



STD2NK70Z STD2NK70Z-1

N-channel 700V - 6Ω - 1.6 A - DPAK/IPAK
Zener protected SuperMESH™ Power MOSFET

General features

| Type | V _{DSS} | R _{DS(on)} | I _D | P _w |
|-------------|------------------|---------------------|----------------|----------------|
| STD2NK70Z | 700V | 7Ω | 1.6A | 45W |
| STD2NK70Z-1 | 700V | 7Ω | 1.6A | 45W |

- Extremely high dv/dt capability
- ESD improved capability
- 100% avalanche tested
- New high voltage benchmark
- Gate charge minimized

Description

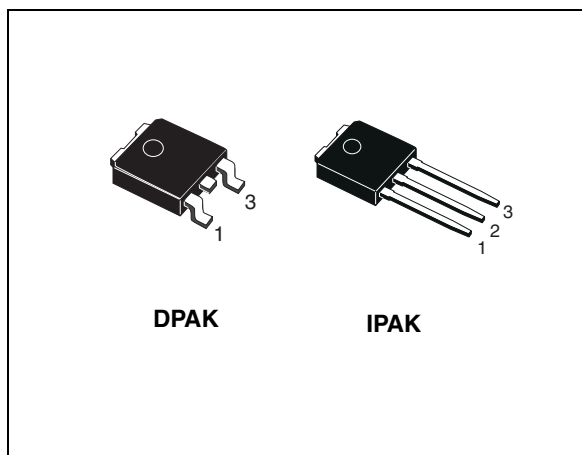
The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding application. Such series complements ST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

Applications

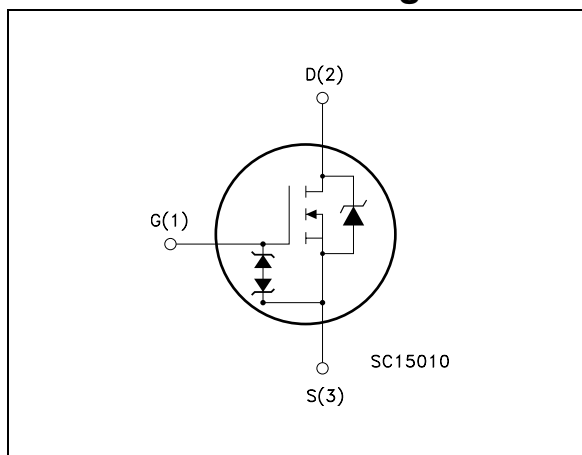
- Switching application

Order codes

| Part number | Marking | Package | Packaging |
|-------------|---------|--------------------|-------------|
| STD2NK70Z | D2NK70Z | D ² PAK | Tape & reel |
| STD2NK70Z-1 | D2NK70Z | IPAK | Tube |



Internal schematic diagram



Contents

| | | |
|----------|---|-----------|
| 1 | Electrical ratings | 3 |
| 2 | Electrical characteristics | 5 |
| | 2.1 Electrical characteristics (curves) | 7 |
| 3 | Test circuit | 10 |
| 4 | Package mechanical data | 11 |
| 5 | Packaging mechanical data | 14 |
| 6 | Revision history | 15 |

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|---|-----------|------|
| V_{DS} | Drain-source voltage ($V_{GS} = 0$) | 700 | V |
| V_{DGR} | Drain-gate voltage ($R_{GS} = 20\text{ k}\Omega$) | 700 | V |
| V_{GS} | Gate- source voltage | ± 30 | V |
| I_D | Drain current (continuous) at $T_C = 25^\circ\text{C}$ | 1.6 | A |
| I_D | Drain current (continuous) at $T_C = 100^\circ\text{C}$ | 1 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 6.4 | A |
| P_{tot} | Total dissipation at $T_C = 25^\circ\text{C}$ | 45 | W |
| | Derating factor | 0.36 | W/°C |
| $V_{ESD(G-S)}$ | Gate source ESD (HBM-C = 100pF, R = 1.5 K Ω) | 2000 | V |
| $dv/dt^{(2)}$ | Peak diode recovery voltage slope | 4.5 | V/ns |
| T_{stg} | Storage temperature | 55 to 150 | °C |
| T_j | Max. operating junction temperature | | |

1. Pulse width limited by safe operating area.
2. $I_{SD} \leq 1.6\text{A}$, $di/dt \leq 200\text{A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX}$

Table 2. Thermal data

| | | | |
|----------------|--|------|------|
| $R_{thj-case}$ | Thermal resistance junction-case max | 2.78 | °C/W |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 100 | °C/W |
| T_j | Maximum lead temperature for soldering purpose | 300 | °C |

Table 3. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------|---|-------|------|
| I_{AS} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_j Max) | 1.6 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_j=25^\circ\text{C}$, $I_d=I_{AS}$, $V_{dd}=50\text{V}$) | 110 | mJ |

Table 4. Gate-source zener diode

| Symbol | Parameter | Test Condition | Min. | Typ. | Max | Unit |
|------------|-------------------------------|--|------|------|-----|------|
| BV_{GSO} | Gate-source breakdown voltage | $I_{GS} = \pm 1 \text{ mA}$ (open drain) | 30 | | | A |

1.1 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.

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 = 1mA, V _{GS} = 0 | 700 | | | V |
| I _{DSS} | Zero gate voltage drain current (V _{GS} = 0) | V _{DS} = Max rating, V _{DS} = Max rating @ 125°C | | | 1 50 | μA μA |
| I _{GSS} | Gate body leakage current (V _{DS} = 0) | V _{GS} = ±20V | | | ±10 | nA |
| V _{GS(th)} | Gate threshold voltage | V _{DS} = V _{GS} , I _D = 50μA | 3 | 3.75 | 4.5 | V |
| R _{DS(on)} | Static drain-source on resistance | V _{GS} = 10V, I _D = 0.8A | | 6 | 7 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|------|---------------------|------|----------------------|
| g _{fs} ⁽¹⁾ | Forward transconductance | V _{DS} = 15V, I _D = 0.8A | | 1.4 | | S |
| C _{iss} C _{oss} C _{rss} | Input capacitance Output capacitance Reverse transfer capacitance | V _{DS} = 25V, f = 1 MHz, V _{GS} = 0 | | 280 35 6.5 | | pF pF pF |
| C _{oss eq} ⁽²⁾ | Equivalent output capacitance | V _{GS} = 0, V _{DS} = 0V to 560V | | 17 | | 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} = 350V, I _D = 0.8A, R _G = 4.7Ω, V _{GS} = 10V (see Figure 14) | | 7 17 20 35 | | ns ns ns ns |
| Q _g Q _{gs} Q _{gd} | Total gate charge Gate-source charge Gate-drain charge | V _{DD} = 560V, I _D = 0.8A V _{GS} = 10V (see Figure 15) | | 11.4 2 6.8 | | nC nC 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. Source drain diode

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|-----------------------------------|--|--|-----|-------------------|-----|--------------------|
| I_{SD} | Source-drain current | | | | 1.6 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 6.4 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD}=1.6A, V_{GS}=0$ | | | 1.6 | V |
| t_{rr} Q_{rr} I_{RRM} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_{SD}=1.6A,$ $di/dt = 100A/\mu s,$ $V_{DD}=50V, T_j=25^\circ C$ (see Figure 16) | | 334 918 5.5 | | ns μC A |
| t_{rr} Q_{rr} I_{RRM} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_{SD}=1.6A,$ $di/dt = 100A/\mu s,$ $V_{DD}= 50V, T_j=150^\circ C$ (see Figure 16) | | 350 1050 6 | | ns μC 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 1. Safe operating area

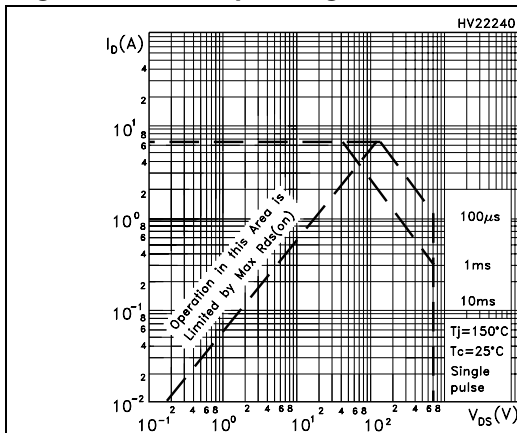


Figure 2. Thermal impedance

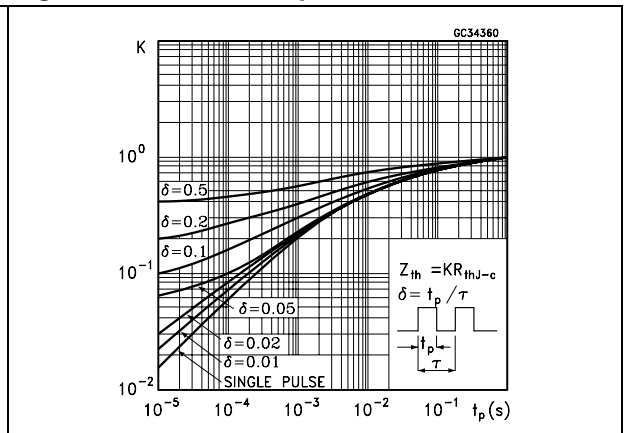


Figure 3. Output characteristics

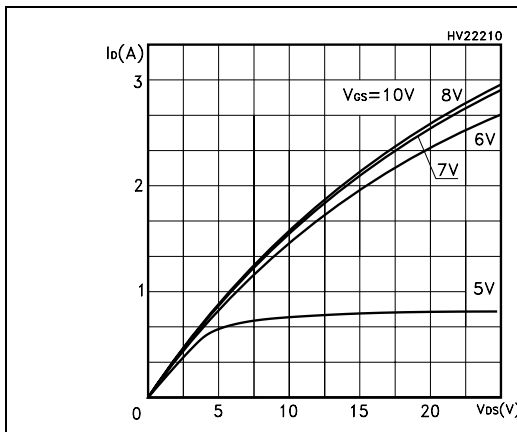


Figure 4. Transfer characteristics

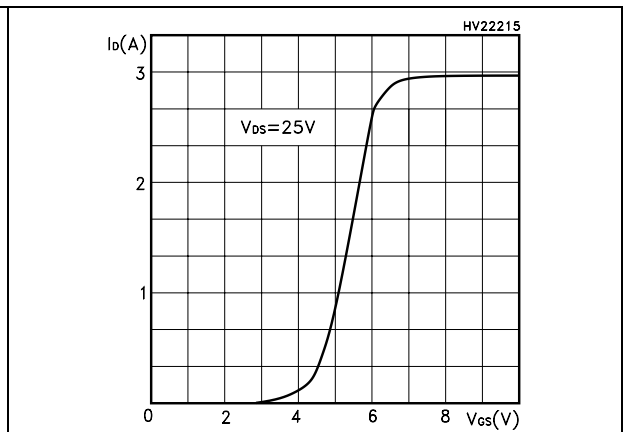


Figure 5. Transconductance

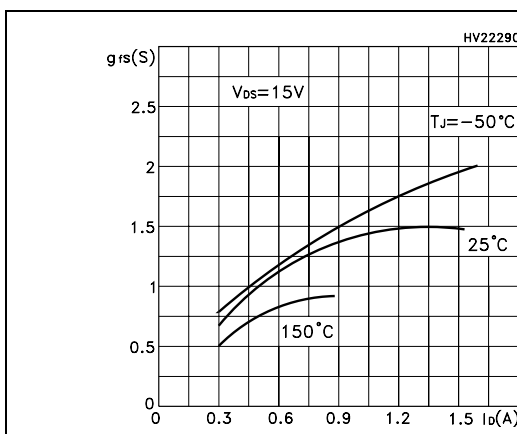


Figure 6. Static drain-source on resistance

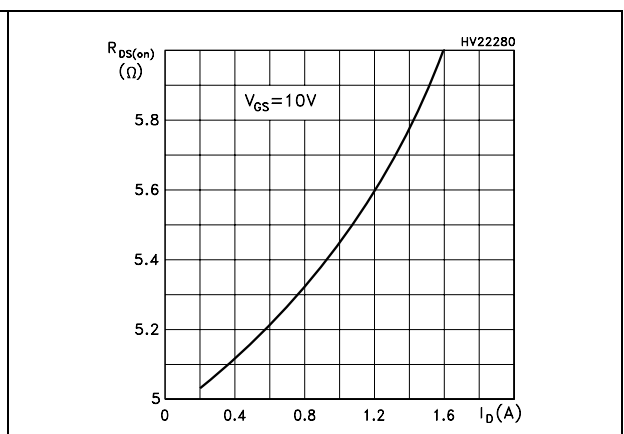


Figure 7. Gate charge vs gate-source voltage Figure 8. Capacitance variations

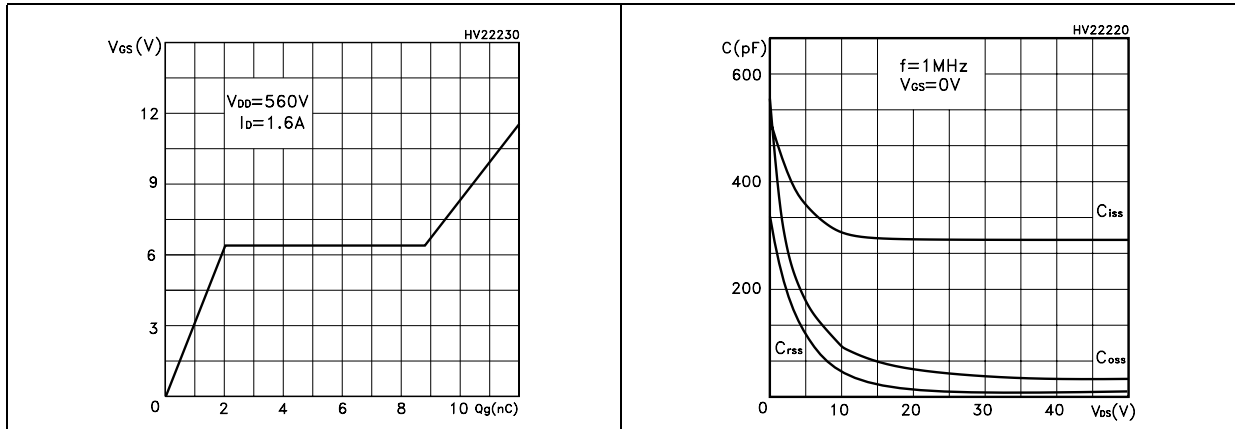


Figure 9. Normalized gate threshold voltage vs temperature Figure 10. Normalized on resistance vs temperature

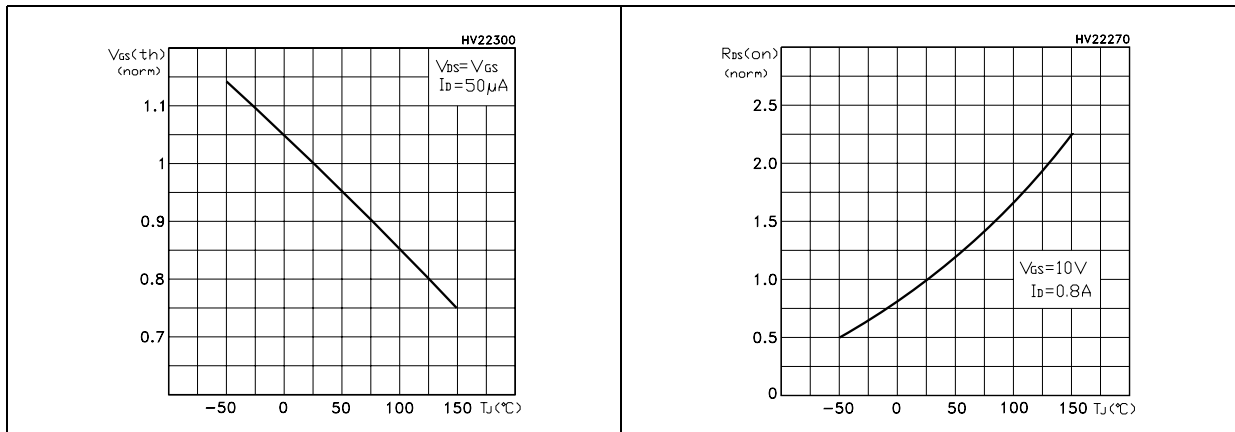


Figure 11. Source-drain diode forward characteristics Figure 12. Normalized $B_{V_{DS}}$ vs temperature

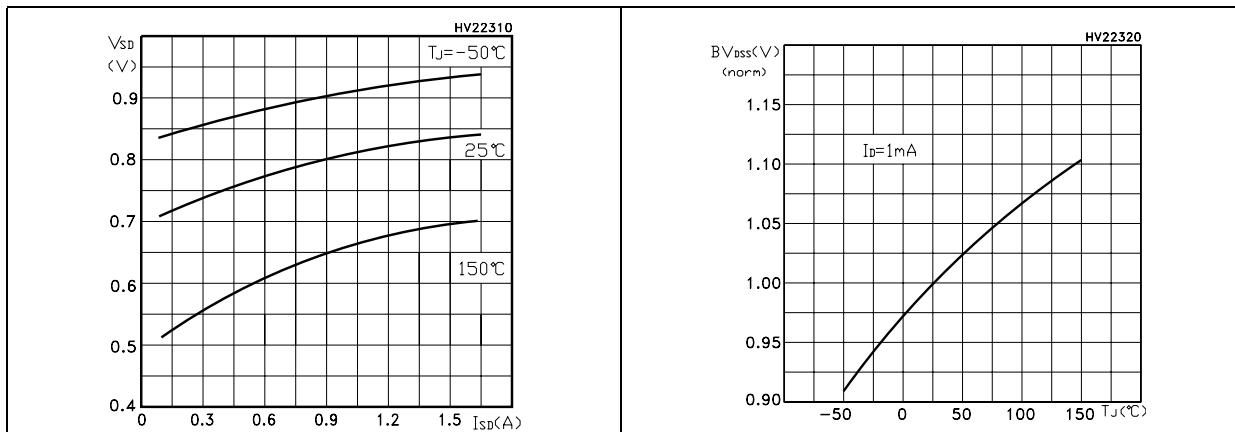
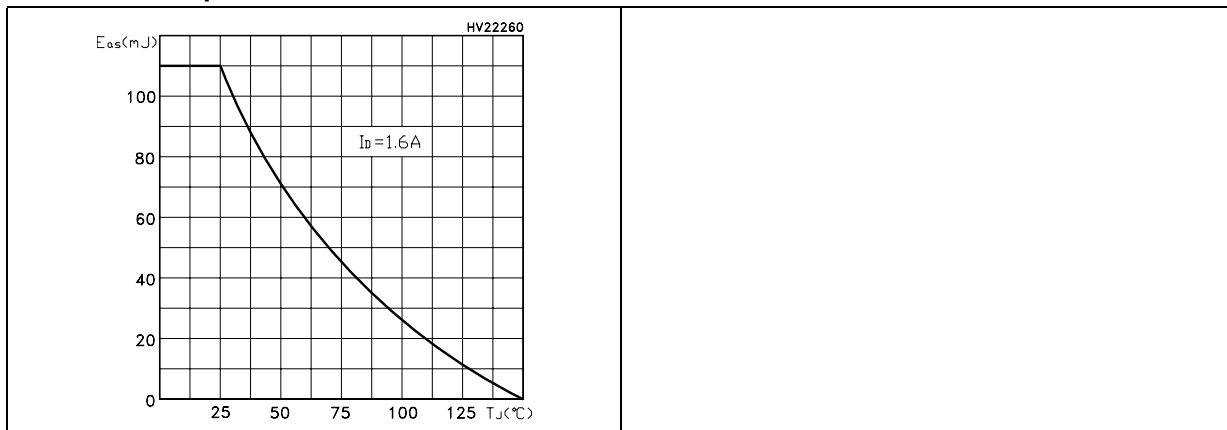


Figure 13. Maximum avalanche energy vs temperature



3 Test circuit

Figure 14. Switching times test circuit for resistive load

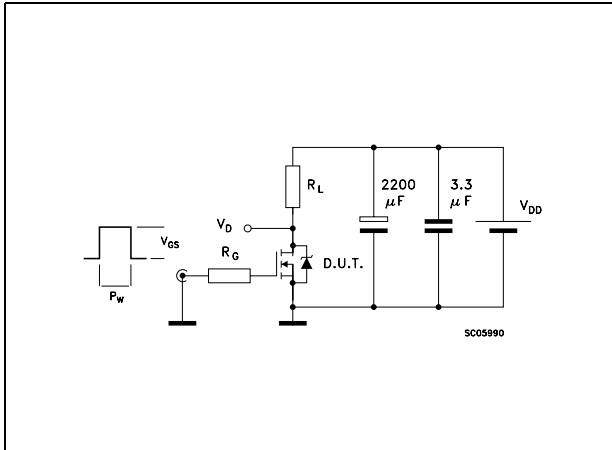


Figure 15. Gate charge test circuit

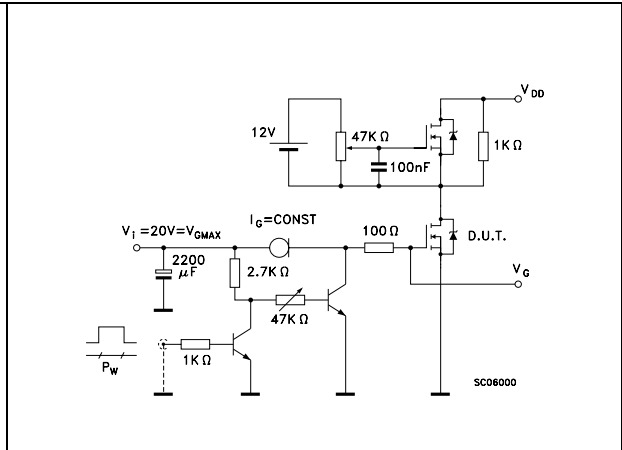


Figure 16. Test circuit for inductive load switching and diode recovery times

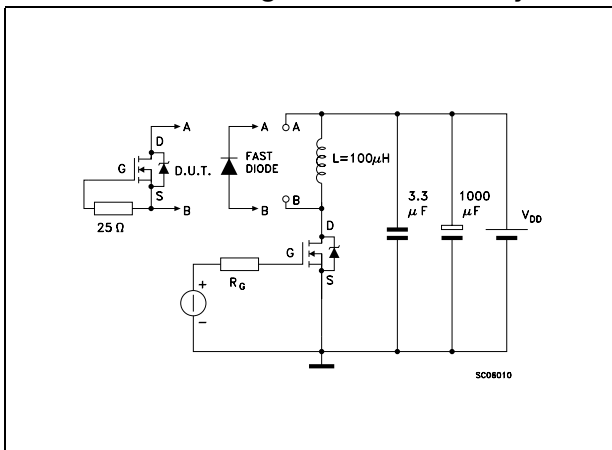


Figure 17. Unclamped Inductive load test circuit

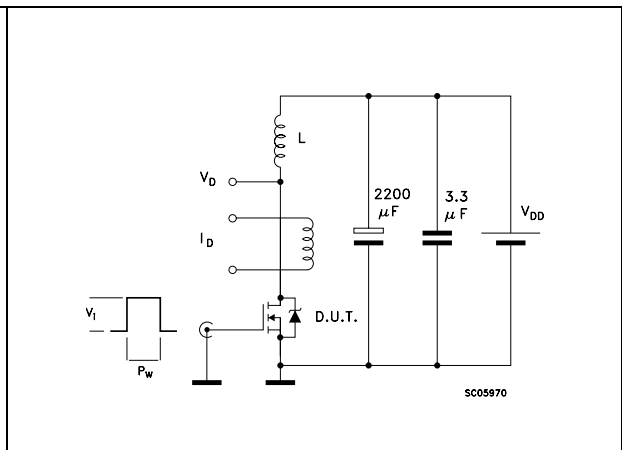


Figure 18. Unclamped inductive waveform

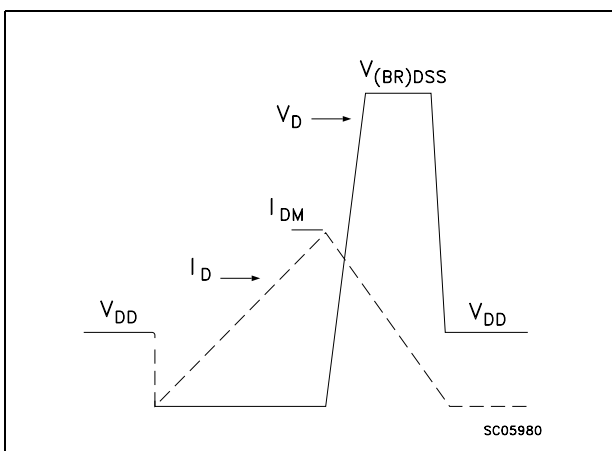
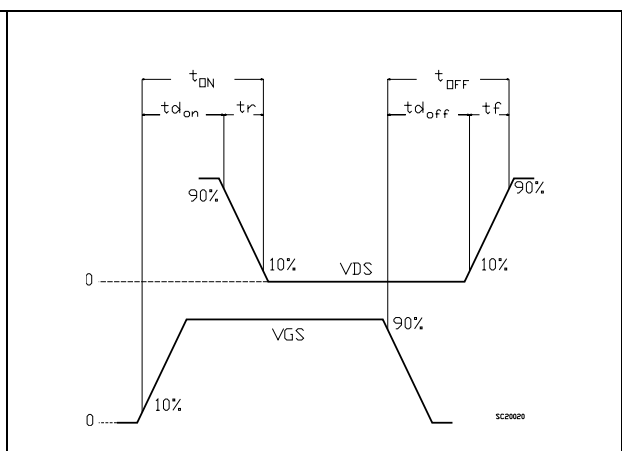


Figure 19. Switching time waveform

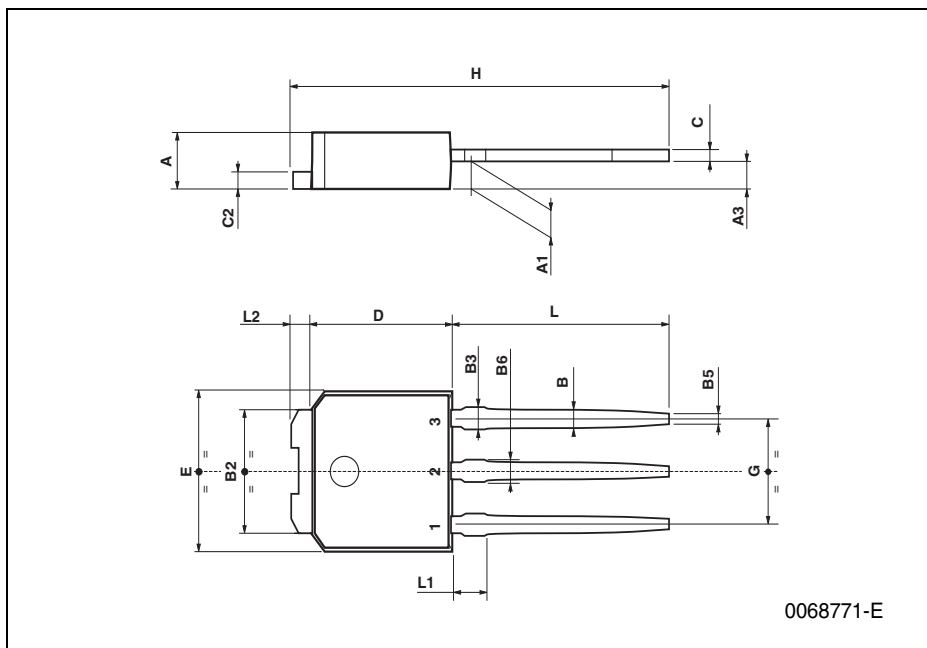


4 Package mechanical data

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

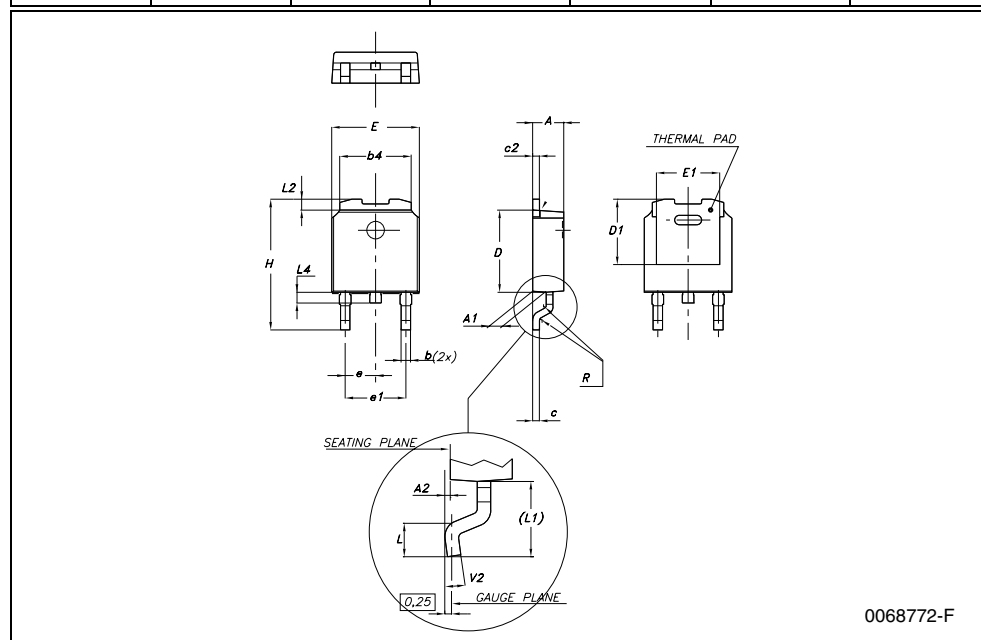
TO-251 (IPAK) MECHANICAL DATA

| 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 |



DPAK MECHANICAL DATA

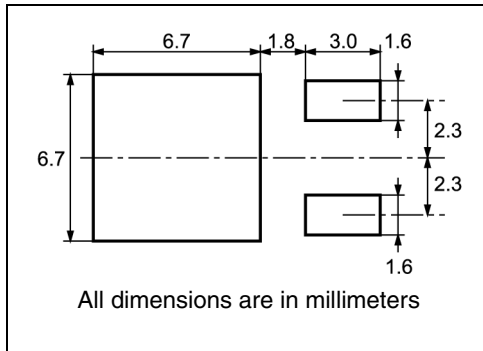
| DIM. | mm. | | | inch | | |
|------|------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.2 | | 2.4 | 0.086 | | 0.094 |
| A1 | 0.9 | | 1.1 | 0.035 | | 0.043 |
| A2 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| B | 0.64 | | 0.9 | 0.025 | | 0.035 |
| b4 | 5.2 | | 5.4 | 0.204 | | 0.212 |
| 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 |
| D1 | | 5.1 | | | 0.200 | |
| E | 6.4 | | 6.6 | 0.252 | | 0.260 |
| E1 | | 4.7 | | | 0.185 | |
| e | | 2.28 | | | 0.090 | |
| e1 | 4.4 | | 4.6 | 0.173 | | 0.181 |
| H | 9.35 | | 10.1 | 0.368 | | 0.397 |
| L | 1 | | | 0.039 | | |
| (L1) | | 2.8 | | | 0.110 | |
| L2 | | 0.8 | | | 0.031 | |
| L4 | 0.6 | | 1 | 0.023 | | 0.039 |
| R | | 0.2 | | | 0.008 | |
| V2 | 0° | | 8° | 0° | | 8° |



0068772-F

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 |

| 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 |

TOP COVER TAPE

User Direction of Feed

Center line of cavity

Bending radius R min.

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

10 pitches cumulative tolerance on tape +/- 0.2 mm

FEED DIRECTION

6 Revision history

Table 8. Revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 21-Jan-2005 | 1 | First Release |
| 10-Jun-2005 | 2 | Updated <i>Figure 1: Safe operating area</i> |
| 13-Jul-2006 | 3 | New template, no content change |

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