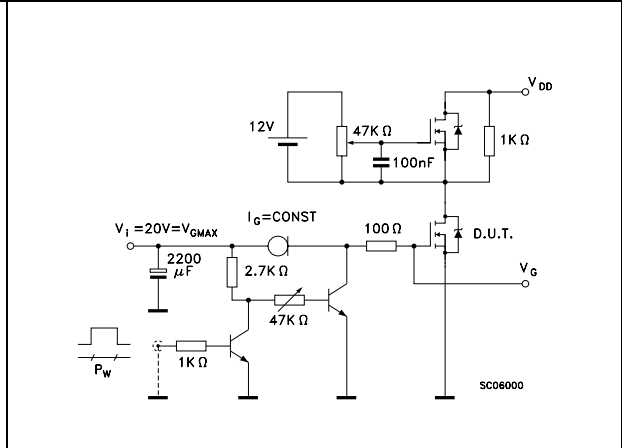


Figure 20. Test circuit for inductive load switching and diode recovery times

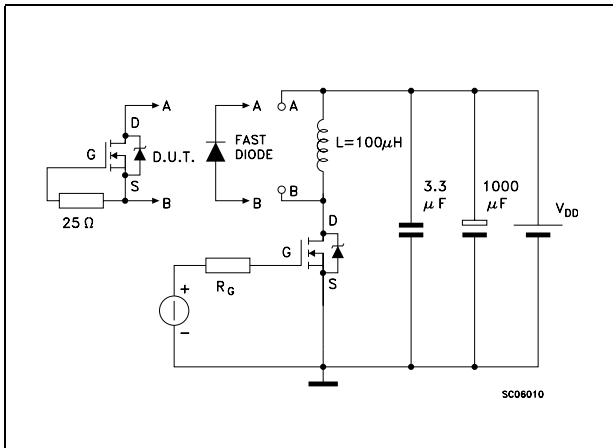


Figure 21. Unclamped inductive load test circuit

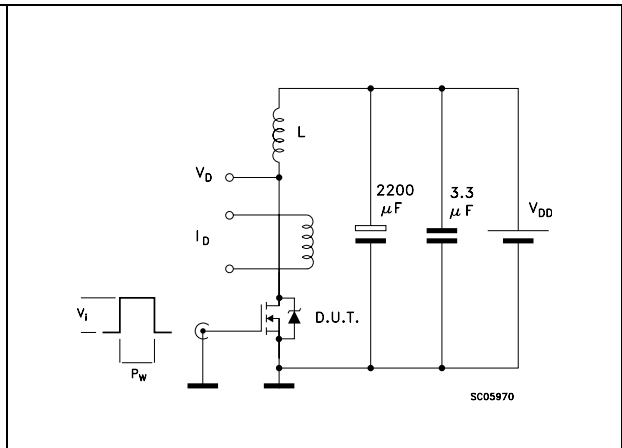


Figure 22. Unclamped inductive waveform

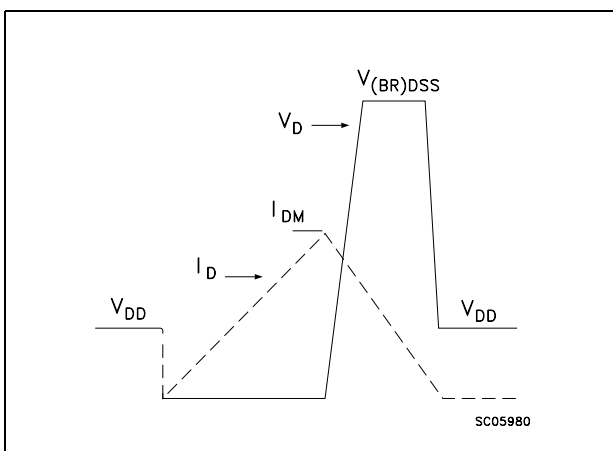
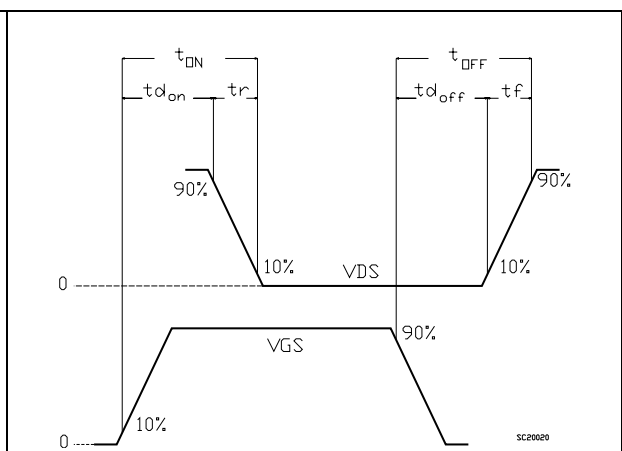


Figure 23. Switching time waveform

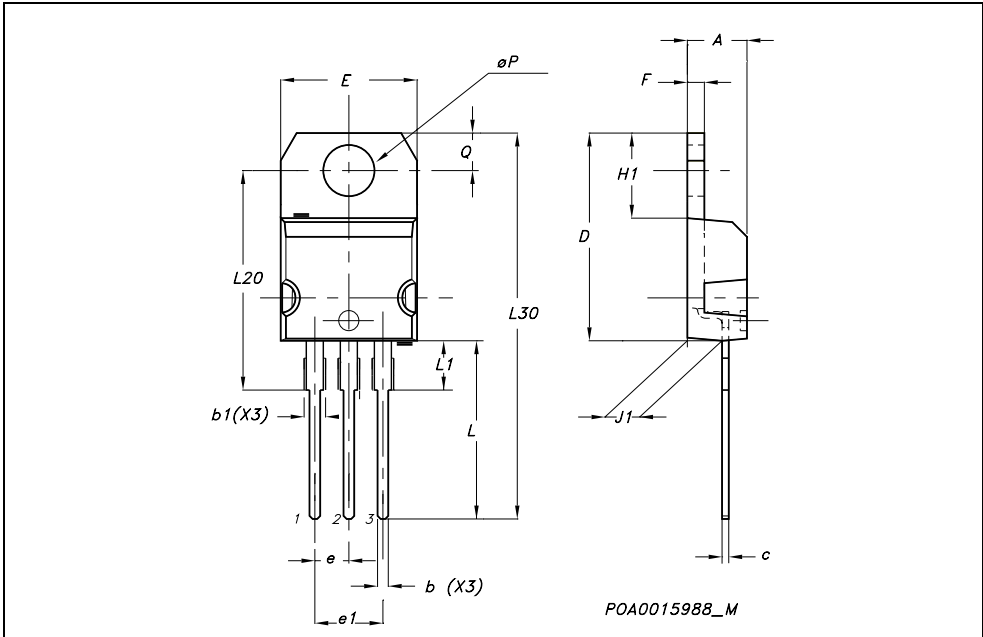


4 Package mechanical data

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

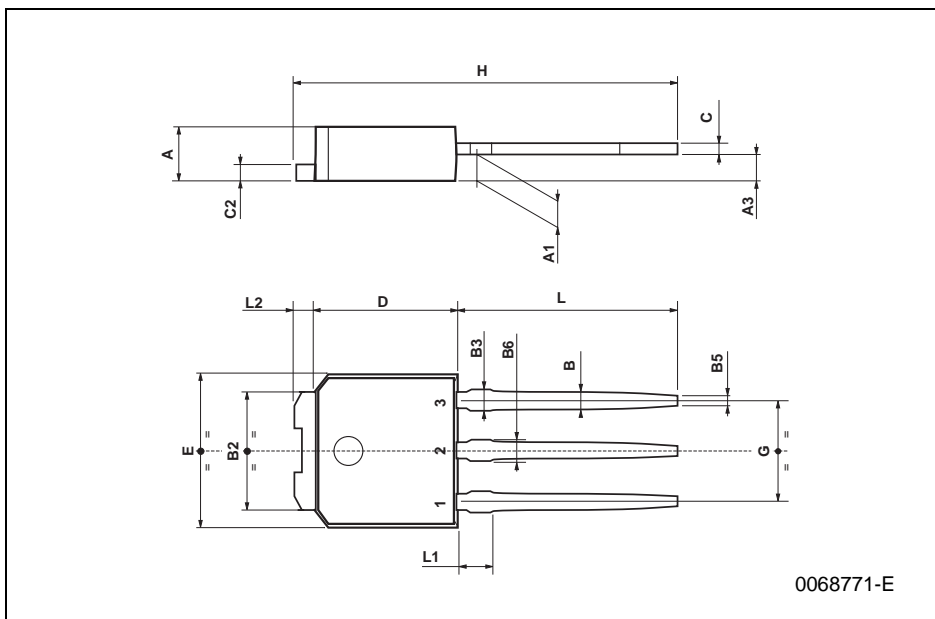
TO-220 MECHANICAL DATA

| 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 | 1.15 | | 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 |



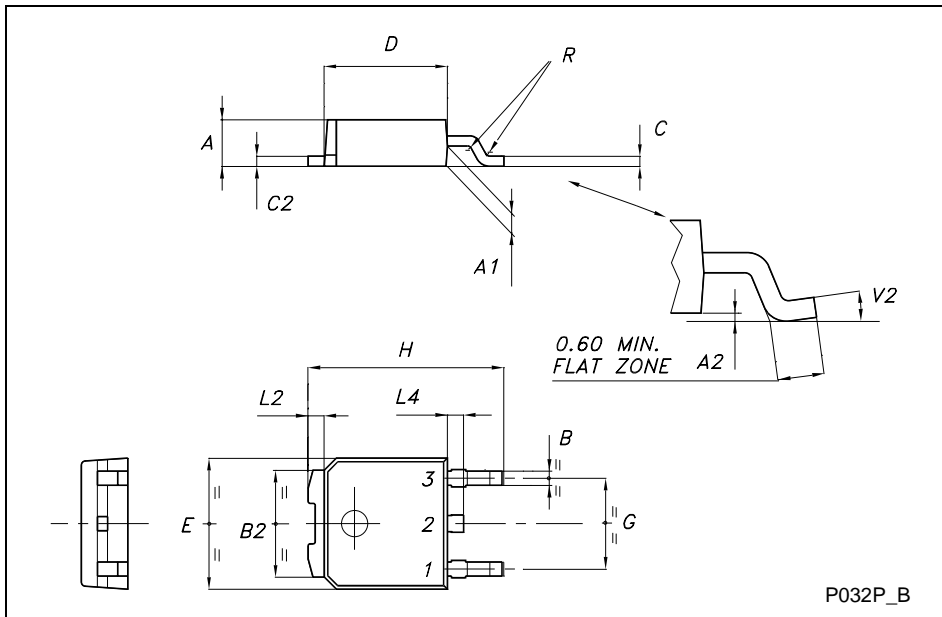
TO-251 (IPAK) MECHANICAL DATA

| 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 |



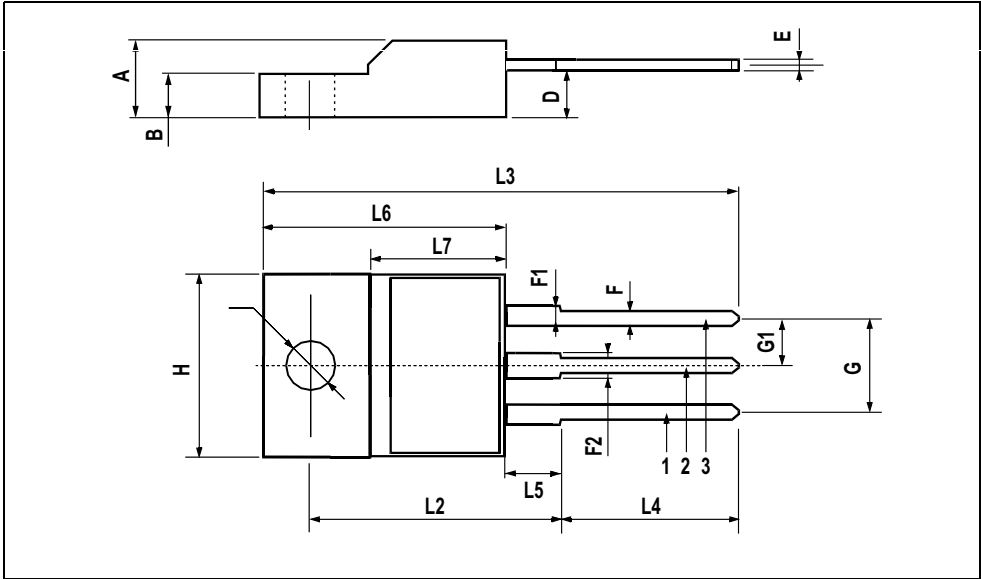
TO-252 (DPAK) MECHANICAL DATA

| 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° |



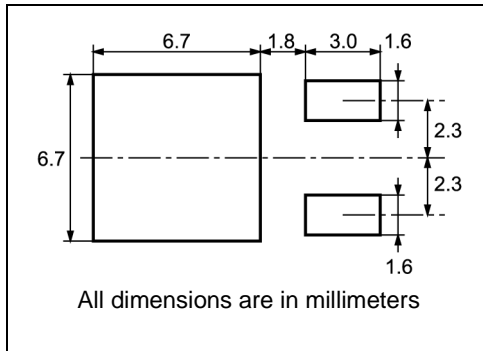
TO-220FP MECHANICAL DATA

| 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 |
| ∅ | 3 | | 3.2 | 0.118 | | 0.126 |



5 Packaging mechanical data

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

| 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 |

For machine ref. only including draft and radii concentric around B0

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius R min.

6 Revision history

Table 9. Revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 09-Feb-2006 | 1 | First Release |
| 20-Feb-2006 | 2 | Corrected Part Number |
| 27-Apr-2006 | 3 | Modified curves on page 6 |

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED REPRESENTATIVE OF ST, ST PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS, WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2006 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com

