



# STP2NK90Z - STD2NK90Z STD2NK90Z-1

N-channel 900V - 5Ω - 2.1A - TO-220 /DPAK/IPAK  
Zener-Protected SuperMESH™ MOSFET

## General features

| Type        | V <sub>DSS</sub><br>(@T <sub>Jmax</sub> ) | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>W</sub> |
|-------------|-------------------------------------------|---------------------|----------------|----------------|
| STD2NK90Z   | 900V                                      | <6.5Ω               | 2.1A           | 70W            |
| STD2NK90Z-1 | 900V                                      | <6.5Ω               | 2.1A           | 70W            |
| STP2NK90Z   | 900V                                      | <6.5Ω               | 2.1A           | 70W            |

- Extremely high dv/dt capability
- Improved esd capability
- 100% avalanche rated
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability

## Description

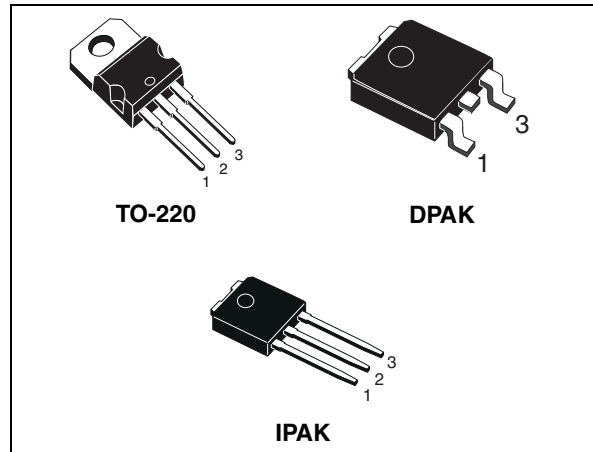
The SuperMESH™ series is obtained through an extreme optimization of ST's well established stripbased PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements ST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

## Applications

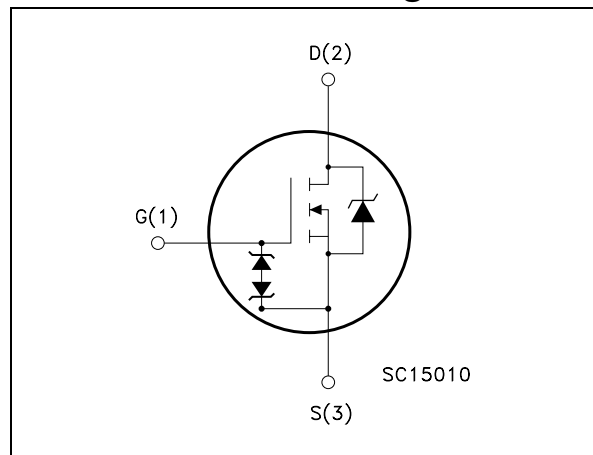
- Switching application

## Order codes

| Part number | Marking | Package | Packaging   |
|-------------|---------|---------|-------------|
| STD2NK90ZT4 | D2NK90Z | DPAK    | Tape & reel |
| STD2NK90Z-1 | D2NK90Z | IPAK    | Tube        |
| STP2NK90Z   | P2NK90Z | TO-220  | Tube        |



## Internal schematic diagram



## Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter                                               | Value      |                          | Unit                |
|----------------|---------------------------------------------------------|------------|--------------------------|---------------------|
|                |                                                         | STP2NK90Z  | STD2NK90Z<br>STD2NK90Z-1 |                     |
| $V_{DS}$       | Drain-source voltage ( $V_{GS} = 0$ )                   | 900        |                          | V                   |
| $V_{DGR}$      | Drain-gate voltage ( $R_{GS} = 20\text{ k}\Omega$ )     | 900        |                          | V                   |
| $V_{GS}$       | Gate- source Voltage                                    | $\pm 30$   |                          | V                   |
| $I_D$          | Drain current (continuous) at $T_C = 25^\circ\text{C}$  | 2.1        |                          | A                   |
| $I_D$          | Drain current (continuous) at $T_C = 100^\circ\text{C}$ | 1.3        |                          | A                   |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                  | 8.4        |                          | A                   |
| $P_{TOT}$      | Total dissipation at $T_C = 25^\circ\text{C}$           | 70         |                          | W                   |
|                | Derating factor                                         | 0.56       |                          | W/ $^\circ\text{C}$ |
| $V_{ESD(G-S)}$ | Gate source ESD(HBM-C=100pF,<br>$R=1.5\text{K}\Omega$ ) | 2000       |                          | V                   |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                       | 4.5        |                          | V/ns                |
| $T_j$          | Operating junction temperature                          | -55 to 150 |                          | $^\circ\text{C}$    |
| $T_{stg}$      | Storage temperature                                     | -55 to 150 |                          | $^\circ\text{C}$    |

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 1\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

**Table 2. Thermal data**

| Symbol         | Parameter                                      | Value | Unit                      |
|----------------|------------------------------------------------|-------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max           | 1.78  | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max        | 62.5  | $^\circ\text{C}/\text{W}$ |
| $T_I$          | Maximum lead temperature for soldering purpose | 300   | $^\circ\text{C}$          |

**Table 3. Avalanche characteristics**

| Symbol   | Parameter                                                                                                       | Value | Unit |
|----------|-----------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive<br>(pulse width limited by $T_j$ max)                           | 2.1   | A    |
| $E_{AS}$ | Single pulse avalanche energy<br>(starting $T_j = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 150   | mJ   |

**Table 4. Gate-source zener diode**

| Symbol            | Parameter                     | Test conditions                     | Min. | Typ. | Max. | Unit |
|-------------------|-------------------------------|-------------------------------------|------|------|------|------|
| BV <sub>GSO</sub> | Gate-source breakdown voltage | I <sub>gs</sub> =± 1mA (open drain) | 30   |      |      | V    |

## 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

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

**Table 5. On/off states**

| Symbol        | Parameter                                        | Test conditions                                                                            | Min. | Typ. | Max.     | Unit                           |
|---------------|--------------------------------------------------|--------------------------------------------------------------------------------------------|------|------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown Voltage                   | $I_D = 1 \text{ mA}$ , $V_{GS} = 0$                                                        | 900  |      |          | V                              |
| $I_{DSS}$     | Zero gate voltage Drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max Rating}$<br>$V_{DS} = \text{Max Rating}$ , $T_C = 125^{\circ}\text{C}$ |      |      | 1<br>50  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body Leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20 \text{ V}$                                                                |      |      | $\pm 10$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 50 \mu\text{A}$                                                 | 3    | 3.75 | 4.5      | V                              |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10 \text{ V}$ , $I_D = 1.05 \text{ A}$                                           |      | 5    | 6.5      | $\Omega$                       |

**Table 6. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                                | Min. | Typ.                | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|------|---------------------|------|----------------|
| $g_{fs}^{(1)}$                      | Forward transconductance                                                | $V_{DS} = 15 \text{ V}$ , $I_D = 1.05 \text{ A}$                                               |      | 2.3                 |      | S              |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25 \text{ V}$ , $f = 1 \text{ MHz}$ ,<br>$V_{GS} = 0$                                |      | 485<br>50<br>10     |      | pF<br>pF<br>pF |
| $C_{oss \text{ eq}}^{(2)}$          | Equivalent output capacitance                                           | $V_{GS} = 0 \text{ V}$ , $V_{DS} = 0 \text{ to } 720 \text{ V}$                                |      | 24                  |      | pF             |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 720 \text{ V}$ , $I_D = 2 \text{ A}$ ,<br>$V_{GS} = 10 \text{ V}$<br>(see Figure 22) |      | 19.5<br>3.4<br>10.8 | 27   | nC<br>nC<br>nC |

1. Pulsed: pulse duration=300 $\mu\text{s}$ , 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 7. 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 | $V_{DD} = 450 \text{ V}$ , $I_D = 1 \text{ A}$ ,<br>$R_G = 4.7 \Omega$ , $V_{GS} = 10 \text{ V}$<br>(see Figure 19) |      | 21<br>11<br>43<br>40 |      | ns<br>ns<br>ns<br>ns |

**Table 8. Source drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                                      | Min | Typ. | Max | Unit          |
|-----------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                      |     |      | 2.1 | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                      |     |      | 8.4 | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 2.1 \text{ A}$ , $V_{GS} = 0$                                                                                              |     |      | 1.6 | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$<br>$V_{DD} = 50\text{V}$<br>(see Figure 20)                             |     | 415  |     | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                      |     | 1.5  |     | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                      |     | 7.2  |     | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$<br>$V_{DD} = 50\text{V}$ , $T_j = 150^\circ\text{C}$<br>(see Figure 20) |     | 515  |     | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                      |     | 1.9  |     | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                      |     | 7.5  |     | A             |

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration=300 $\mu\text{s}$ , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for TO-220/ DPAK/ D<sup>2</sup>PAK

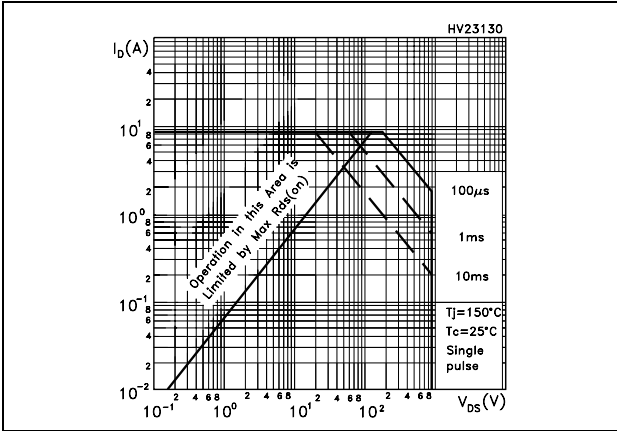


Figure 2. Thermal impedance for TO-220/ DPAK/ D<sup>2</sup>PAK

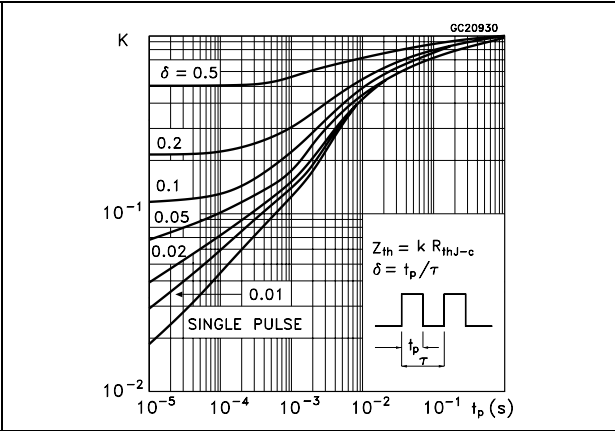


Figure 3. Safe operating area for TO-220FP

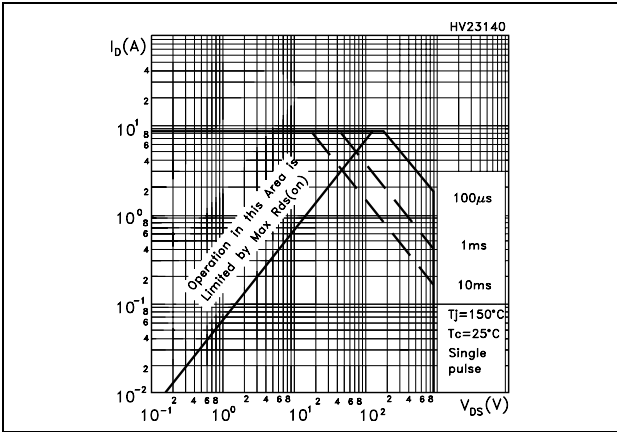


Figure 4. Thermal impedance for TO-220FP

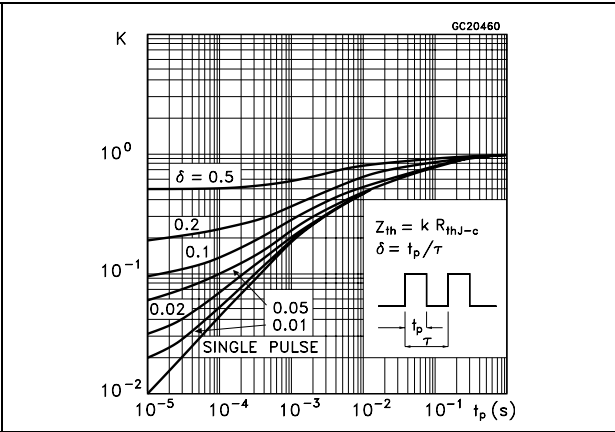


Figure 5. Output characteristics

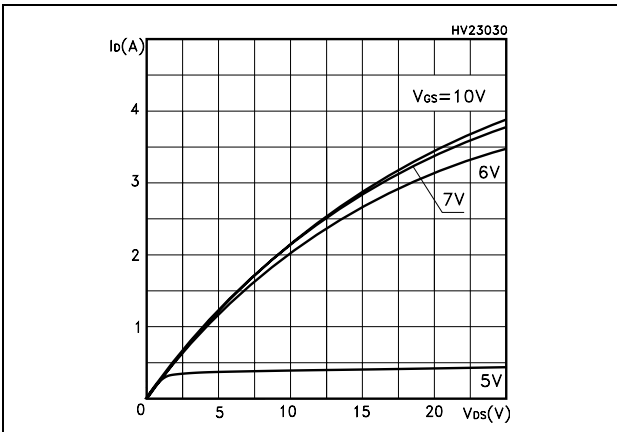


Figure 6. Transfer characteristics

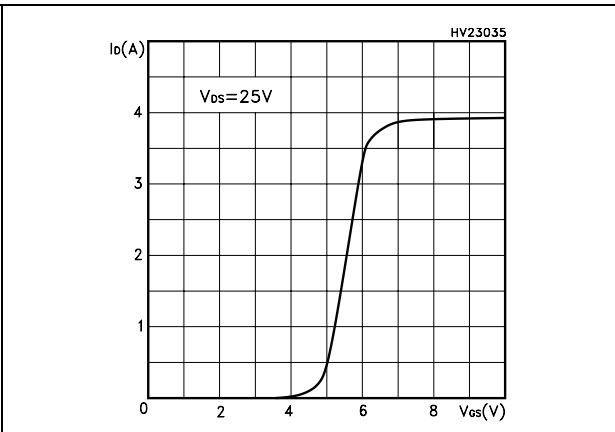


Figure 7. Transconductance

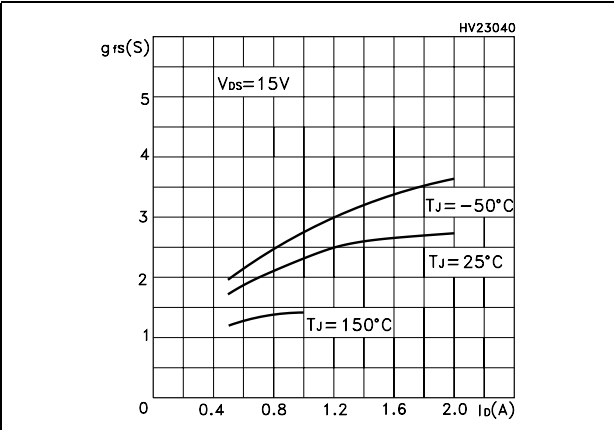


Figure 8. Static drain-source on resistance

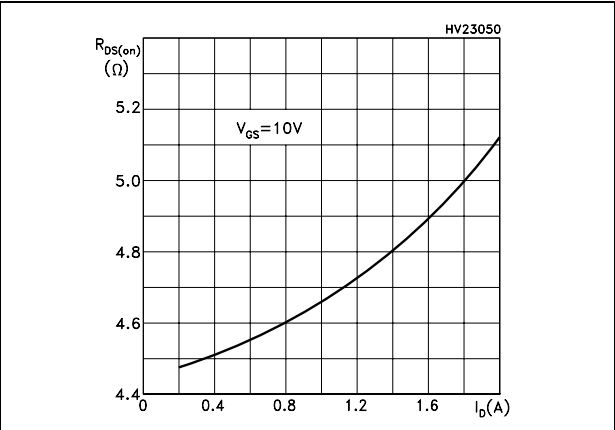


Figure 9. Gate charge vs gate-source voltage

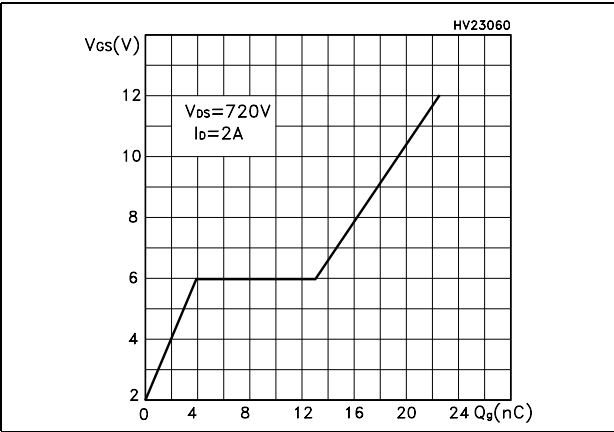


Figure 10. Capacitance variations

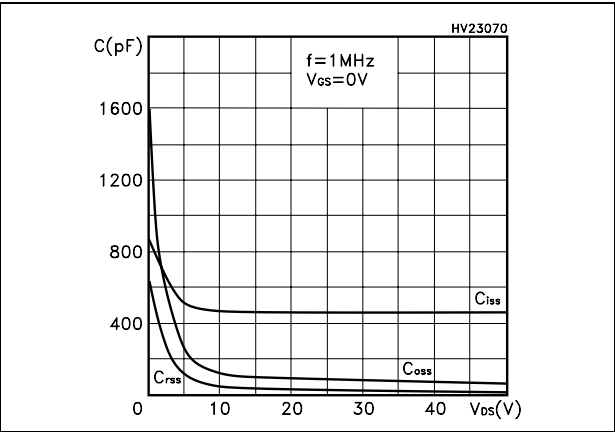


Figure 11. Normalized gate threshold voltage vs temperature

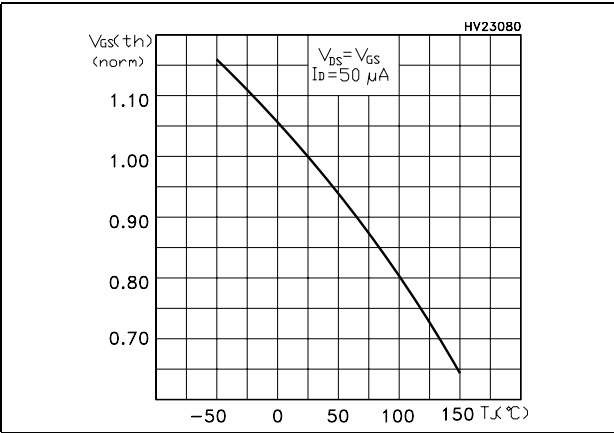


Figure 12. Normalized on resistance vs temperature

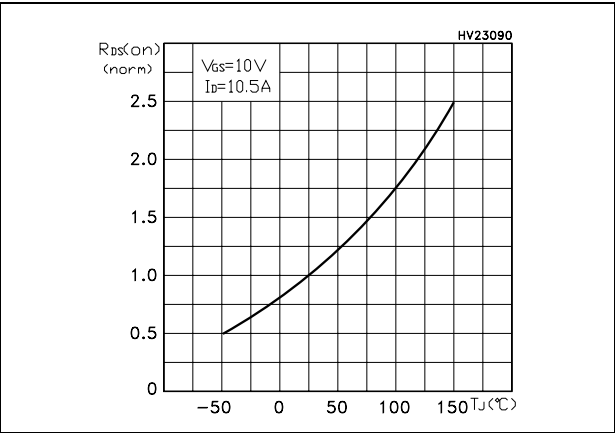


Figure 13. Source-drain diode forward characteristics

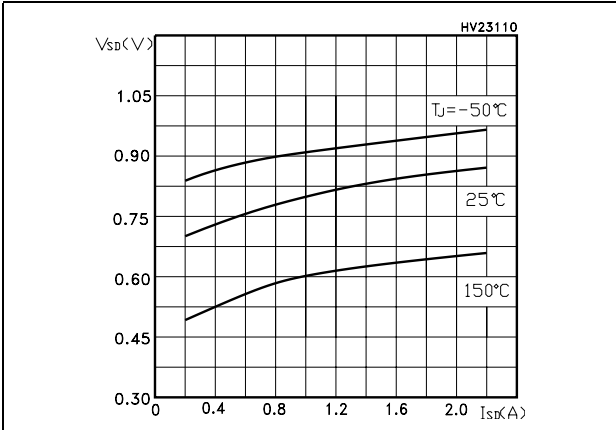


Figure 14. Normalized  $B_{VDSS}$  vs temperature

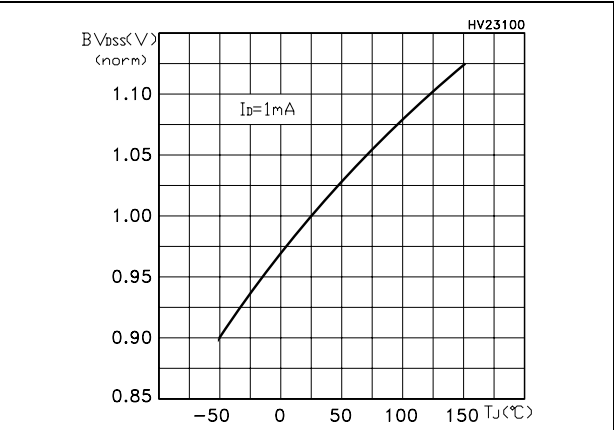
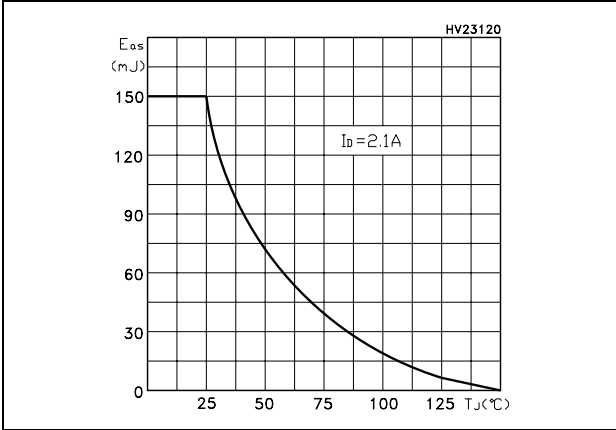


Figure 15. Maximum avalanche energy vs temperature



### 3 Test circuit

Figure 16. Switching times test circuit for resistive load

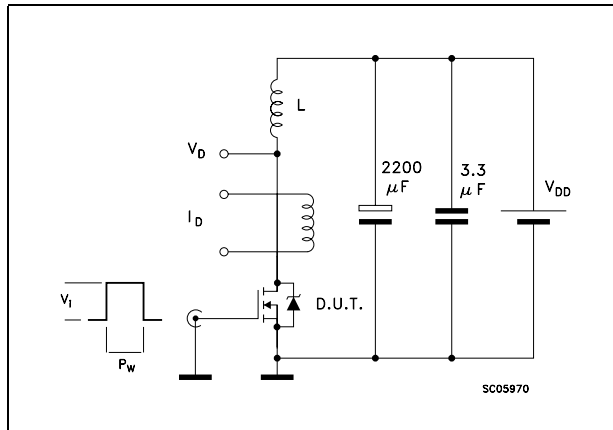


Figure 17. Gate charge test circuit

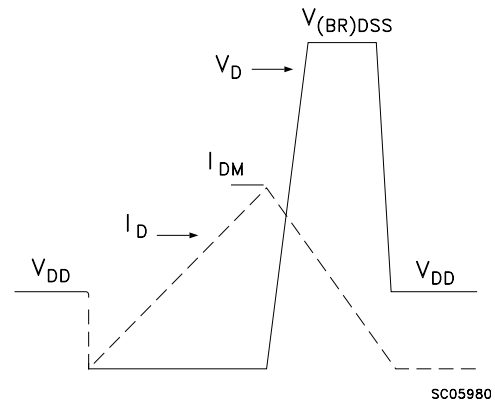


Figure 18. Test circuit for inductive load switching and diode recovery times

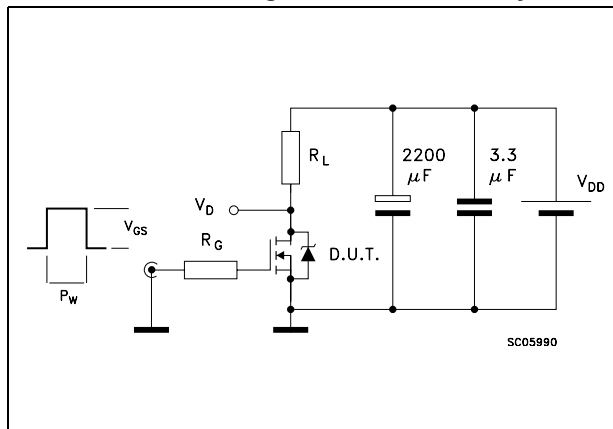


Figure 19. Unclamped Inductive load test circuit

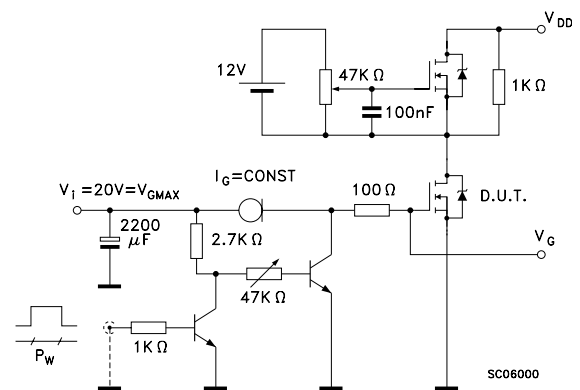
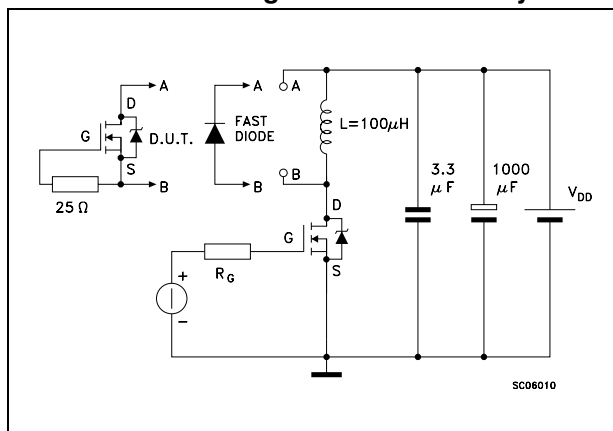


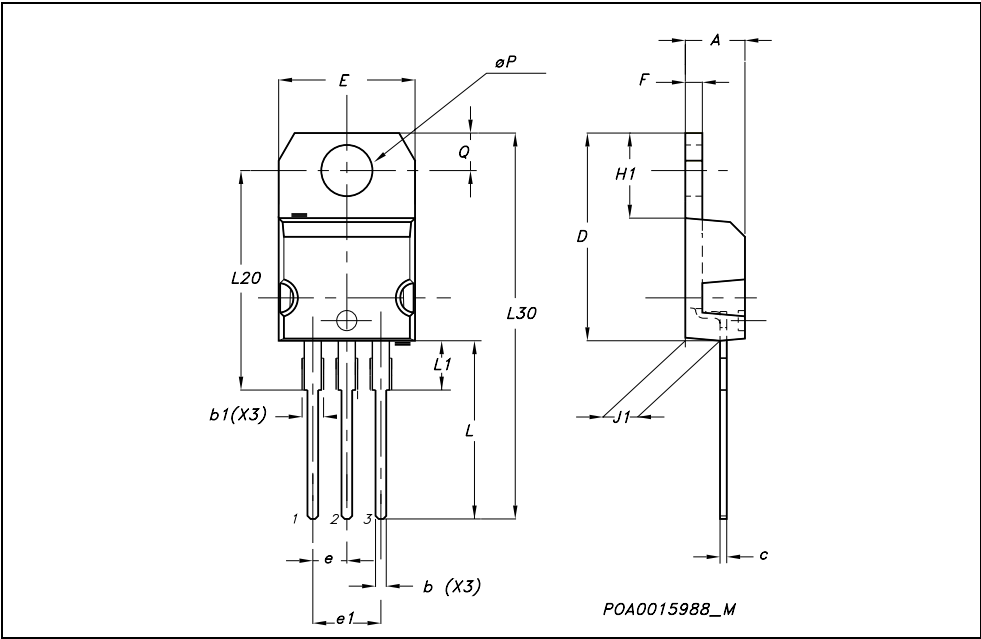
Figure 20. Test circuit for inductive load switching and diode recovery times



## 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](http://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 |

0068771-E

| 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°    |

The mechanical drawing illustrates the DPAK package geometry. It includes a top view showing dimensions E, b4, L2, L4, H, e, e1, and b(2x). A side view shows dimensions A, c2, D, A1, R, and c. A detail view of the lead shows dimensions A2, L, (L1), V2, and a gauge plane at 0.25. A thermal pad is also indicated on the top view.

0068772-F



All dimensions are in millimeters

40 mm min. Access hole at slot location

B

D

Full radius

Tape slot in core for tape start

2.5mm min. width

C

T

N

G measured at hub

### 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  |

### 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 |

### BASE QTY

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

K<sub>0</sub>

T

D

P<sub>2</sub>

P<sub>0</sub> 10 pitches cumulative tolerance on tape  $\pm 0.2$  mm

E

F

W

B<sub>1</sub>

B<sub>0</sub>

D<sub>1</sub>

A<sub>0</sub>

P<sub>1</sub>

P<sub>2</sub>

Center line of cavity

User Direction of Feed

Bending radius R min.

FEED DIRECTION

## 6 Revision history

**Table 9. Revision history**

| Date        | Revision | Changes                         |
|-------------|----------|---------------------------------|
| 06-Oct-2004 | 1        | First version                   |
| 08-Sep-2005 | 2        | Complete version                |
| 05-Mar-2006 | 3        | Inserted Ecopack indication     |
| 27-Jul-2006 | 4        | New template, no content change |

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