



## STD3NK60ZD

N-channel 600 V, 3.3  $\Omega$ , 2.4 A, DPAK  
SuperFREDMesh™ Power MOSFET

### Features

| Type       | V <sub>DSS</sub> | R <sub>DS(on)</sub><br>max | I <sub>D</sub> |
|------------|------------------|----------------------------|----------------|
| STD3NK60ZD | 600 V            | < 3.6 $\Omega$             | 2.4 A          |

- 100% avalanche tested
- Extremely high dv/dt capability
- Gate charge minimized
- Very low intrinsic capacitances
- Fast internal recovery diode

### Application

- Switching applications

### Description

The SuperFREDMesh™ series associates all advantages of reduced on-resistance, Zener gate protection and very high dv/dt capability with a fast body-drain recovery diode. Such series complements the “FDmesh™” advanced technology.

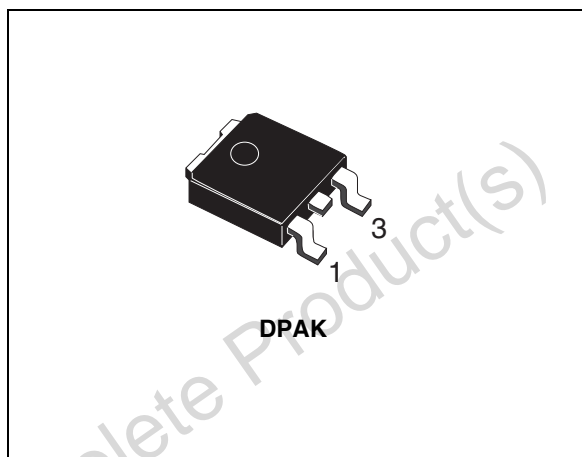


Figure 1. Internal schematic diagram

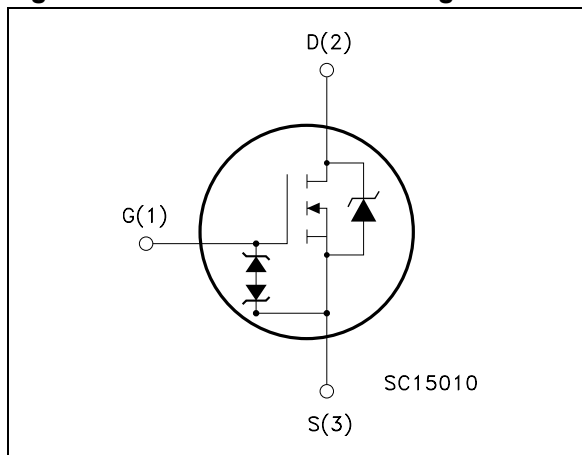


Table 1. Device summary

| Order code | Marking | Package | Packaging     |
|------------|---------|---------|---------------|
| STD3NK60ZD | 3NK60ZD | DPAK    | Tape and reel |

# Contents

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Obsolete Product(s) - Obsolete Product(s)

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol             | Parameter   | Value      | Unit                |
|--------------------|---|------------|---------------------|
| $V_{DS}$           | Drain-source voltage ( $V_{GS} = 0$ )                           | 600        | V                   |
| $V_{GS}$           | Gate- source voltage  | $\pm 30$   | V                   |
| $I_D$              | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$  | 2.4        | A                   |
| $I_D$              | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 1.51       | A                   |
| $I_{DM}^{(1)}$     | Drain current (pulsed)  | 9.6        | A                   |
| $P_{TOT}$          | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$           | 45         | W                   |
|                    | Derating factor   | 0.36       | W/ $^\circ\text{C}$ |
| $dv/dt^{(2)}$      | Peak diode recovery voltage slope                               | 15         | V/ns                |
| $T_j$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature           | -55 to 150 | $^\circ\text{C}$    |

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 2.4\text{ A}$ ,  $di/dt \leq 600\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol        | Parameter                                      | Value | Unit                      |
|---------------|--|-------|---------------------------|
| $R_{thj-amb}$ | Thermal resistance junction-ambient max        | 100   | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}$ | Thermal resistance junction-pcb max            | 50    | $^\circ\text{C}/\text{W}$ |
| $T_l$         | Maximum lead temperature for soldering purpose | 300   | $^\circ\text{C}$          |

**Table 4. Avalanche characteristics**

| Symbol   | Parameter  | Max value | Unit |
|----------|--|-----------|------|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)                                   | 2.4       | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 150       | mJ   |

## 2 Electrical characteristics

(T<sub>case</sub> = 25 °C unless otherwise specified)

**Table 5. On /off states**

| Symbol               | Parameter   | Test conditions   | Min. | Typ. | Max.    | Unit     |
|----------------------|---|---|------|------|---------|----------|
| V <sub>(BR)DSS</sub> | Drain-source breakdown voltage                        | I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0  | 600  |      |         | V        |
| I <sub>DSS</sub>     | Zero gate voltage drain current (V <sub>GS</sub> = 0) | V <sub>DS</sub> = Max rating<br>V <sub>DS</sub> = Max rating, T <sub>C</sub> = 125 °C |      |      | 1<br>50 | μA<br>μA |
| I <sub>GSS</sub>     | Gate-body leakage current (V <sub>DS</sub> = 0)       | V <sub>GS</sub> = ± 20 V  |      |      | ± 10    | μA       |
| V <sub>GS(th)</sub>  | Gate threshold voltage                                | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 50 μA                            | 3    | 3.75 | 4.5     | V        |
| R <sub>DS(on)</sub>  | Static drain-source on resistance                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 1.2 A  |      | 3.3  | 3.6     | Ω        |

**Table 6. Dynamic**

| Symbol                             | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit |
|------------------------------------|-------------------------------|--|------|------|------|------|
| C <sub>iss</sub>                   | Input capacitance             | V <sub>DS</sub> = 25 V, f = 1 MHz, V <sub>GS</sub> = 0 |      | 311  |      | pF   |
| C <sub>oss</sub>                   | Output capacitance            |  |      | 43   |      | pF   |
| C <sub>rss</sub>                   | Reverse transfer capacitance  |  |      | 8    |      | pF   |
| C <sub>oss eq</sub> <sup>(1)</sup> | Equivalent output capacitance | V <sub>GS</sub> = 0, V <sub>DS</sub> = 0 to 400 V      |      | 27   |      | pF   |
| Q <sub>g</sub>                     | Total gate charge             | V <sub>DD</sub> = 400 V, I <sub>D</sub> = 2.4 A,       |      | 11.8 |      | nC   |
| Q <sub>gs</sub>                    | Gate-source charge            | V <sub>GS</sub> = 10 V                                 |      | 2.6  |      | nC   |
| Q <sub>gd</sub>                    | Gate-drain charge             | (see <a href="#">Figure 16</a> )                       |      | 6.4  |      | nC   |

1. C<sub>oss eq</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>

**Table 7. Switching times**

| Symbol       | Parameter           | Test conditions  | Min. | Typ. | Max | Unit |
|--------------|---------------------|--|------|------|-----|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 480\text{ V}$ , $I_D = 3\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 15</a> ) |      | 9    |     | ns   |
| $t_r$        | Rise time           |  |      | 14   |     | ns   |
| $t_{d(off)}$ | Turn-off-delay time |  |      | 19   |     | ns   |
| $t_f$        | Fall time           |  |      | 14   |     | ns   |

**Table 8. Source drain diode**

| Symbol          | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|------|
| $I_{SD}$        | Source-drain current          |  |      |      | 2.4  | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |  |      |      | 9.6  | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 10\text{ A}$ , $V_{GS} = 0$                        |      |      | 1.6  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ |      | 98   |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 60\text{ V}$                                       |      | 170  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      | (see <a href="#">Figure 20</a> )                             |      | 3.4  |      | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 2.4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ |      | 105  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       | $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$   |      | 184  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      | (see <a href="#">Figure 20</a> )                             |      | 3.5  |      | 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 2. Safe operating area

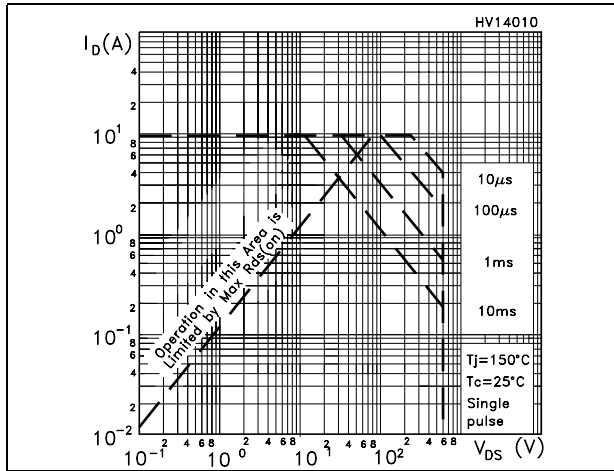


Figure 3. Thermal impedance

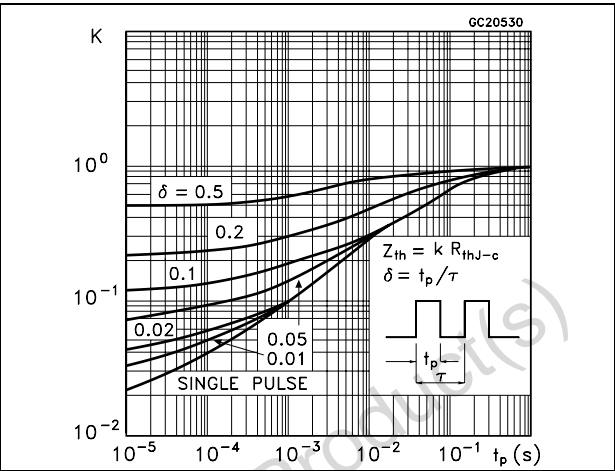


Figure 4. Output characteristics

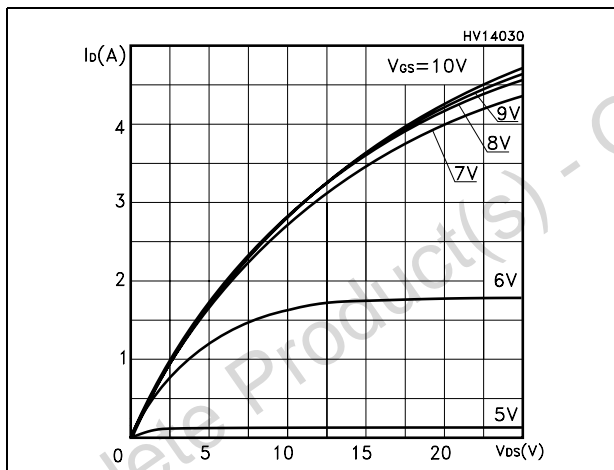


Figure 5. Transfer characteristics

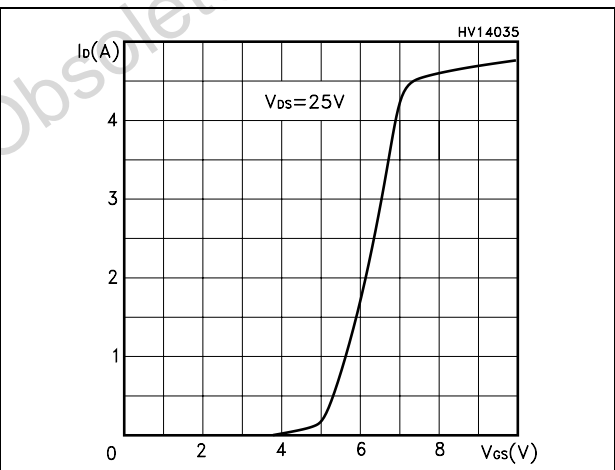


Figure 6. Transconductance

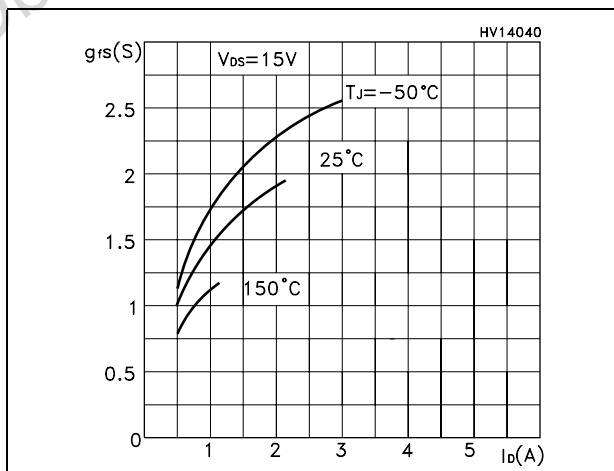


Figure 7. Static drain-source on resistance

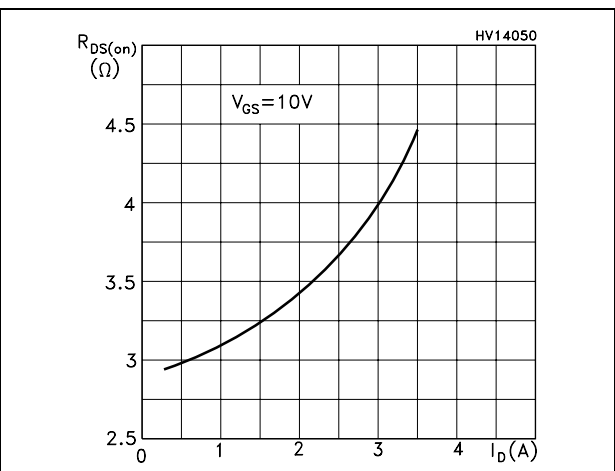


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

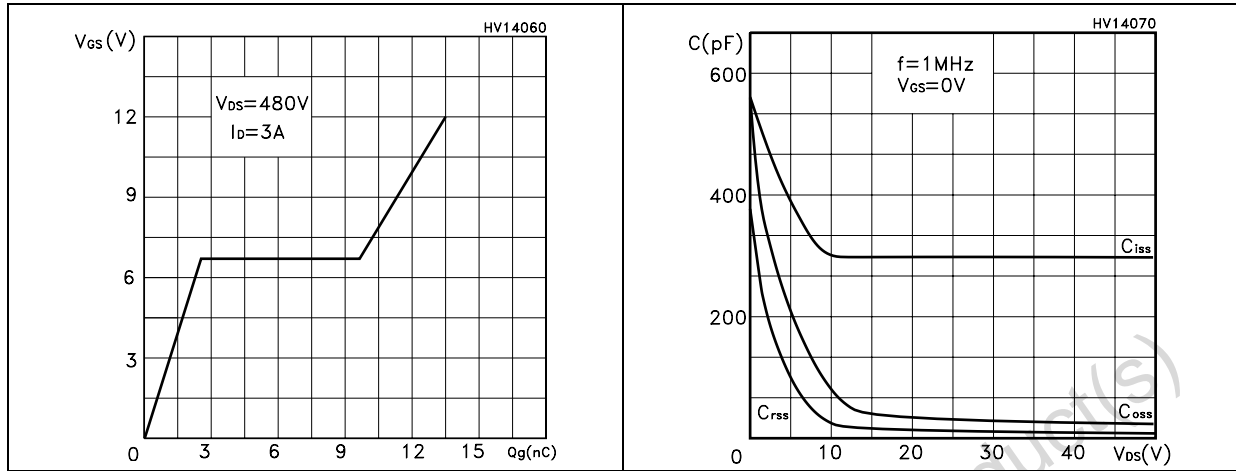


Figure 10. Normalized gate threshold voltage vs temperature

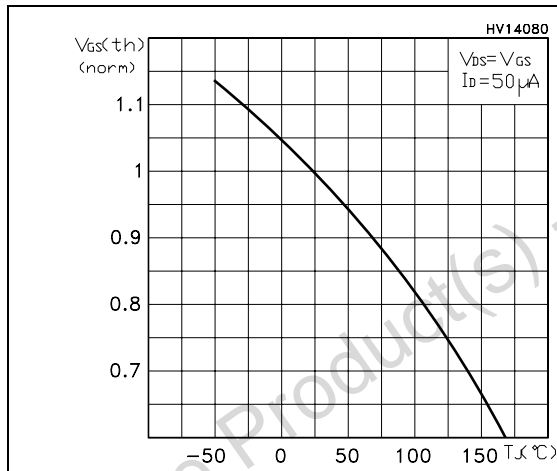


Figure 11. Normalized on resistance vs temperature

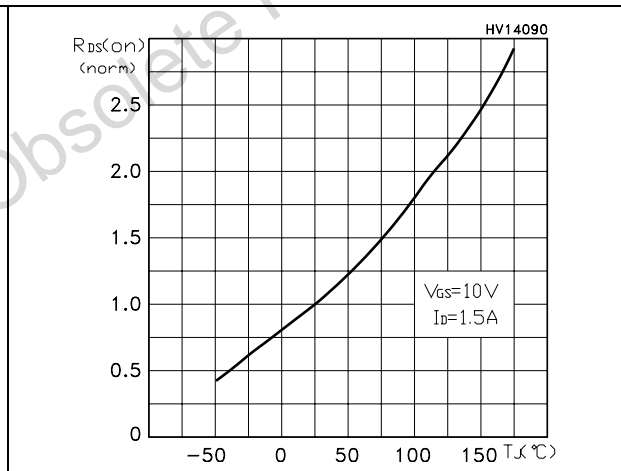


Figure 12. Source-drain diode forward characteristics

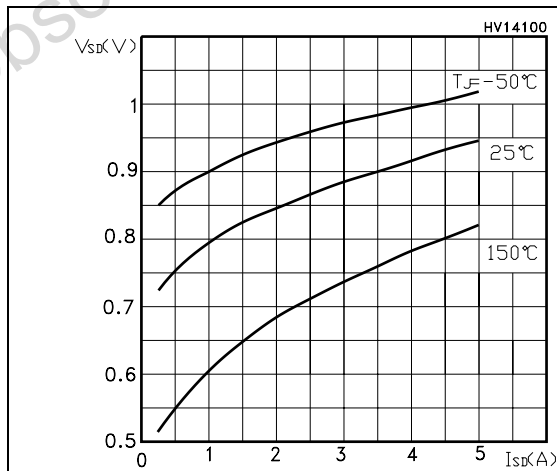
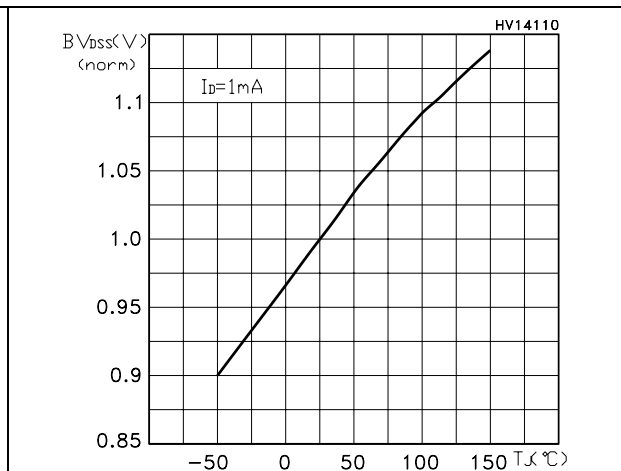
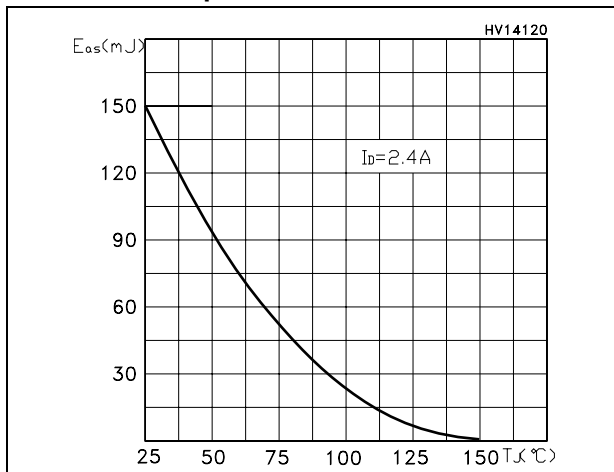


Figure 13. Normalized  $B_{VDS}$  vs temperature



**Figure 14. Maximum avalanche energy vs temperature**

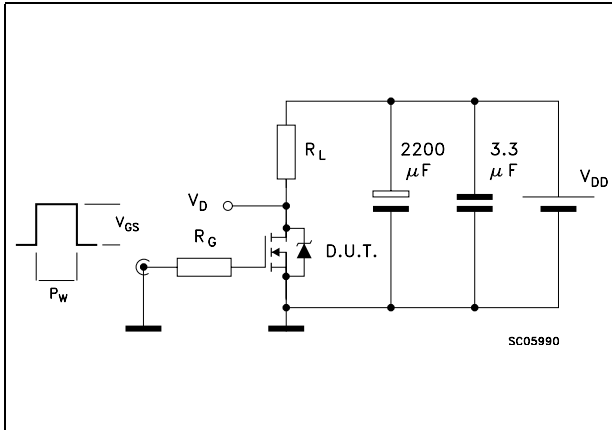


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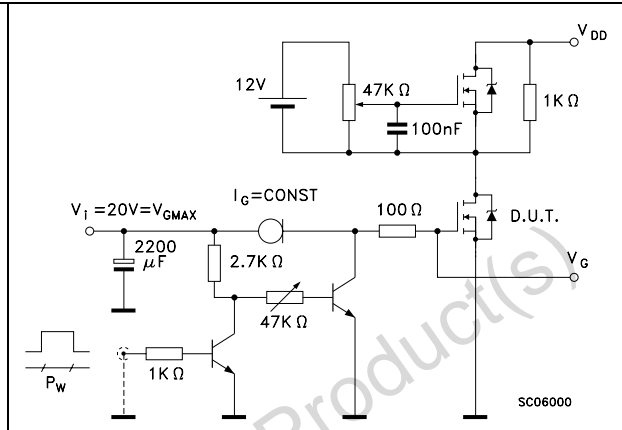


### 3 Test circuits

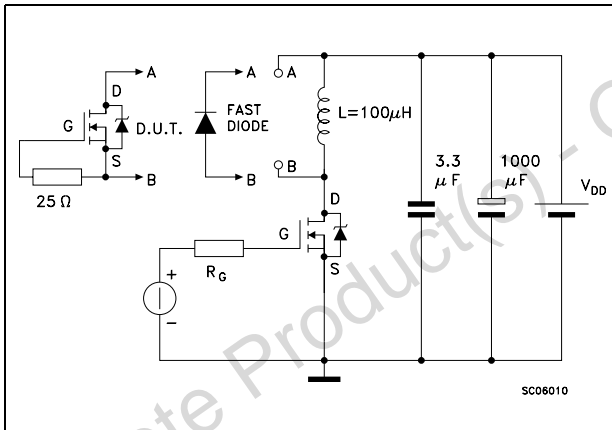
**Figure 15. Switching times test circuit for resistive load**



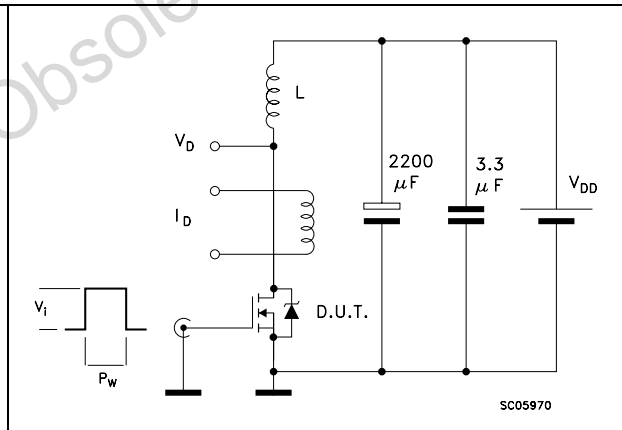
**Figure 16. Gate charge test circuit**



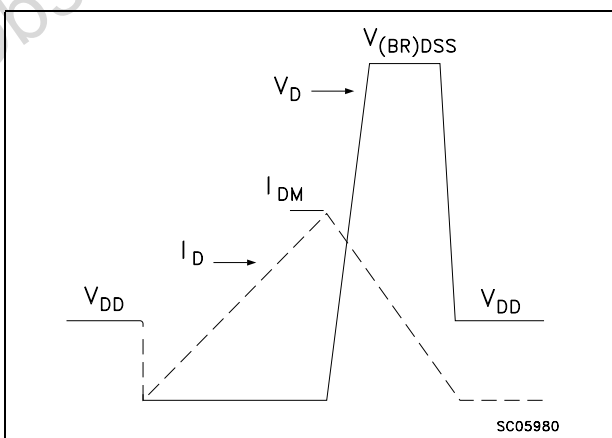
**Figure 17. Test circuit for inductive load switching and diode recovery times**



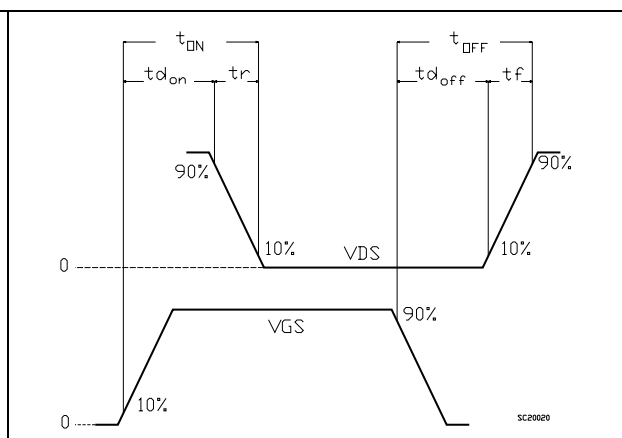
**Figure 18. Unclamped Inductive load test circuit**



**Figure 19. Unclamped inductive waveform**



**Figure 20. Switching time waveform**



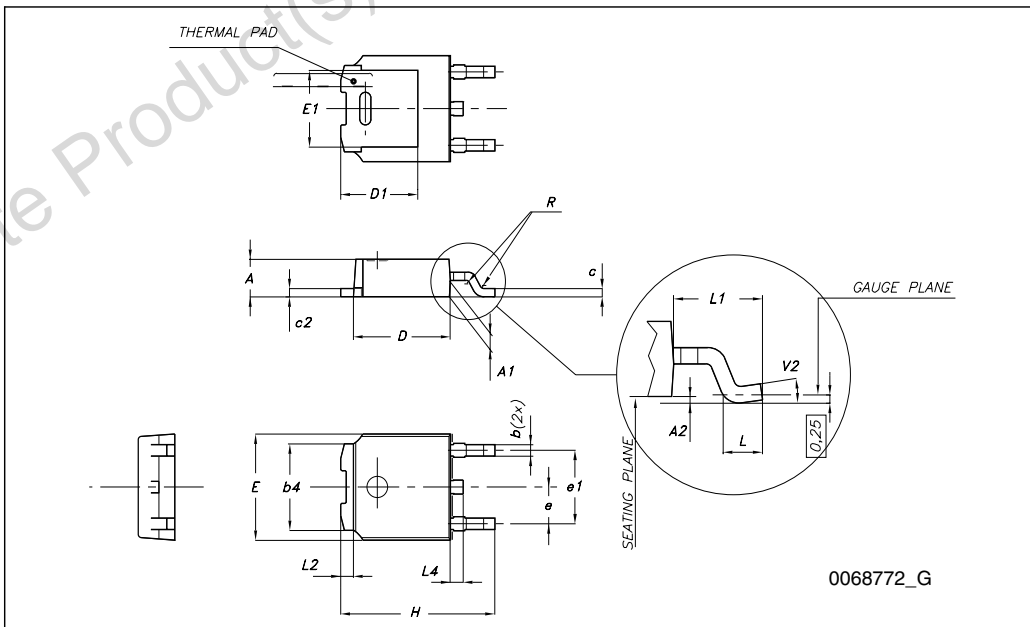
## 4 Package mechanical data

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](http://www.st.com)

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**TO-252 (DPAK) mechanical data**

| DIM. | mm.  |      |       |
|------|------|------|-------|
|      | min. | typ  | max.  |
| A    | 2.20 |      | 2.40  |
| A1   | 0.90 |      | 1.10  |
| A2   | 0.03 |      | 0.23  |
| b    | 0.64 |      | 0.90  |
| b4   | 5.20 |      | 5.40  |
| c    | 0.45 |      | 0.60  |
| c2   | 0.48 |      | 0.60  |
| D    | 6.00 |      | 6.20  |
| D1   |      | 5.10 |       |
| E    | 6.40 |      | 6.60  |
| E1   |      | 4.70 |       |
| e    |      | 2.28 |       |
| e1   | 4.40 |      | 4.60  |
| H    | 9.35 |      | 10.10 |
| L    | 1    |      |       |
| L1   |      | 2.80 |       |
| L2   |      | 0.80 |       |
| L4   | 0.60 |      | 1     |
| R    |      | 0.20 |       |
| V2   | 0°   |      | 8°    |



# 5 Package 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 |

TOP COVER TAPE

User Direction of Feed

Center line of cavity

FEED DIRECTION

Bending radius R min.

10 pitches cumulative tolerance on tape +/- 0.2 mm

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

## 6 Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 24-Jul-2008 | 1        | First release  |
| 11-Sep-2008 | 2        | Document status changed from preliminary data to datasheet |

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