



# STP4NM60 STD3NM60, STD3NM60-1

N-channel 600 V, 1.3  $\Omega$ , 3 A TO-220, DPAK, IPAK  
Zener-protected MDmesh™ Power MOSFET

## Features

| Type       | V <sub>DSS</sub><br>(@T <sub>jmax</sub> ) | R <sub>DS(on)</sub><br>max | I <sub>D</sub> | P <sub>W</sub> |
|------------|-------------------------------------------|----------------------------|----------------|----------------|
| STD3NM60   | 650                                       | < 1.5 $\Omega$             | 3 A            | 42 W           |
| STD3NM60-1 |                                           |                            |                |                |
| STP4NM60   |                                           |                            | 4 A            | 69 W           |

- High dv/dt and avalanche capabilities
- Improved ESD capability
- Low input capacitance and gate charge
- Low gate input resistance
- Tight process control and high manufacturing yields

## Applications

- Switching

## Description

Modems technology applies the benefits of the multiple drain process to STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product offers low on-resistance, high dv/dt capability and excellent avalanche characteristics.

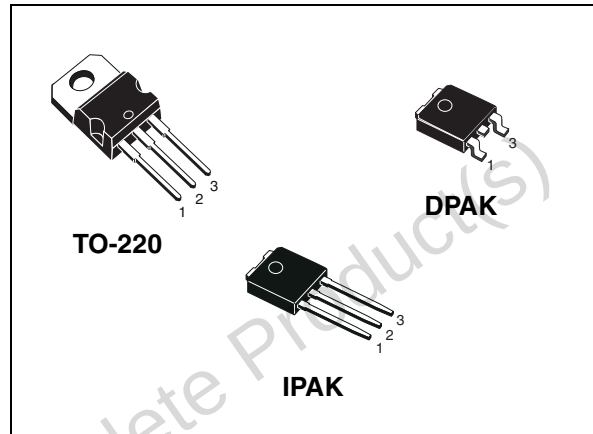


Figure 1. Internal schematic diagram

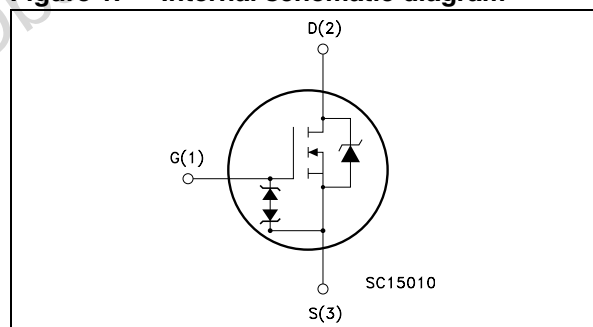


Table 1. Device summary

| Order code | Marking | Package | Packing       |
|------------|---------|---------|---------------|
| STD3NM60   | D3NM60  | DPAK    | Tape and reel |
| STD3NM60-1 | D3NM60  | IPAK    | Tube          |
| STP4NM60   | P4NM60  | TO-220  | Tube          |

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter                                             | Value      |                        | Unit                |
|----------------|-------------------------------------------------------|------------|------------------------|---------------------|
|                |                                                       | STP4NM60   | STD3NM60<br>STD3NM60-1 |                     |
| $V_{DS}$       | Drain-source voltage ( $V_{GS}=0$ )                   | 600        |                        | V                   |
| $V_{GS}$       | Gate- source Voltage                                  | $\pm 30$   |                        | V                   |
| $I_D$          | Drain current (continuous) at $T_C=25^\circ\text{C}$  | 4          | 3                      | A                   |
| $I_D$          | Drain current (continuous) at $T_C=100^\circ\text{C}$ | 2.52       | 1.9                    | A                   |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                | 16         | 12                     | A                   |
| $P_{TOT}$      | Total dissipation at $T_C=25^\circ\text{C}$           | 69         | 42                     | W                   |
|                | Derating factor                                       | 0.55       | 0.33                   | W/ $^\circ\text{C}$ |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                     | 15         |                        | V/ns                |
| $T_j$          | Operating junction temperature                        | -65 to 150 |                        | $^\circ\text{C}$    |
| $T_{stg}$      | Storage temperature                                   |            |                        | $^\circ\text{C}$    |

1. Pulse width limited by safe operating area

2.  $I_{SD} \leq 3\text{ A}$ ,  $di/dt \leq 400\text{ }\mu\text{A}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

**Table 3. Thermal data**

| Symbol         | Parameter                                      | Value  |             | Unit               |
|----------------|------------------------------------------------|--------|-------------|--------------------|
|                |                                                | To-220 | DPAK / IPAK |                    |
| $R_{thj-case}$ | Thermal resistance junction-case max           | 1.82   | 3           | $^\circ\text{C/W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max        | 62.5   |             | $^\circ\text{C/W}$ |
| $T_l$          | Maximum lead temperature for soldering purpose | 300    |             | $^\circ\text{C}$   |

**Table 4. Avalanche characteristics**

| Symbol   | Parameter                                                                                              | Value | Unit |
|----------|--------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_{jmax}$ )                   | 1.5   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j=25^\circ\text{C}$ , $I_D=I_{AR}$ , $V_{DD}=50\text{ V}$ ) | 200   | mJ   |

## 2 Electrical characteristics

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

**Table 5. On/off states**

| Symbol        | Parameter                                        | Test conditions                                                                         | Min. | Typ. | Max.    | Unit                           |
|---------------|--------------------------------------------------|-----------------------------------------------------------------------------------------|------|------|---------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0$                                           | 600  |      |         | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{max rating}$<br>$V_{DS} = \text{max rating}$ ,<br>$T_C = 125\text{ °C}$ |      |      | 1<br>10 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$                                                              |      |      | $\pm 5$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                      | 3    | 4    | 5       | V                              |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 1.5\text{ A}$                                           |      | 1.3  | 1.5     | $\Omega$                       |

**Table 6. Dynamic**

| Symbol                                        | Parameter                                                               | Test conditions                                                                                                                          | Min. | Typ.                   | Max. | Unit                 |
|-----------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------|------|----------------------|
| $g_{fs}^{(1)}$                                | Forward transconductance                                                | $V_{DS} = 15\text{ V}$ , $I_D = 1.5\text{ A}$                                                                                            | -    | 2.7                    | -    | 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>$V_{GS} = 0$                                                                            | -    | 324<br>132<br>7.4      | -    | pF<br>pF<br>pF       |
| $t_{d(on)}$<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     | $V_{DD} = 300\text{ V}$ , $I_D = 1.5\text{ A}$<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 15</a> ) | -    | 9<br>4<br>16.5<br>10.5 | -    | ns<br>ns<br>ns<br>ns |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$                 | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 480\text{ V}$ , $I_D = 3\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 21</a> )                             | -    | 10<br>3<br>4.7         | 14   | nC<br>nC<br>nC       |

1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

**Table 7. Source drain diode**

| Symbol                            | Parameter                                                                    | Test conditions                                                                                                                                         | Min. | Typ.              | Max.    | Unit                     |
|-----------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------|---------|--------------------------|
| $I_{SD}$<br>$I_{SDM}^{(1)}$       | Source-drain current<br>Source-drain current<br>(pulsed)                     |                                                                                                                                                         | -    |                   | 3<br>12 | A<br>A                   |
| $V_{SD}^{(2)}$                    | Forward on voltage                                                           | $I_{SD} = 3\text{ A}$ , $V_{GS} = 0$                                                                                                                    | -    |                   | 1.5     | V                        |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 3\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 100\text{ V}$ , $T_j = 25^\circ\text{C}$<br>(see <a href="#">Figure 17</a> )  | -    | 224<br>1<br>9     |         | ns<br>nC<br>A            |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 3\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 100\text{ V}$ , $T_j = 150^\circ\text{C}$<br>(see <a href="#">Figure 17</a> ) | -    | 296<br>1.4<br>9.3 |         | ns<br>$\mu\text{C}$<br>A |

1. Pulse width limited by safe operating area.

2. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %

**Table 8. Gate-source Zener diode <sup>(1)</sup>**

| 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. 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 2. Safe operating area for TO-220

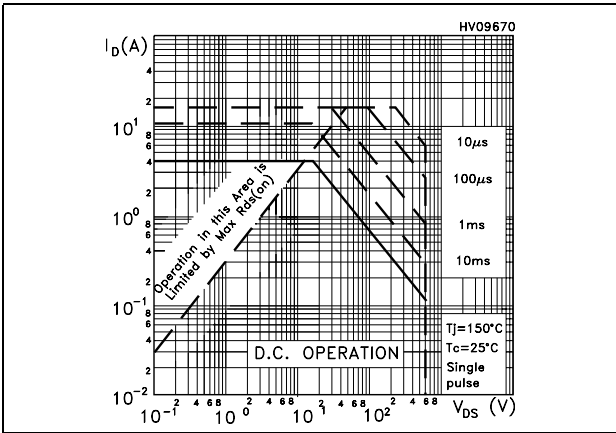


Figure 3. Thermal impedance for TO-220

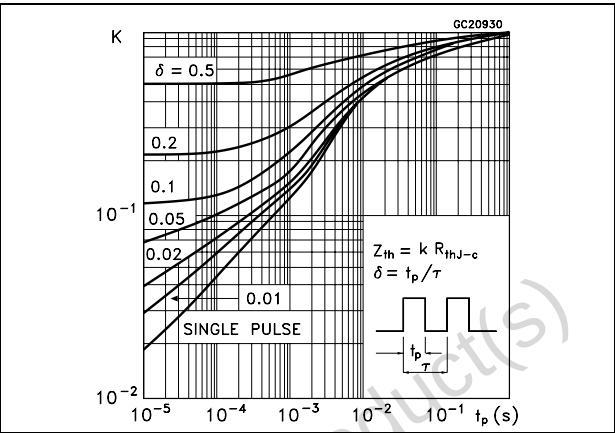


Figure 4. Safe operating area for DPAK and IPAK

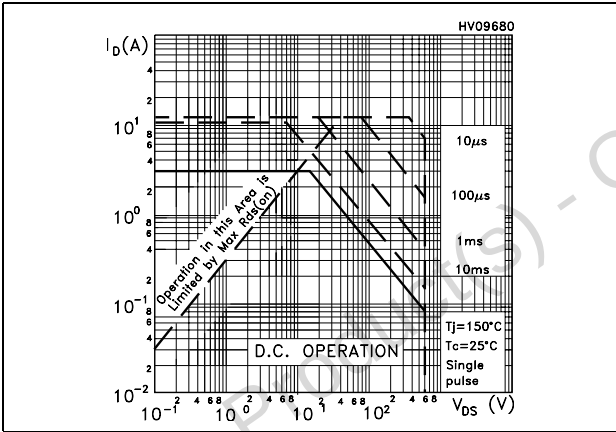


Figure 5. Thermal impedance for DPAK and IPAK

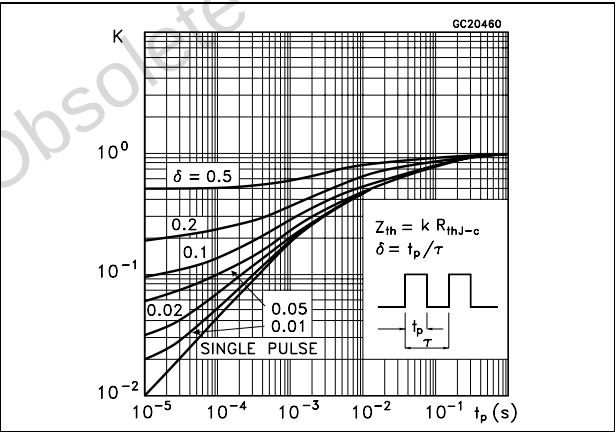


Figure 6. Output characteristics

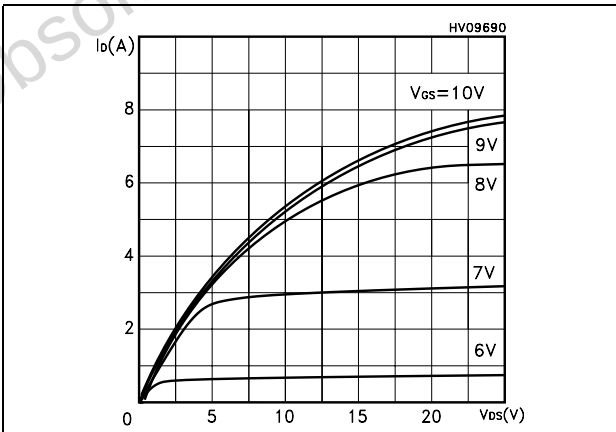


Figure 7. Transfer characteristics

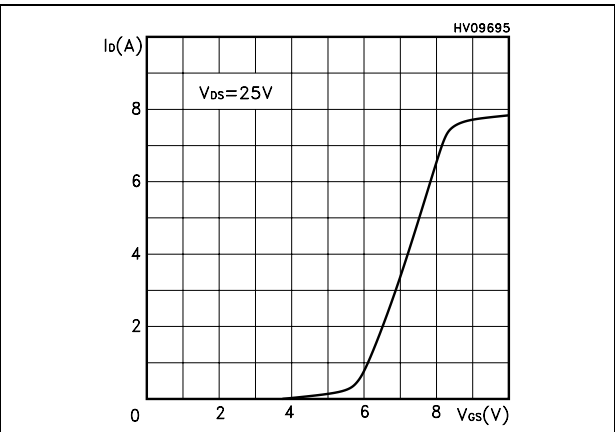


Figure 8. Transconductance

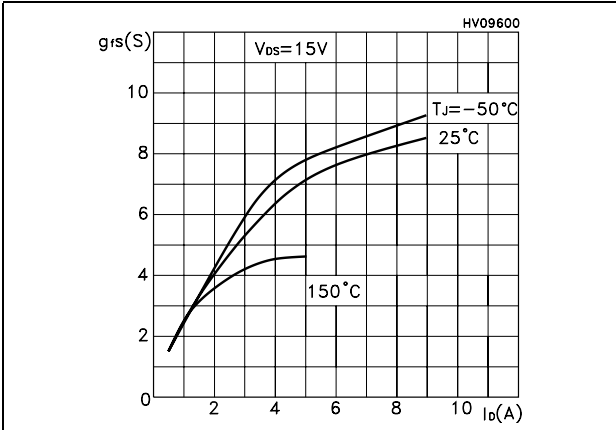


Figure 9. Static drain-source on resistance

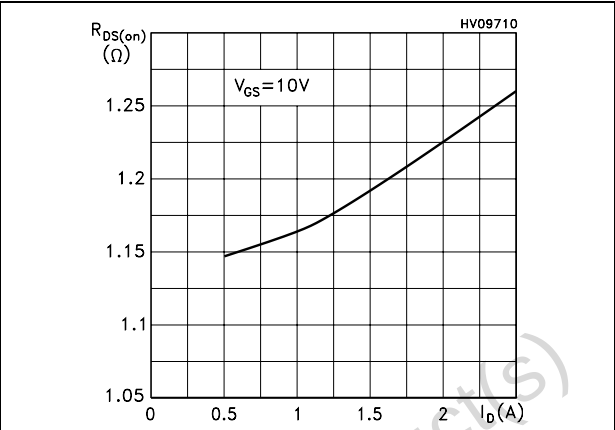


Figure 10. Gate charge vs gate-source voltage

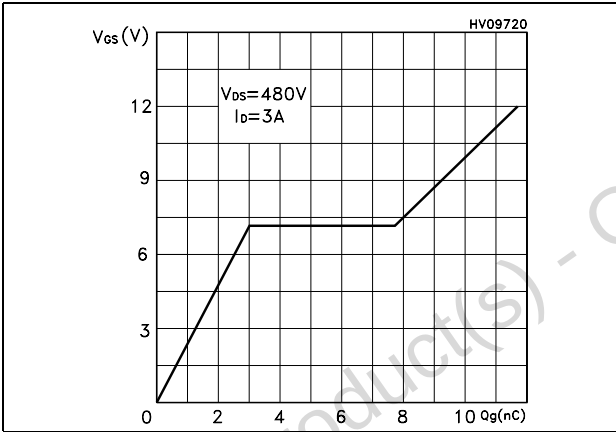


Figure 11. Capacitance variations

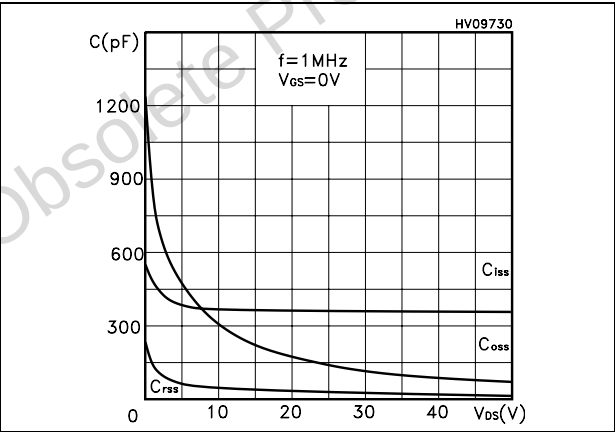


Figure 12. Normalized gate threshold voltage vs temperature

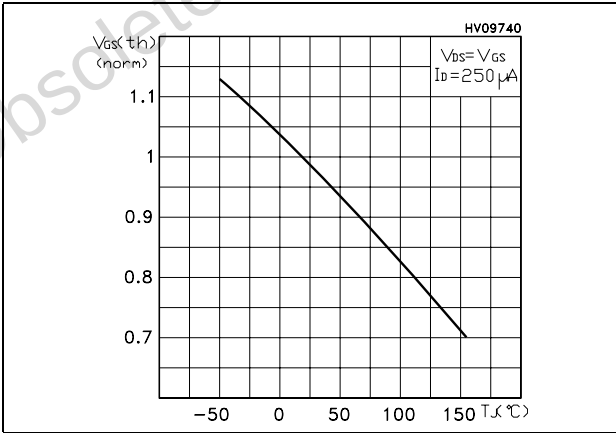


Figure 13. Normalized on resistance vs temperature

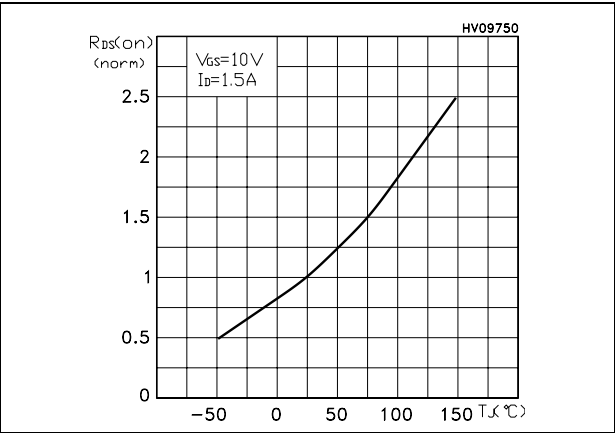
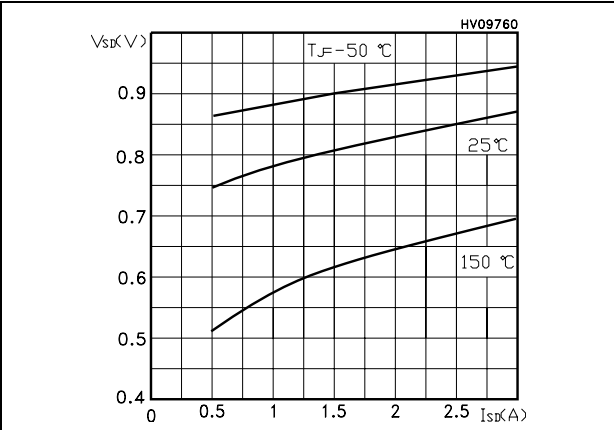


Figure 14. Source-drain diode forward characteristics

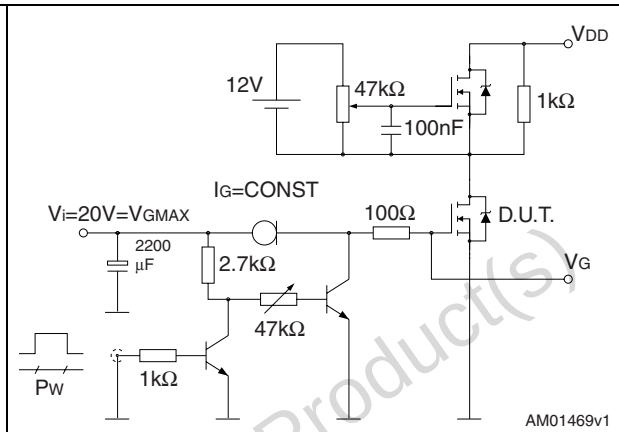


### 3 Test circuits

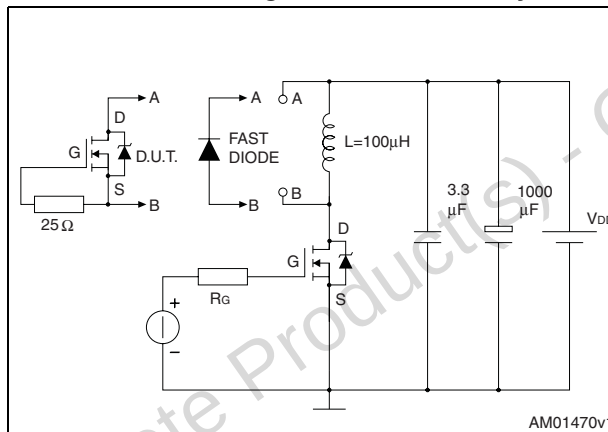
**Figure 15. Switching times test circuit for resistive load**



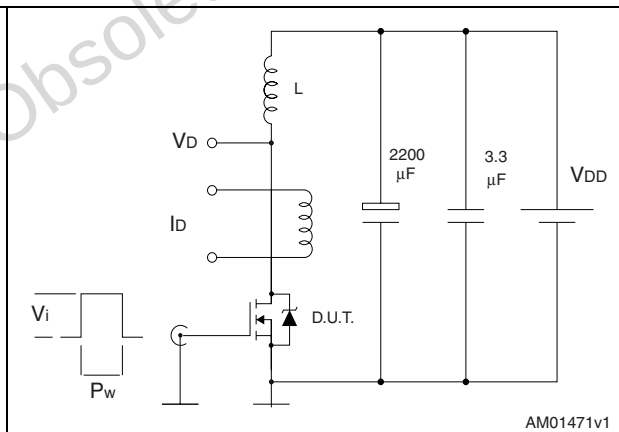
**Figure 16. Gate charge test circuit**



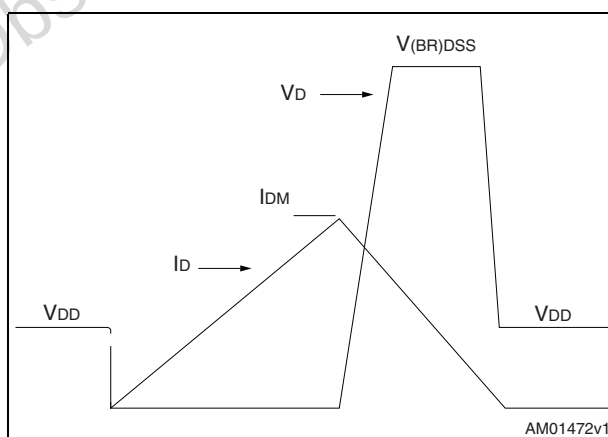
**Figure 17. Test circuit for inductive load switching and diode recovery times**



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



**Figure 19. Unclamped inductive waveform**



**Figure 20. Switching time waveform**

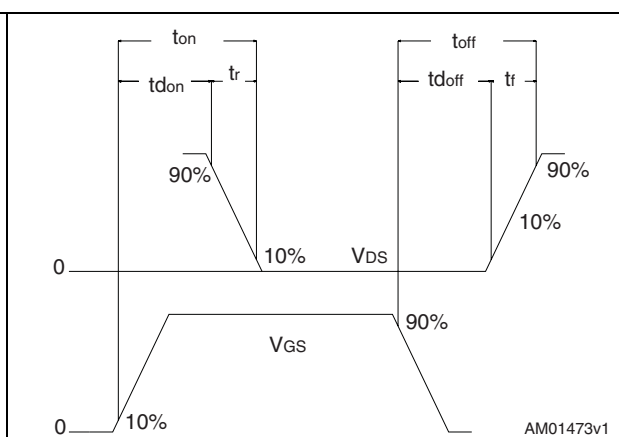
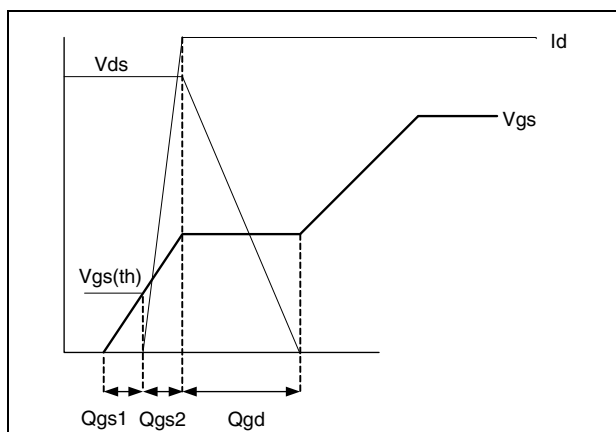


Figure 21. Gate charge waveform



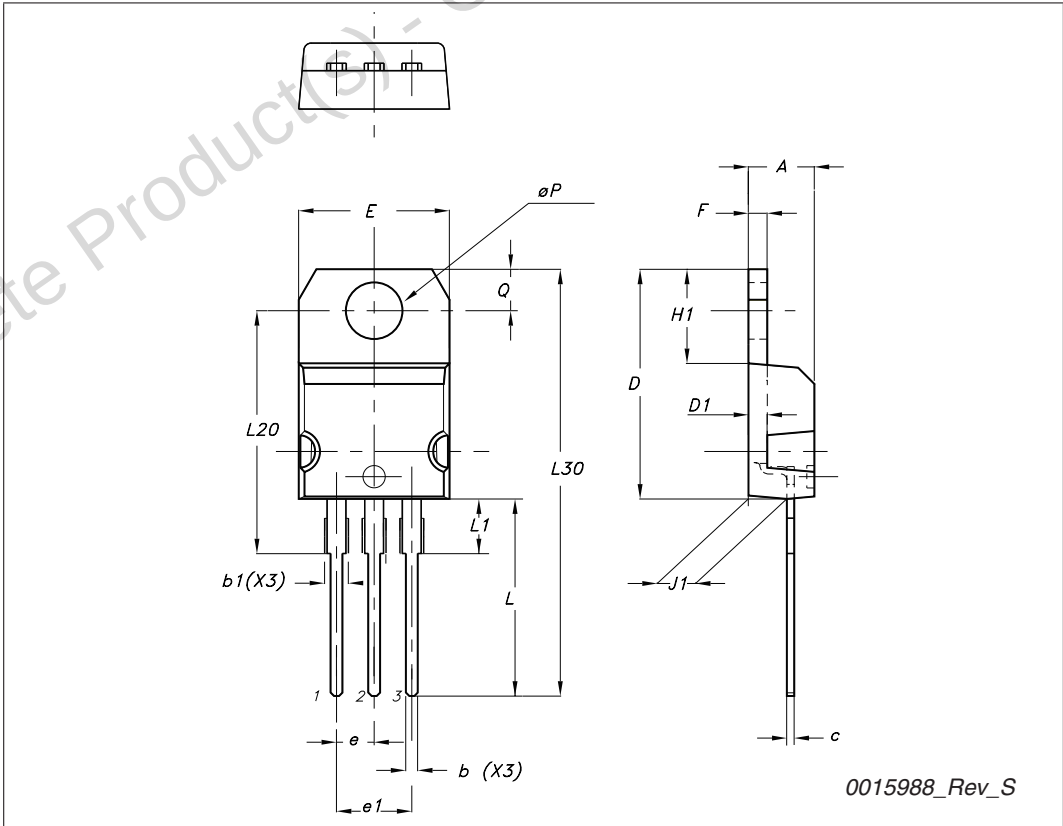
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

Obsolete Product(s) - Obsolete Product(s)

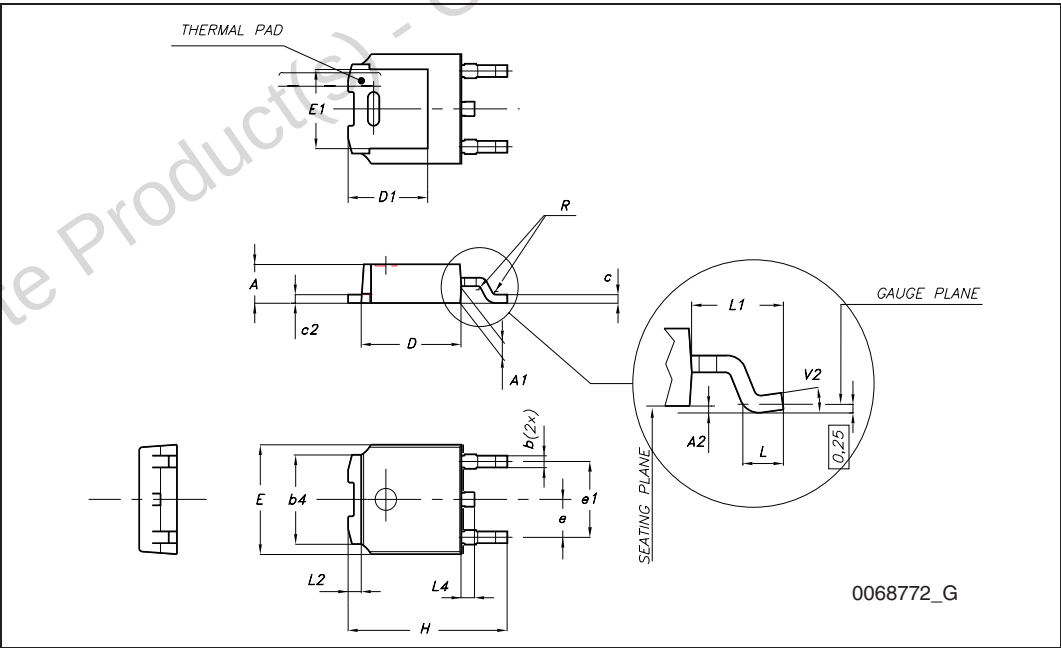
TO-220 type A mechanical data

| Dim | mm    |       |       |
|-----|-------|-------|-------|
|     | Min   | Typ   | Max   |
| A   | 4.40  |       | 4.60  |
| b   | 0.61  |       | 0.88  |
| b1  | 1.14  |       | 1.70  |
| c   | 0.48  |       | 0.70  |
| D   | 15.25 |       | 15.75 |
| D1  |       | 1.27  |       |
| E   | 10    |       | 10.40 |
| e   | 2.40  |       | 2.70  |
| e1  | 4.95  |       | 5.15  |
| F   | 1.23  |       | 1.32  |
| H1  | 6.20  |       | 6.60  |
| J1  | 2.40  |       | 2.72  |
| L   | 13    |       | 14    |
| L1  | 3.50  |       | 3.93  |
| L20 |       | 16.40 |       |
| L30 |       | 28.90 |       |
| ØP  | 3.75  |       | 3.85  |
| Q   | 2.65  |       | 2.95  |



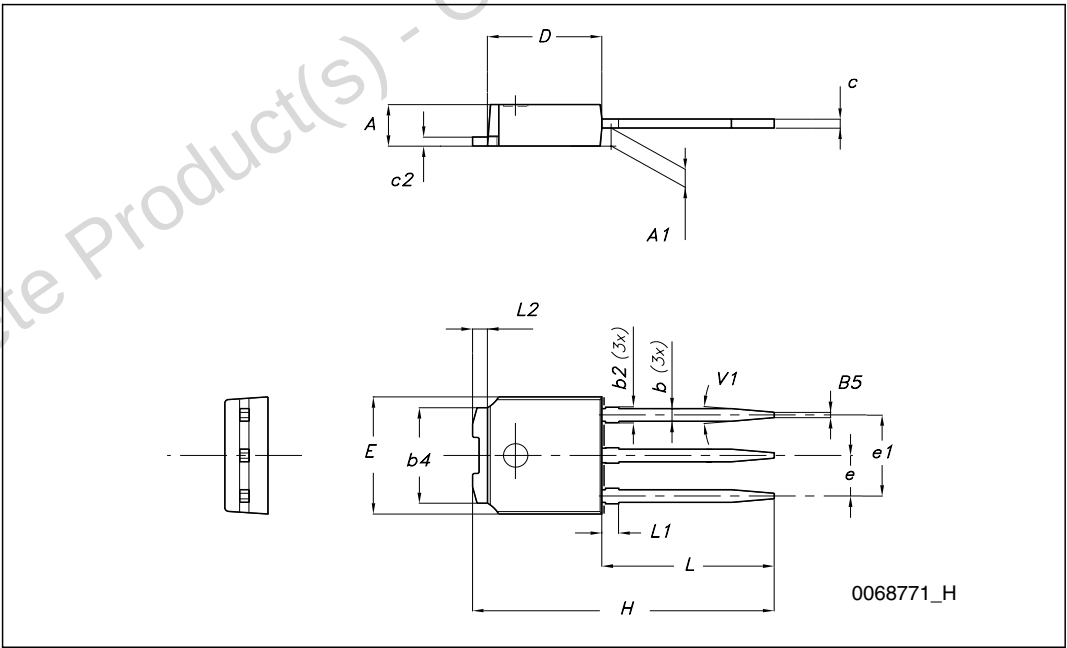
TO-252 (DPAK) mechanical data

| 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°    |



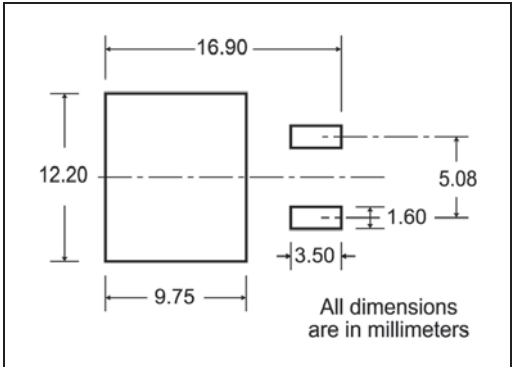
TO-251 (IPAK) mechanical data

| DIM. | mm.  |       |      |
|------|------|-------|------|
|      | min. | typ   | max. |
| A    | 2.20 |       | 2.40 |
| A1   | 0.90 |       | 1.10 |
| b    | 0.64 |       | 0.90 |
| b2   |      |       | 0.95 |
| b4   | 5.20 |       | 5.40 |
| c    | 0.45 |       | 0.60 |
| c2   | 0.48 |       | 0.60 |
| D    | 6.00 |       | 6.20 |
| E    | 6.40 |       | 6.60 |
| e    |      | 2.28  |      |
| e1   | 4.40 |       | 4.60 |
| H    |      | 16.10 |      |
| L    | 9.00 |       | 9.40 |
| (L1) | 0.80 |       | 1.20 |
| L2   |      | 0.80  |      |
| V1   |      | 10°   |      |

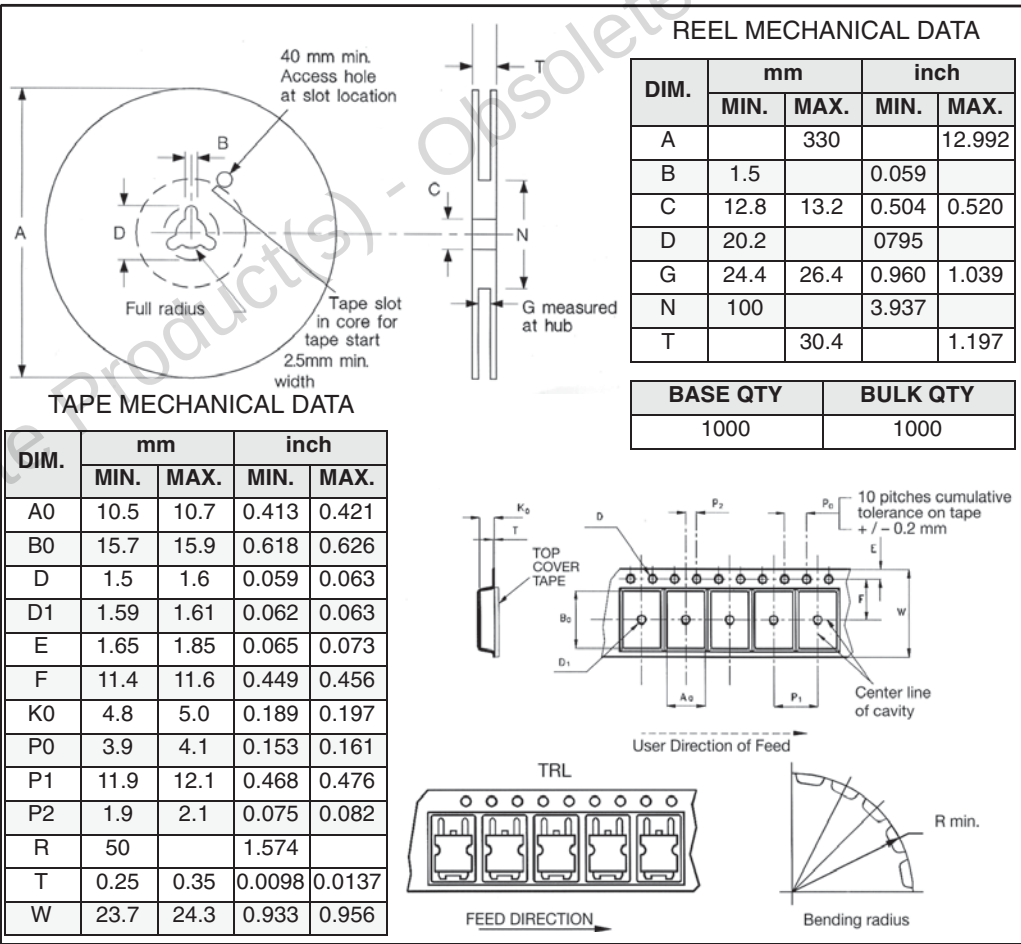


# 5 Packaging mechanical data

D<sup>2</sup>PAK FOOTPRINT



TAPE AND REEL SHIPMENT



## 6 Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes                                                                                                            |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------|
| 14-Jan-2004 | 3        |                                                                                                                    |
| 02-Sep-2009 | 4        | Inserted $V_{DSS}$ value @ $T_{jmax} = 150\text{ °C}$ on cover page<br>Document reformatted to improve readability |

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