



# STP4NK80Z - STP4NK80ZFP STD4NK80Z - STD4NK80Z-1

N-channel 800V - 3Ω - 3A - TO-220/TO-220FP/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> |
|-------------|-------------------------------------------|---------------------|----------------|
| STP4NK80Z   | 800 V                                     | < 3.5 Ω             | 3 A            |
| STP4NK80ZFP | 800 V                                     | < 3.5 Ω             | 3 A            |
| STD4NK80Z   | 800 V                                     | < 3.5 Ω             | 3 A            |
| STD4NK80Z-1 | 800 V                                     | < 3.5 Ω             | 3 A            |

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

## Description

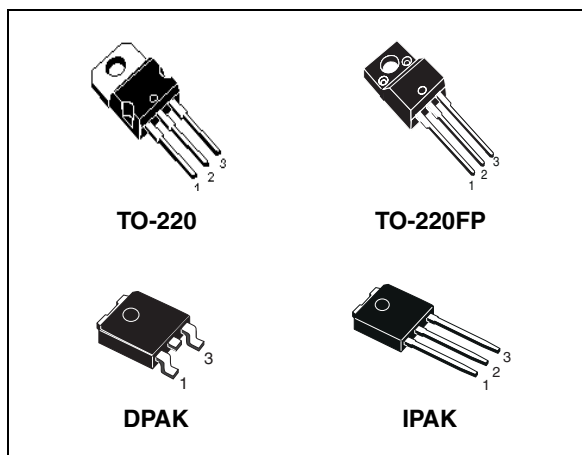
The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements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

## Applications

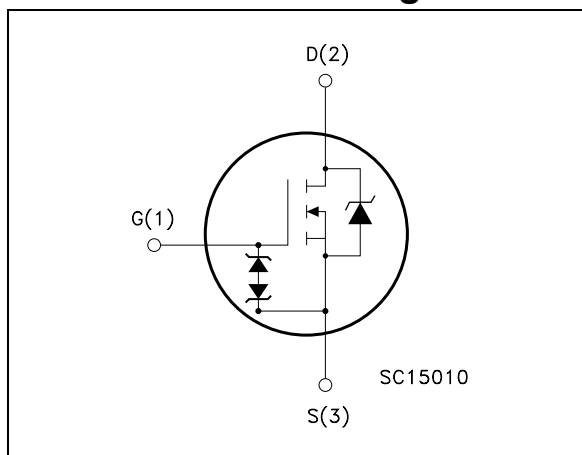
- Switching application

## Order codes

| Part number | Marking   | Package  | Packaging   |
|-------------|-----------|----------|-------------|
| STP4NK80Z   | P4NK80Z   | TO-220   | Tube        |
| STP4NK80ZFP | P4NK80ZFP | TO-220FP | Tube        |
| STD4NK80ZT4 | D4NK80Z   | DPAK     | Tape & reel |
| STD4NK80Z-1 | D4NK80Z   | IPAK     | Tube        |



## Internal schematic diagram



## Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                 | Parameter                                                                                                                        | Value                |                     | Unit |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------|------|
|                        |                                                                                                                                  | TO-220/DPAK/<br>IPAK | TO-220FP            |      |
| $V_{DS}$               | Drain-source voltage ( $V_{GS} = 0$ )                                                                                            | 800                  |                     | V    |
| $V_{GS}$               | Gate-source voltage                                                                                                              | $\pm 30$             |                     | V    |
| $I_D$                  | Drain current (continuous) at $T_C = 25^\circ\text{C}$                                                                           | 3                    | 3 <sup>(1)</sup>    | A    |
| $I_D$                  | Drain current (continuous) at $T_C = 100^\circ\text{C}$                                                                          | 1.89                 | 1.89 <sup>(1)</sup> | A    |
| $I_{DM}^{(2)}$         | Drain current (pulsed)                                                                                                           | 12                   | 12 <sup>(1)</sup>   | A    |
| $P_{TOT}$              | Total dissipation at $T_C = 25^\circ\text{C}$                                                                                    | 80                   | 25                  | W    |
|                        | Derating factor                                                                                                                  | 0.64                 | 0.21                | W/°C |
| $V_{ESD(G-S)}$         | Gate source ESD<br>(HBM-C=100pF, R=1.5K $\Omega$ )                                                                               | 3000                 |                     | V    |
| $dv/dt$ <sup>(3)</sup> | Peak diode recovery voltage slope                                                                                                | 4.5                  |                     | V/ns |
| $V_{ISO}$              | Insulation withstand voltage (RMS) from<br>all three leads to external heat sink<br>( $t=1\text{s}$ ; $T_C = 25^\circ\text{C}$ ) | -                    | 2500                | V    |
| $T_J$<br>$T_{stg}$     | Operating junction temperature<br>Storage temperature                                                                            | -55 to 150           |                     | °C   |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3.  $I_{SD} \leq 4\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq T_{JMAX}$ .

**Table 2. Thermal data**

| Symbol         | Parameter                                         | Value  |          |              | Unit |
|----------------|---------------------------------------------------|--------|----------|--------------|------|
|                |                                                   | TO-220 | TO-220FP | DPAK<br>IPAK |      |
| $R_{thj-case}$ | Thermal resistance junction-<br>case max          | 1.56   | 5        | 1.56         | °C/W |
| $R_{thj-a}$    | Thermal resistance junction-<br>ambient max       | 62.5   |          | 100          | °C/W |
| $T_I$          | Maximum lead temperature for<br>soldering purpose | 300    |          |              | °C   |

**Table 3. Avalanche characteristics**

| 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 $T_j=25^{\circ}\text{C}$ , $I_d=I_{AR}$ , $V_{dd}=50\text{V}$ ) | 190   | mJ   |

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

| Symbol     | Parameter                     | Test conditions                      | Min. | Typ. | Max. | Unit |
|------------|-------------------------------|--------------------------------------|------|------|------|------|
| $BV_{GSO}$ | Gate-source breakdown voltage | $I_{gs}=\pm 1\text{mA}$ (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                   | $I_D = 1\text{mA}$ , $V_{GS} = 0$                                                               | 800  |      |          | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating}$ ,<br>$V_{DS} = \text{Max rating}$ ,<br>$T_c = 125^{\circ}\text{C}$ |      |      | 1<br>50  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{GS} = 0$ )       | $V_{GS} = \pm 20\text{V}$                                                                       |      |      | $\pm 10$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | 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                | $V_{GS} = 10\text{V}$ , $I_D = 1.5\text{A}$                                                     |      | 3    | 3.5      | $\Omega$                       |

**Table 6. Dynamic**

| Symbol            | Parameter                     | Test conditions                                                                                                                 | Min. | Typ. | Max. | Unit |
|-------------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $g_{fs}^{(1)}$    | Forward transconductance      | $V_{DS} = 15\text{V}$ , $I_D = 1.5\text{A}$                                                                                     |      | 2.9  |      | S    |
| $C_{iss}$         | Input capacitance             | $V_{DS} = 25\text{V}$ , $f = 1\text{MHz}$ , $V_{GS} = 0$                                                                        |      | 575  |      | pF   |
| $C_{oss}$         | Output capacitance            |                                                                                                                                 |      | 67   |      | pF   |
| $C_{rss}$         | Reverse transfer capacitance  |                                                                                                                                 |      | 13   |      | pF   |
| $C_{osseq}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0$ , $V_{DS} = 0\text{V}$ to $400\text{V}$                                                                            |      | 60   |      | pF   |
| $t_{d(on)}$       | Turn-on delay time            | $V_{DD} = 400\text{V}$ , $I_D = 1.5\text{A}$ ,<br>$R_G = 4.7\Omega$ , $V_{GS} = 10\text{V}$<br>(see <a href="#">Figure 18</a> ) |      | 13   |      | ns   |
| $t_r$             | Rise time                     |                                                                                                                                 |      | 12   |      | ns   |
| $t_{d(off)}$      | Off-voltage rise time         |                                                                                                                                 |      | 35   |      | ns   |
| $t_f$             | Fall time                     |                                                                                                                                 |      | 32   |      | ns   |
| $t_{r(Voff)}$     | Off-voltage rise time         | $V_{DD} = 640\text{V}$ , $I_D = 3\text{A}$ ,<br>$R_G = 4.7\Omega$ , $V_{GS} = 10\text{V}$<br>(see <a href="#">Figure 16</a> )   |      | 18   |      | ns   |
| $t_r$             | Fall time                     |                                                                                                                                 |      | 7.5  |      | ns   |
| $t_c$             | Cross-over time               |                                                                                                                                 |      | 25   |      | ns   |
| $Q_g$             | Total gate charge             | $V_{DD} = 640\text{V}$ , $I_D = 3\text{A}$                                                                                      |      | 22.5 |      | nC   |
| $Q_{gs}$          | Gate-source charge            | $V_{GS} = 10\text{V}$                                                                                                           |      | 4.2  |      | nC   |
| $Q_{gd}$          | Gate-drain charge             | (see <a href="#">Figure 19</a> )                                                                                                |      | 11.3 |      | 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. 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            | $I_{SD} = 3\text{ A}$ , $V_{GS} = 0$                                                                                                                      |     |      | 1.6 | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 3\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 80\text{ V}$ , $T_j = 150^\circ\text{C}$<br>(see <a href="#">Figure 20</a> ) |     | 400  |     | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                           |     | 1520 |     | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                           |     | 7.6  |     | 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/IPAK

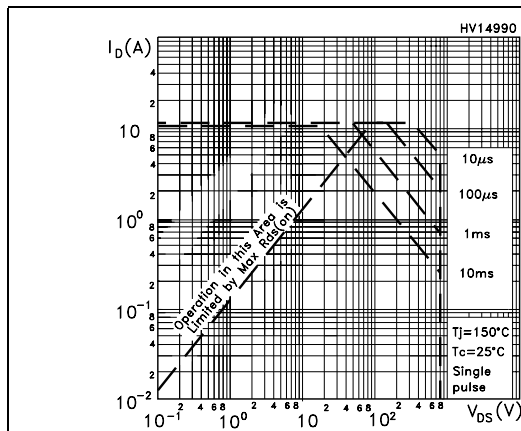


Figure 2. Thermal impedance for TO-220/DPAK/IPAK

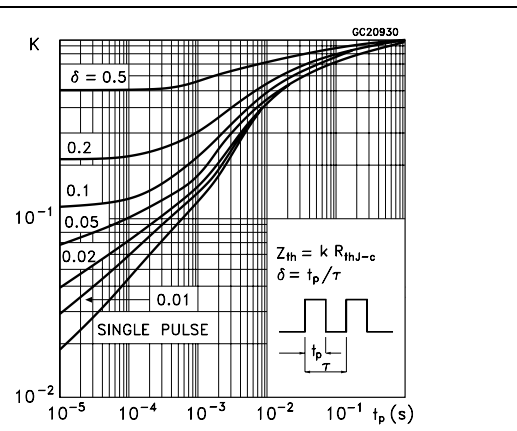


Figure 3. Safe operating area for TO-220FP

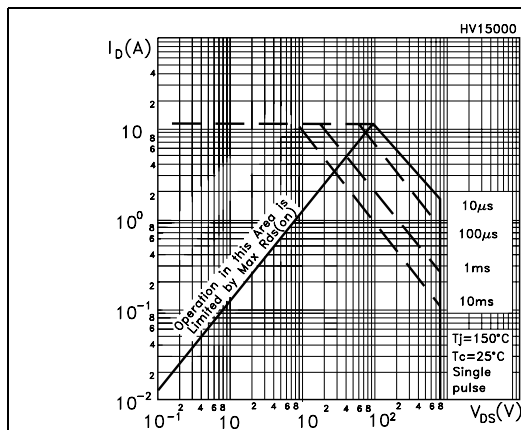


Figure 4. Thermal impedance for TO-220FP

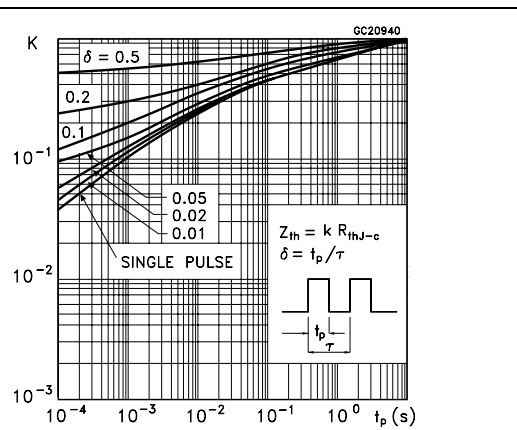


Figure 5. Output characteristics

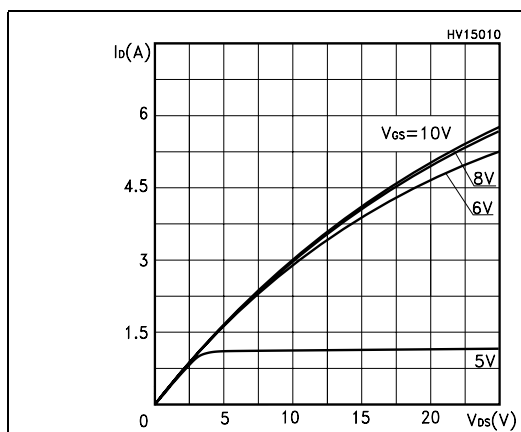


Figure 6. Transfer characteristics

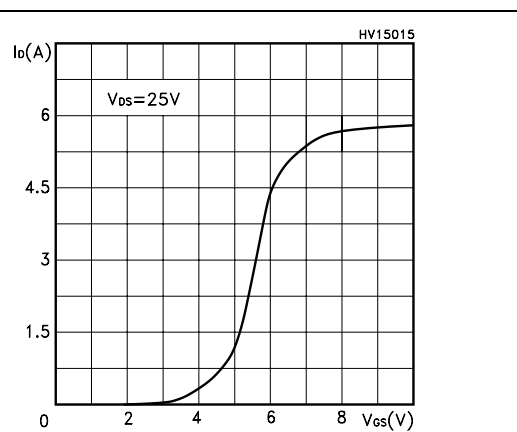


Figure 7. Transconductance

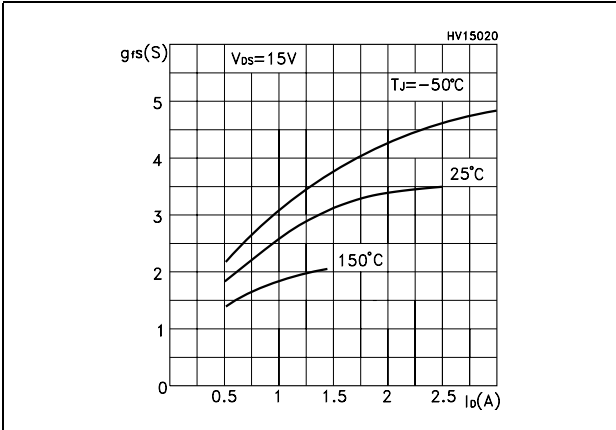


Figure 8. Static drain-source on resistance

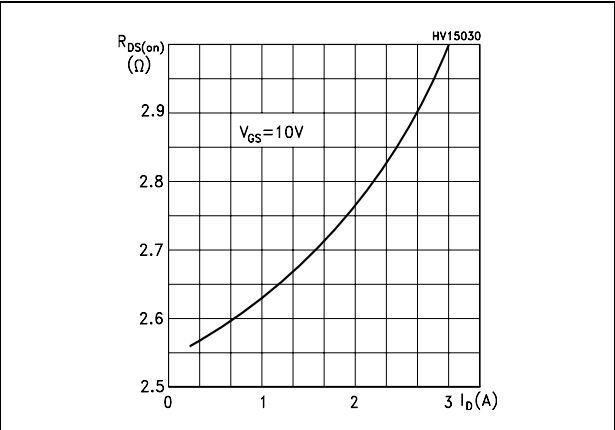


Figure 9. Gate charge vs gate-source voltage

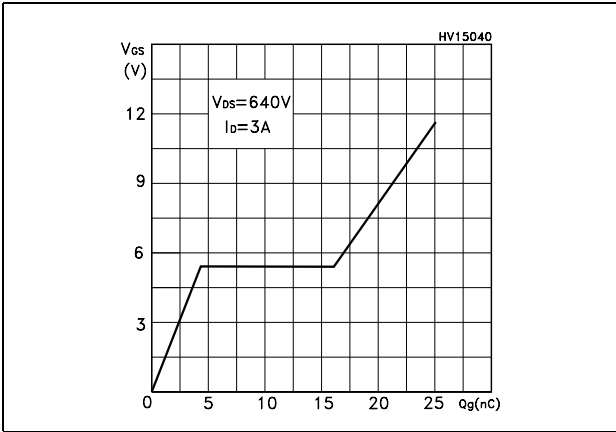


Figure 10. Capacitance variations

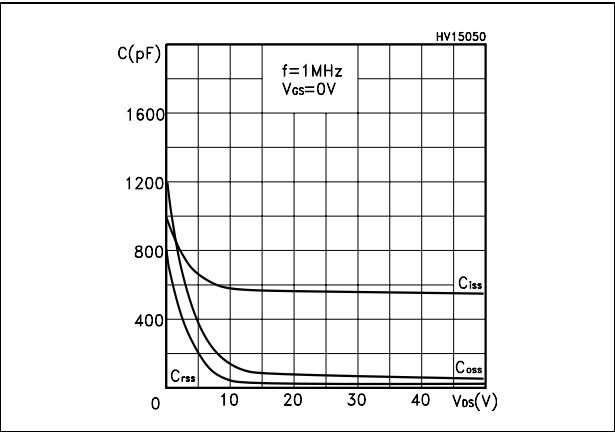


Figure 11. Source-drain diode forward characteristics

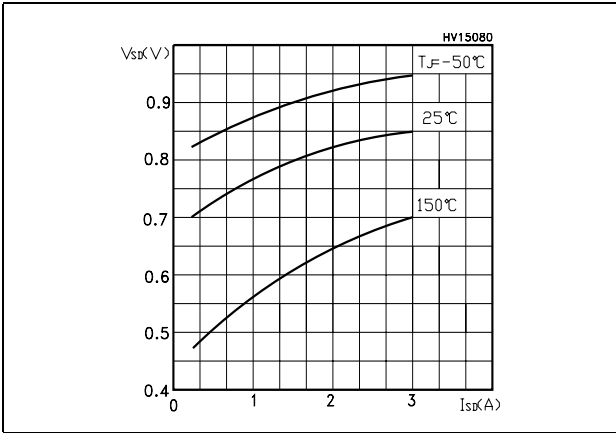


Figure 12. Normalized  $BV_{DSS}$  vs temperature

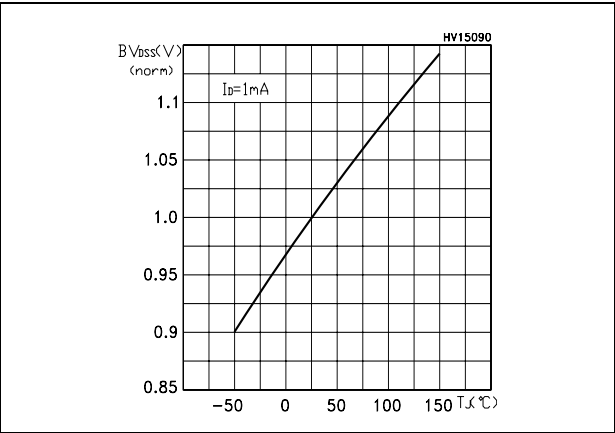




Figure 13. Normalized gate threshold voltage vs temperature

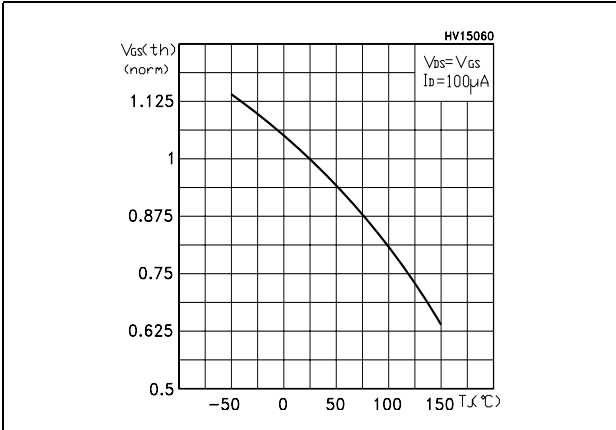


Figure 14. Avalanche energy vs temperature

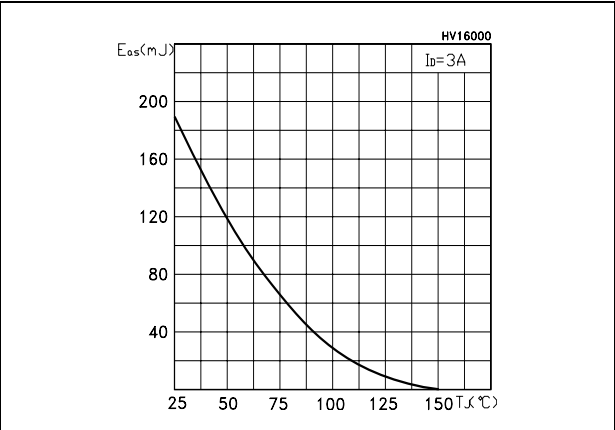
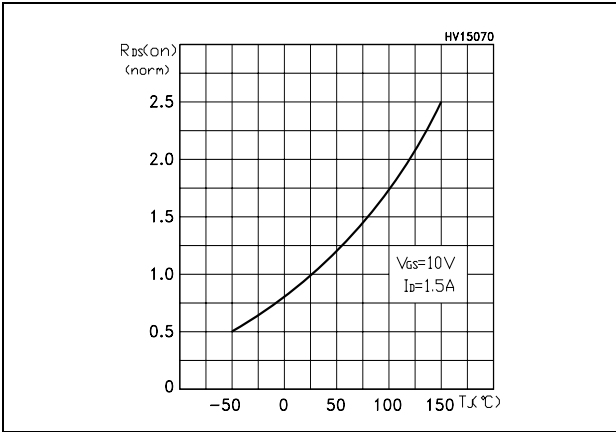


Figure 15. Normalized on resistance vs temperature



### 3 Test circuit

Figure 16. Unclamped Inductive load test circuit

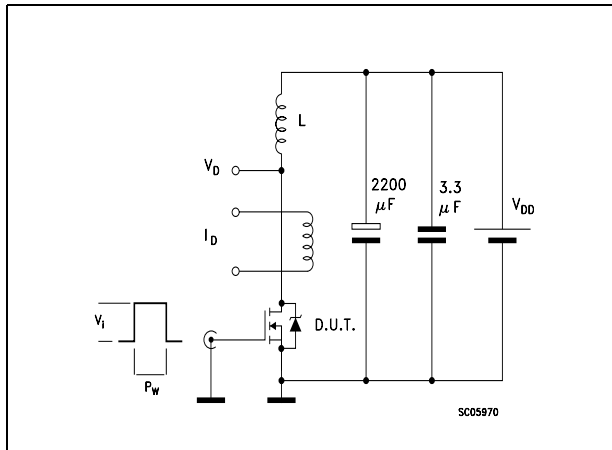


Figure 17. Unclamped Inductive waveform

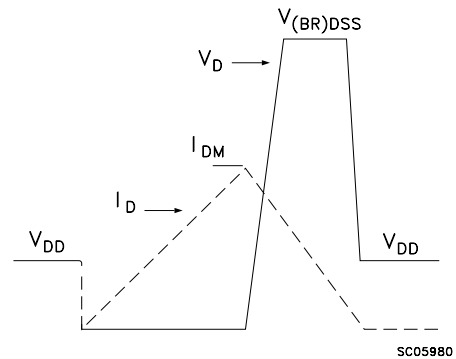


Figure 18. Switching times test circuit for resistive load

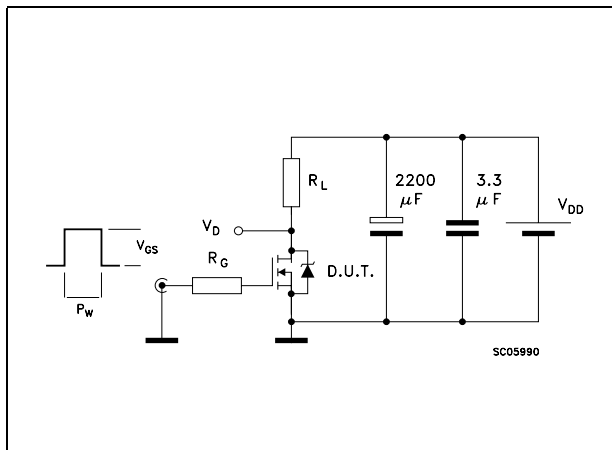


Figure 19. Gate charge test circuit

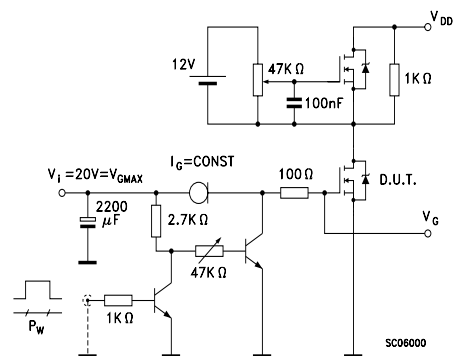
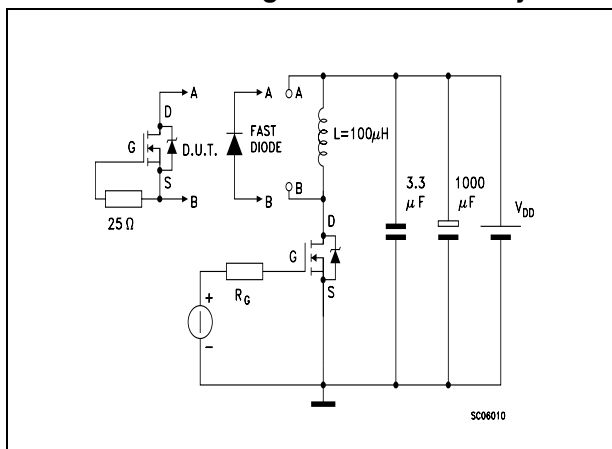


Figure 20. Test circuit for inductive load switching and diode recovery times

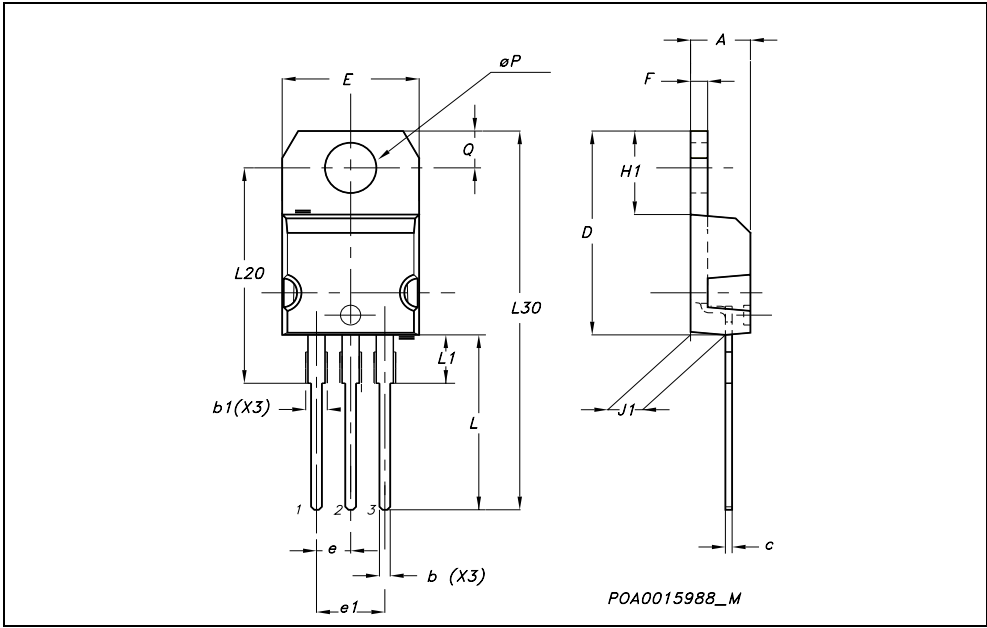


## 4 Package mechanical data

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)

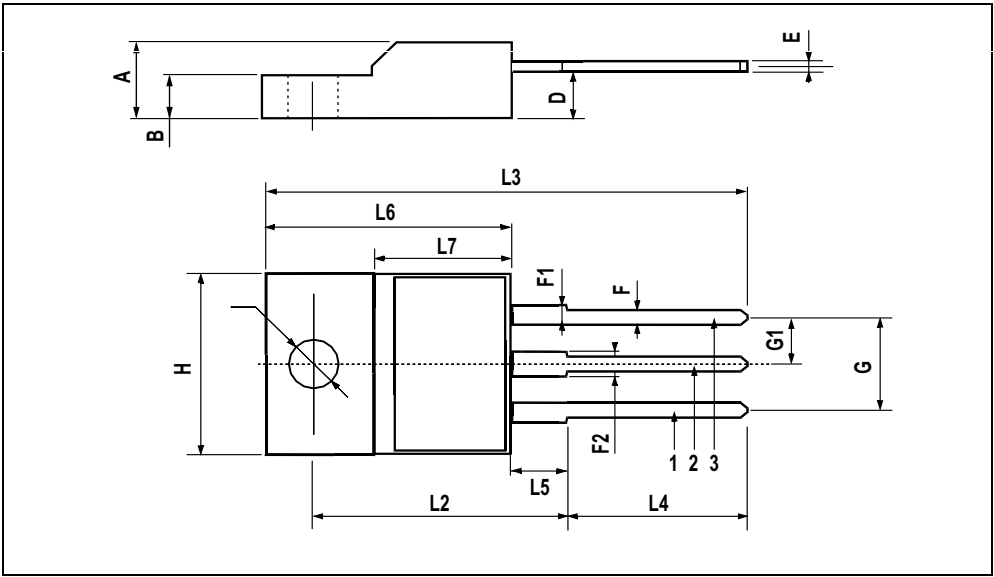
TO-220 MECHANICAL DATA

| 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-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 |



| 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°    |

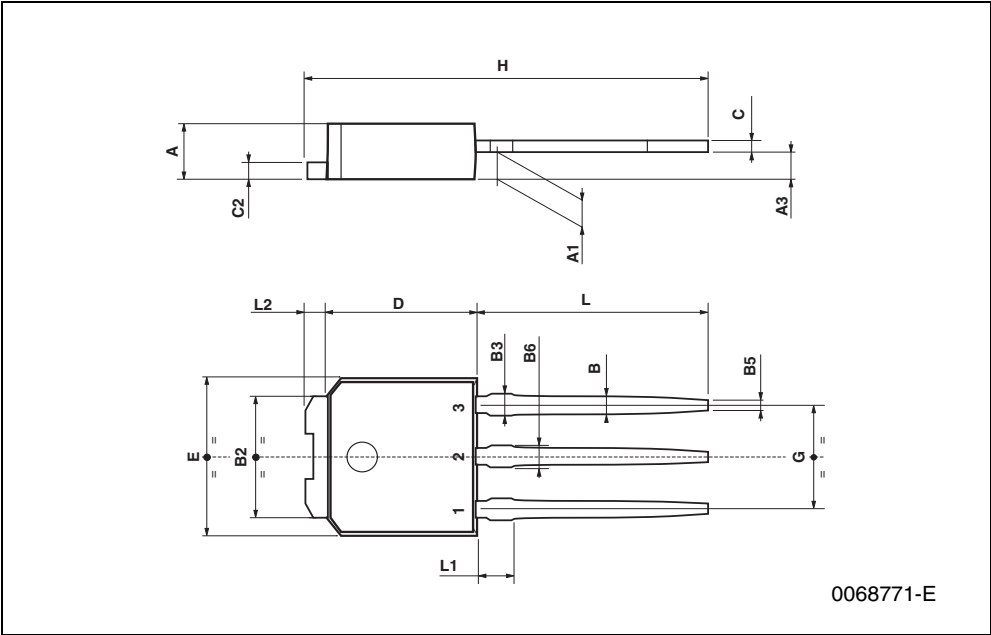
  

The mechanical drawing illustrates the DPAK package geometry. It includes a top view showing dimensions E, b4, L2, L4, H, e, e1, and b(2x). A side view shows dimensions A, c2, D, A1, c, and R. A detail view of the lead shows dimensions A2, L, (L1), V2, and a 0.25mm gauge plane. A thermal pad is also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

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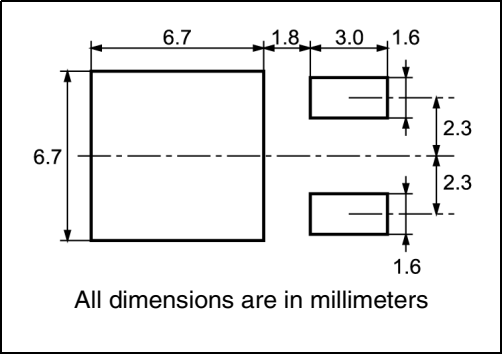
TO-251 (IPAK) MECHANICAL DATA

| 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 |

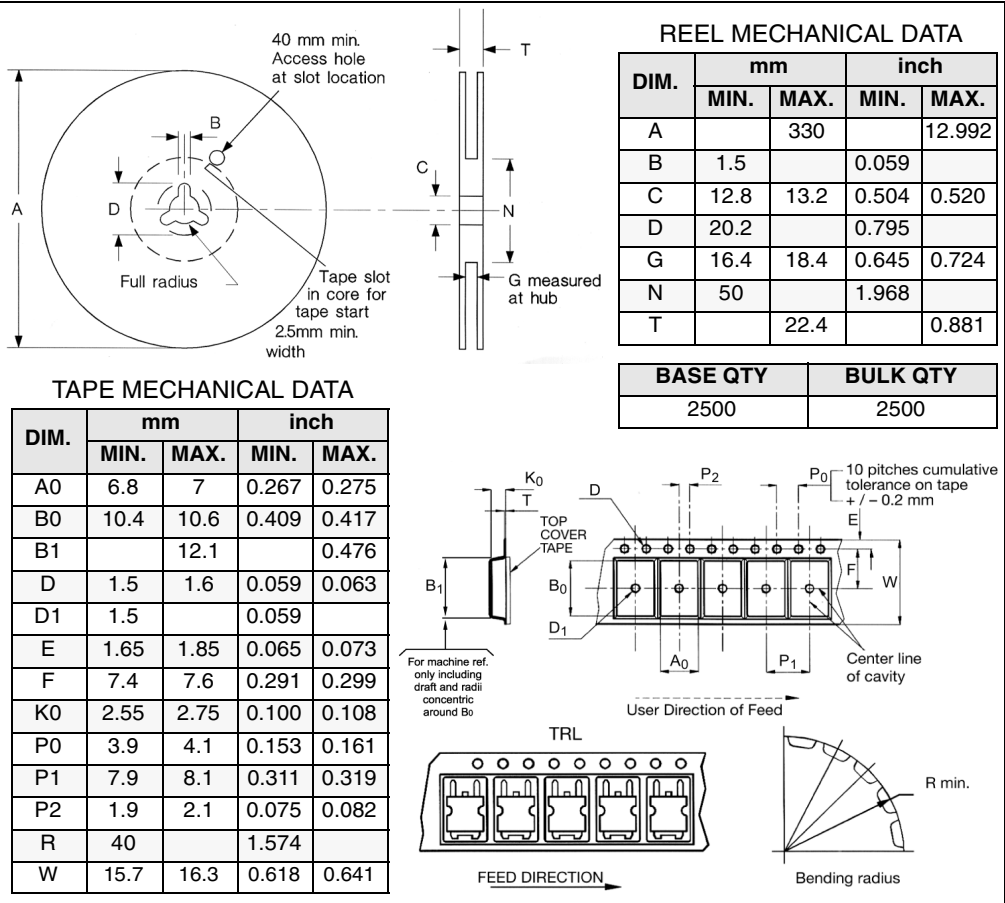


# 5 Packaging mechanical data

## DPAK FOOTPRINT



## TAPE AND REEL SHIPMENT





## 6 Revision history

**Table 8. Revision history**

| Date        | Revision | Changes                         |
|-------------|----------|---------------------------------|
| 30-Mar-2005 | 5        | Preliminary version             |
| 06-Sep-2005 | 6        | Final version                   |
| 21-Jan-2006 | 7        | Inserted ecopack indication     |
| 16-Aug-2006 | 8        | New template, no content change |

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