



# STD85N3LH5 STP85N3LH5, STU85N3LH5

N-channel 30 V, 0.0042  $\Omega$  , 80 A, DPAK, TO-220, IPAK  
STripFET™ V Power MOSFET

## Features

| Type       | V <sub>DSS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|------------|------------------|--------------------------|----------------|
| STD85N3LH5 | 30 V             | < 0.005 $\Omega$         | 80 A           |
| STP85N3LH5 |                  |                          |                |
| STU85N3LH5 |                  |                          |                |

- R<sub>DS(on)</sub> \* Q<sub>g</sub> industry benchmark
- Extremely low on-resistance R<sub>DS(on)</sub>
- High avalanche ruggedness
- Low gate drive power losses

## Application

Switching applications

## Description

This product utilizes the 5<sup>th</sup> generation of design rules of ST's proprietary STripFET™ technology. The lowest available R<sub>DS(on)</sub> \* Q<sub>g</sub>, in the standard packages, makes this device suitable for the most demanding DC-DC converter applications, where high power density is to be achieved.

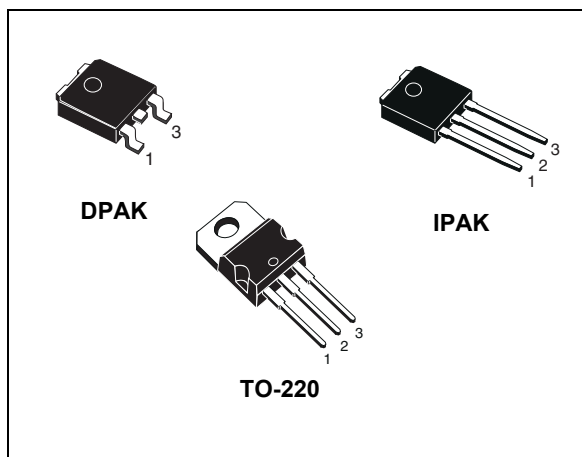


Figure 1. Internal schematic diagram

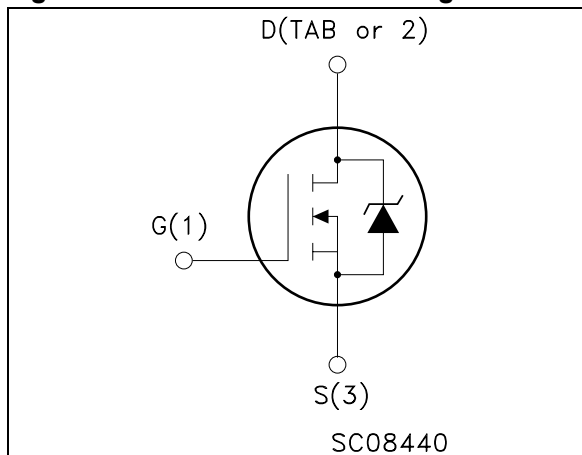


Table 1. Device summary

| Order codes | Marking | Package | Packaging     |
|-------------|---------|---------|---------------|
| STD85N3LH5  | 85N3LH5 | DPAK    | Tape and reel |
| STP85N3LH5  |         | TO-220  | Tube          |
| STU85N3LH5  |         | IPAK    |               |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter                                                         | Value      | Unit                  |
|----------------|-------------------------------------------------------------------|------------|-----------------------|
| $V_{DS}$       | Drain-source voltage ( $V_{GS} = 0$ )                             | 30         | V                     |
| $V_{DS}$       | Drain-source voltage ( $V_{GS} = 0$ ) @ $T_{JMAX}$                | 35         | V                     |
| $V_{GS}$       | Gate-source voltage                                               | $\pm 22$   | V                     |
| $I_D^{(1)}$    | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$  | 80         | A                     |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 55         | A                     |
| $I_{DM}^{(2)}$ | Drain current (pulsed)                                            | 320        | A                     |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$           | 70         | W                     |
|                | Derating factor                                                   | 0.47       | W/ $^{\circ}\text{C}$ |
| $E_{AS}^{(3)}$ | Single pulse avalanche energy                                     | 165        | mJ                    |
| $T_{stg}$      | Storage temperature                                               | -55 to 175 | $^{\circ}\text{C}$    |
| $T_j$          | Max. operating junction temperature                               | 175        | $^{\circ}\text{C}$    |

1. Limited by wire bonding
2. Pulse width limited by safe operating area
3. Starting  $T_j = 25\text{ }^{\circ}\text{C}$ ,  $I_D = 40\text{ A}$ ,  $V_{DD} = 25\text{ V}$

**Table 3. Thermal resistance**

| Symbol         | Parameter                                      | Value  |      |      | Unit                        |
|----------------|------------------------------------------------|--------|------|------|-----------------------------|
|                |                                                | TO-220 | DPAK | IPAK |                             |
| $R_{thj-case}$ | Thermal resistance junction-case max           | 2.14   |      |      | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-amb max            | 62.5   |      | 100  | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-pcb}$  | Thermal resistance junction-pcb max            |        | 100  |      | $^{\circ}\text{C}/\text{W}$ |
| $T_l$          | Maximum lead temperature for soldering purpose | 275    |      |      | $^{\circ}\text{C}$          |

## 2 Electrical characteristics

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

**Table 4. Static**

| Symbol        | Parameter                                        | Test conditions                                                                        | Min. | Typ.   | Max.      | Unit                           |
|---------------|--------------------------------------------------|----------------------------------------------------------------------------------------|------|--------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown Voltage                   | $I_D = 250\text{ }\mu\text{A}$ , $V_{GS} = 0$                                          | 30   |        |           | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 30\text{ V}$<br>$V_{DS} = 30\text{ V}$ , $T_c = 125\text{ }^{\circ}\text{C}$ |      |        | 1<br>10   | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 22\text{ V}$                                                             |      |        | $\pm 100$ | nA                             |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                     | 1    | 1.8    | 2.5       | V                              |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 40\text{ A}$<br>SMD version                            |      | 0.042  | 0.005     | $\Omega$                       |
|               |                                                  | $V_{GS} = 10\text{ V}$ , $I_D = 40\text{ A}$                                           |      | 0.0046 | 0.0054    | $\Omega$                       |
|               |                                                  | $V_{GS} = 5\text{ V}$ , $I_D = 40\text{ A}$<br>SMD version                             |      | 0.0052 | 0.0065    | $\Omega$                       |
|               |                                                  | $V_{GS} = 5\text{ V}$ , $I_D = 40\text{ A}$                                            |      | 0.0058 | 0.0071    | $\Omega$                       |

**Table 5. Dynamic**

| Symbol    | Parameter                           | Test conditions                                                                     | Min. | Typ. | Max. | Unit     |
|-----------|-------------------------------------|-------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$ | Input capacitance                   | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$                       |      | 1850 |      | pF       |
| $C_{oss}$ | Output capacitance                  |                                                                                     |      | 380  |      | pF       |
| $C_{rss}$ | Reverse transfer capacitance        |                                                                                     |      | 58   |      | pF       |
| $Q_g$     | Total gate charge                   | $V_{DD} = 15\text{ V}$ , $I_D = 80\text{ A}$                                        |      | 14   |      | nC       |
| $Q_{gs}$  | Gate-source charge                  | $V_{GS} = 5\text{ V}$                                                               |      | 6.8  |      | nC       |
| $Q_{gd}$  | Gate-drain charge                   | <a href="#">Figure 16</a>                                                           |      | 4.7  |      | nC       |
| $Q_{gs1}$ | Pre $V_{th}$ gate-to-source charge  | $V_{DD} = 15\text{ V}$ , $I_D = 80\text{ A}$                                        |      | 2.3  |      | nC       |
| $Q_{gs2}$ | Post $V_{th}$ gate-to-source charge | $V_{GS} = 5\text{ V}$<br><a href="#">Figure 16</a>                                  |      | 4.5  |      | nC       |
| $R_G$     | Gate input resistance               | $f = 1\text{ MHz}$ gate bias<br>Bias = 0 test signal<br>level = 20 mV<br>open drain |      | 1.2  |      | $\Omega$ |

**Table 6. Switching on/off (inductive load)**

| Symbol       | Parameter           | Test conditions                                                                                                   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|-------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 15\text{ V}$ , $I_D = 40\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 5\text{ V}$<br><i>Figure 15</i> |      | 6    |      | ns   |
| $t_r$        | Rise time           |                                                                                                                   |      | 14   |      | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                   |      | 23.6 |      | ns   |
| $t_f$        | Fall time           |                                                                                                                   |      | 10.8 |      | ns   |

**Table 7. Source drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|----------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                |      |      | 80   | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                |      |      | 320  | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 40\text{ A}$ , $V_{GS} = 0$                                                                          |      |      | 1.1  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 80\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 20\text{ V}$<br><i>Figure 17</i> |      | 31.8 |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                |      | 26.1 |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                |      | 1.6  |      | 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 2. Safe operating area

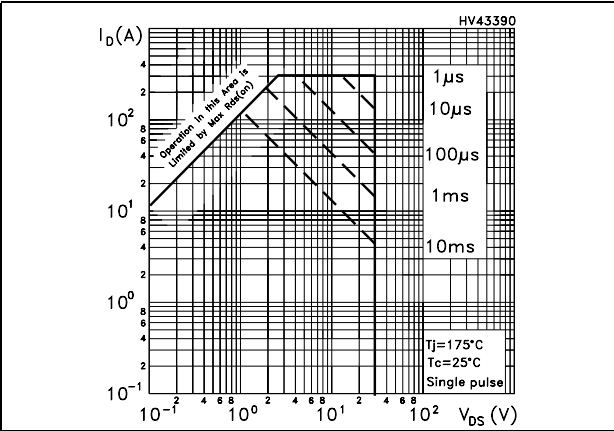


Figure 3. Thermal impedance

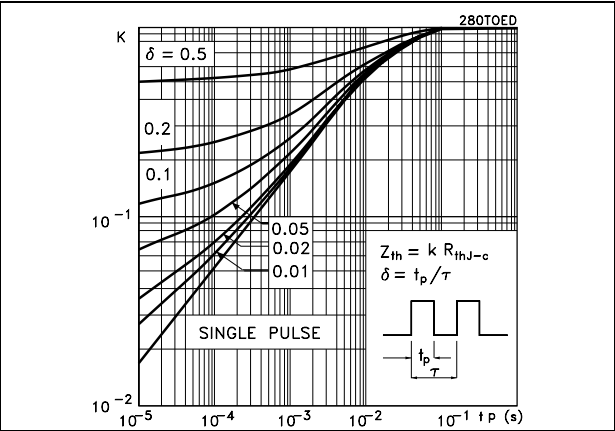


Figure 4. Output characteristics

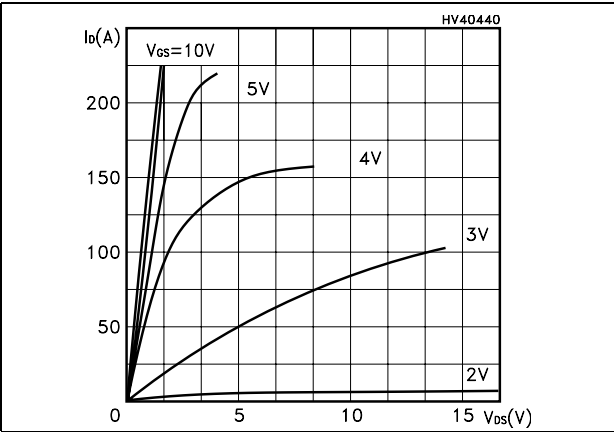


Figure 5. Transfer characteristics

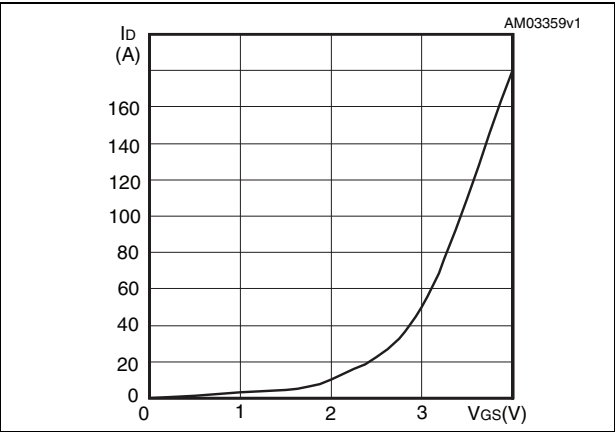


Figure 6. Normalized  $B_{V_{DSS}}$  vs temperature

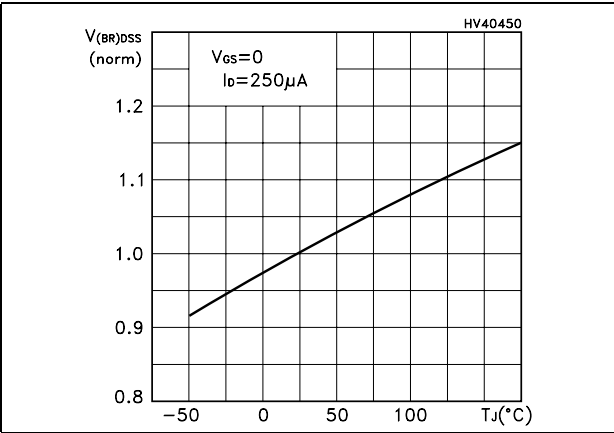


Figure 7. Static drain-source on resistance

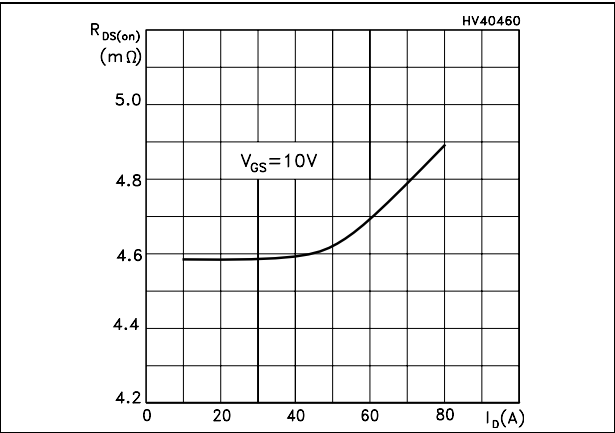


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

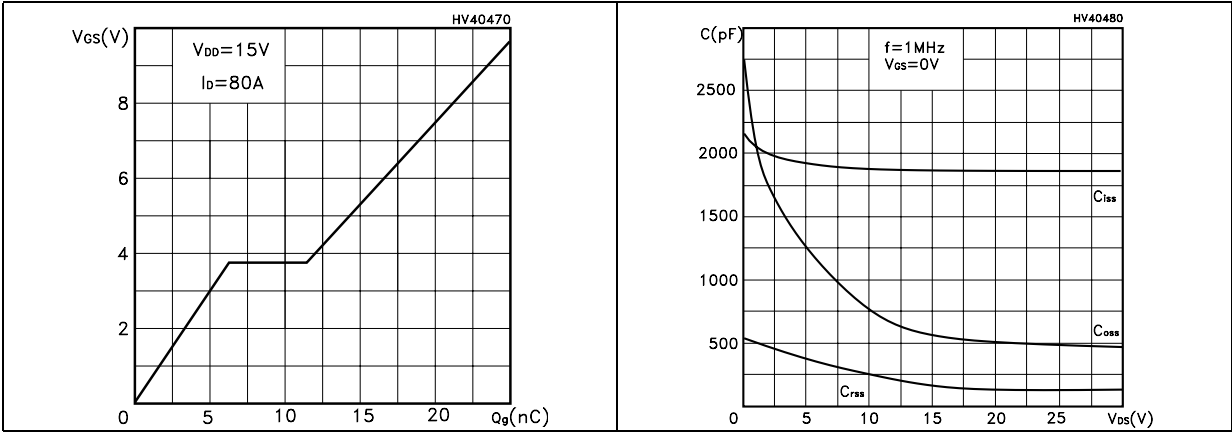


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on resistance vs temperature

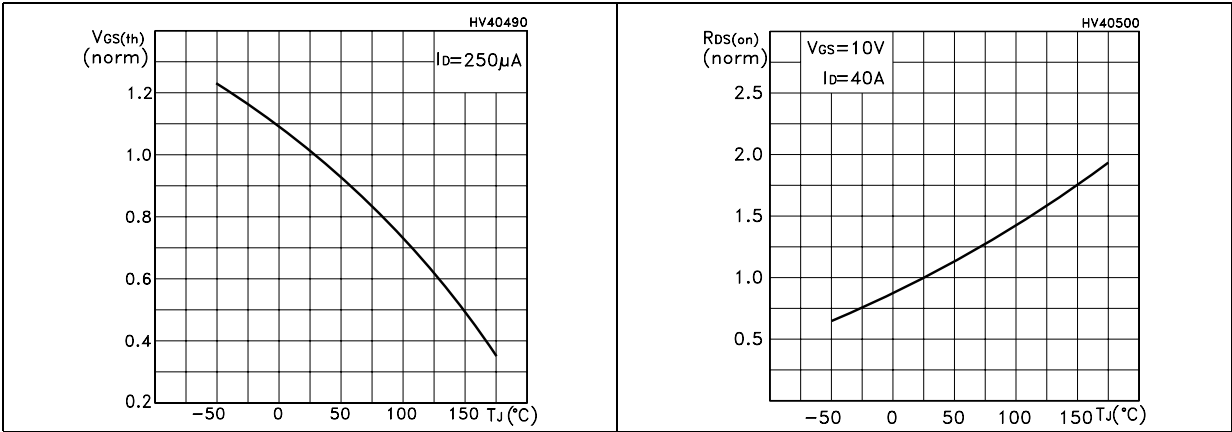
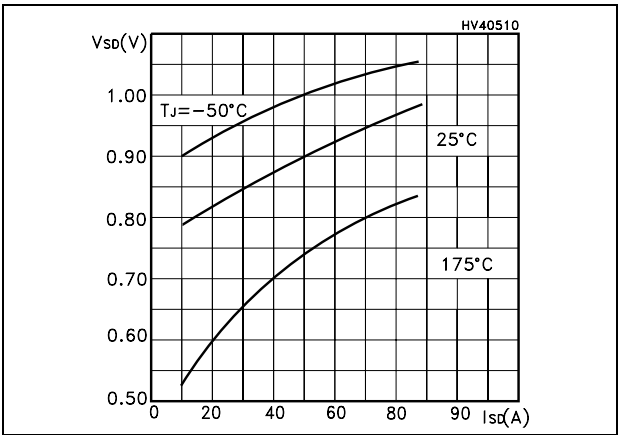
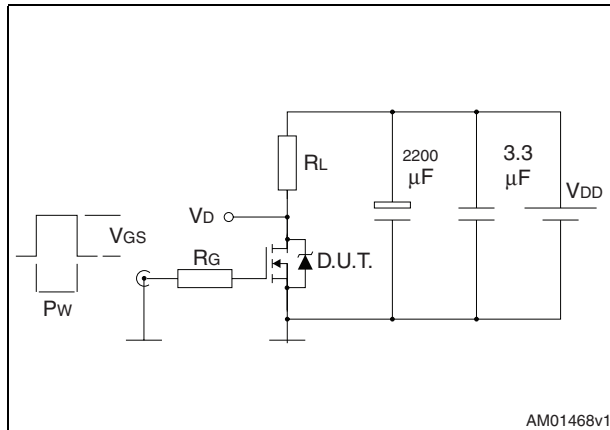


Figure 12. Source-drain diode forward characteristics

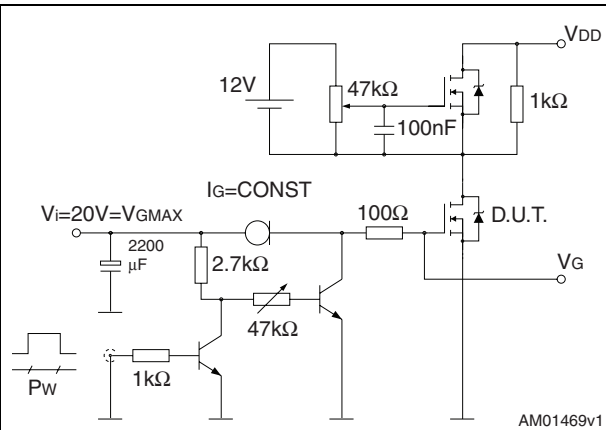


### 3 Test circuit

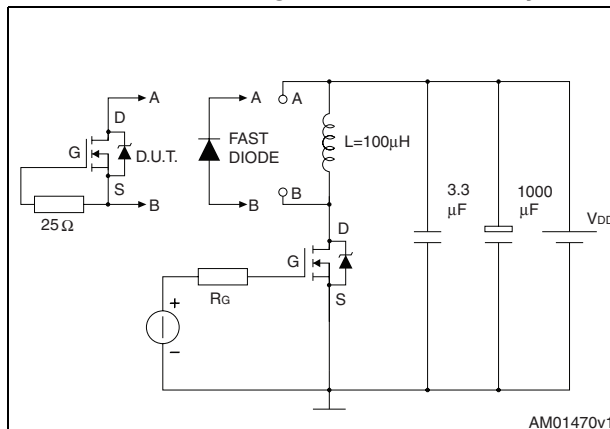
**Figure 13. Switching times test circuit for resistive load**



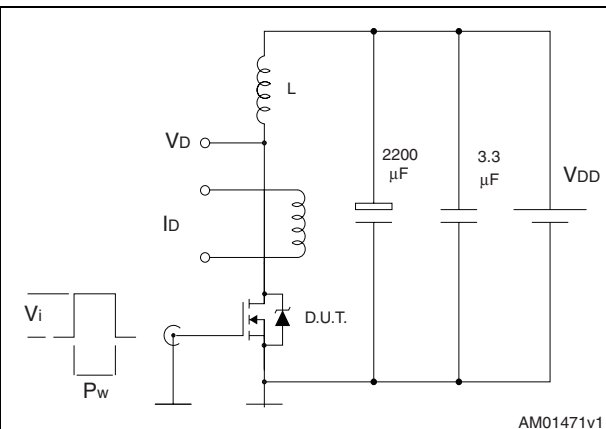
**Figure 14. Gate charge test circuit**



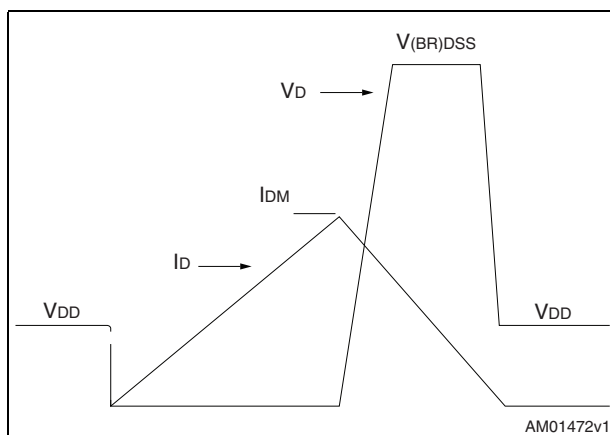
**Figure 15. Test circuit for inductive load switching and diode recovery times**



**Figure 16. Unclamped inductive load test circuit**



**Figure 17. Unclamped inductive waveform**



**Figure 18. Switching time waveform**

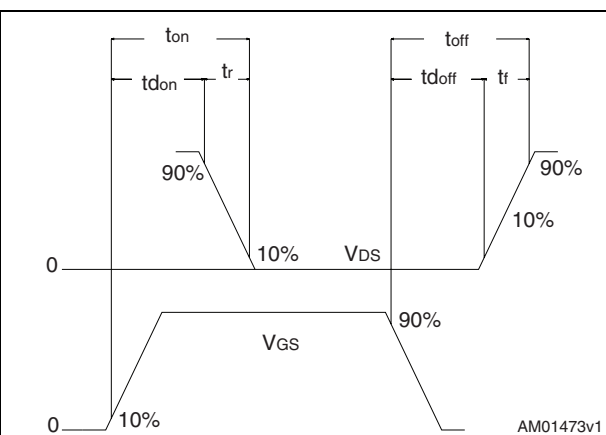
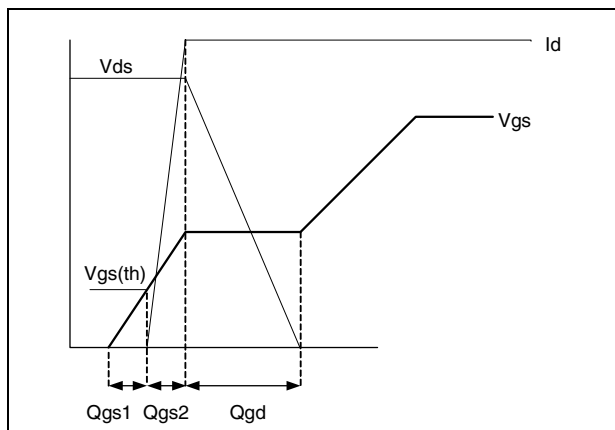




Figure 19. Gate charge waveform

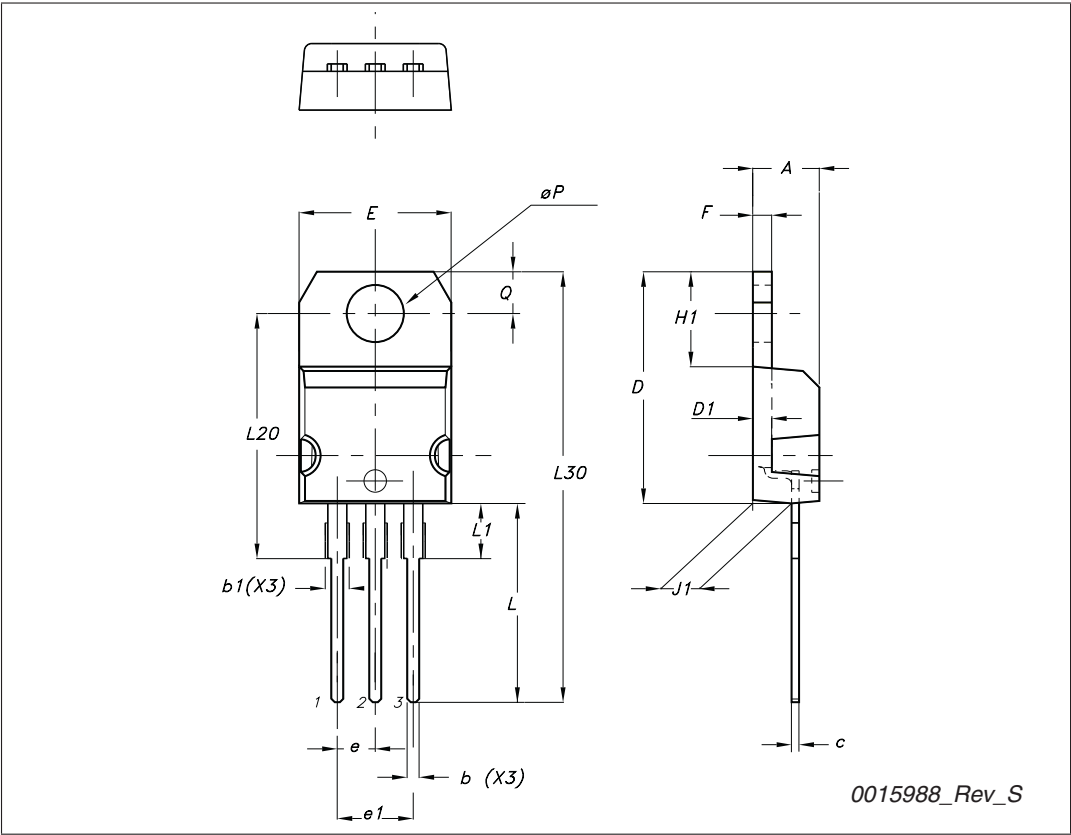


## 4 Package mechanical data

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

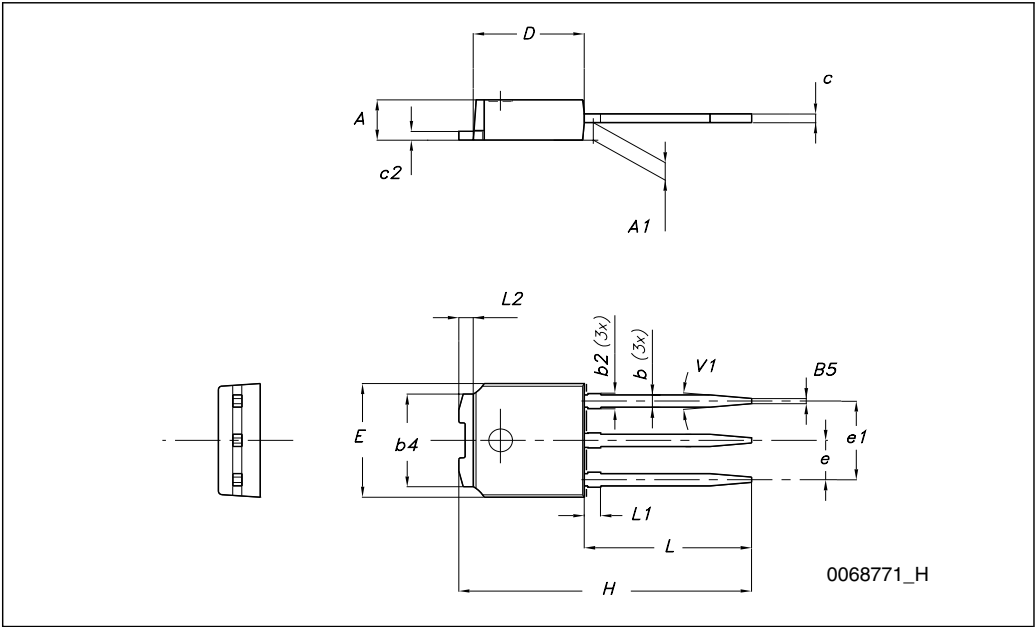
TO-220 type A mechanical data

| 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  |



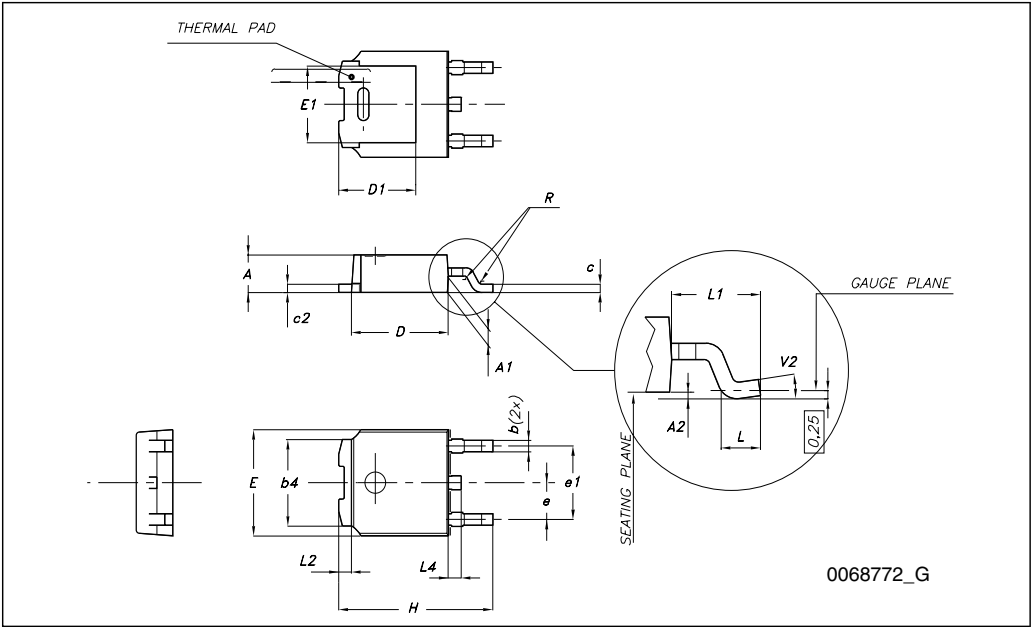
TO-251 (IPAK) mechanical data

| 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°   |      |



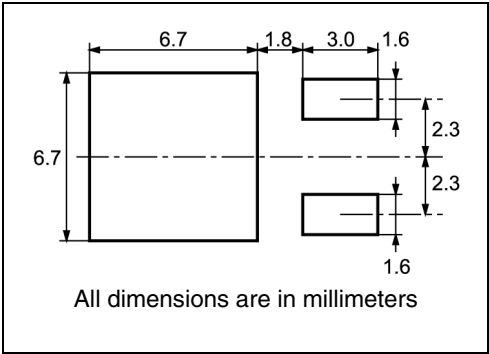
TO-252 (DPAK) mechanical data

| 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°    |

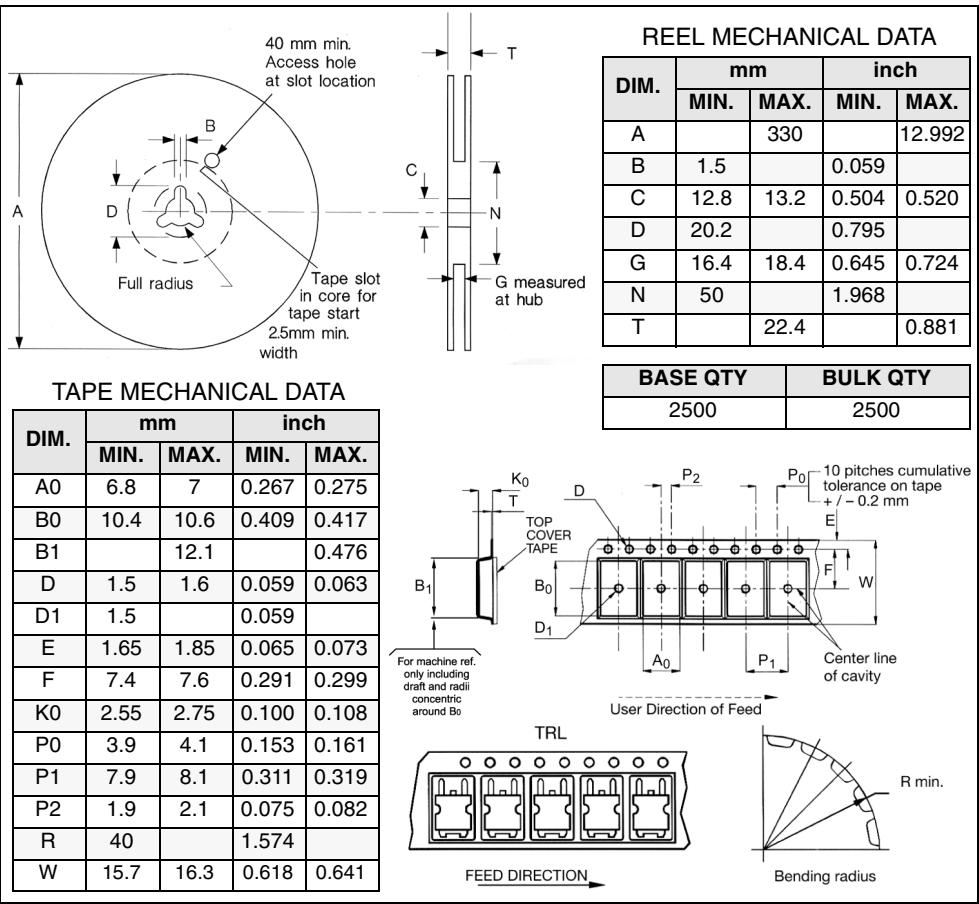


# 5 Packaging mechanical data

## DPAK FOOTPRINT



## TAPE AND REEL SHIPMENT



## 6 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                             |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19-Oct-2007 | 1        | First release                                                                                                                                                                                                                                                                                                                       |
| 20-Feb-2008 | 2        | Minor text changes to improve readability                                                                                                                                                                                                                                                                                           |
| 21-Jul-2008 | 3        | <ul style="list-style-type: none"> <li>– Added new package, mechanical data: TO-220</li> <li>– <a href="#">Figure 2: Safe operating area</a> has been corrected</li> <li>– <a href="#">Figure 7: Static drain-source on resistance</a> updated</li> <li>– New value on <a href="#">Table 2: Absolute maximum ratings</a></li> </ul> |
| 20-Aug-2008 | 4        | Added max value on $V_{GS(th)}$ ( <a href="#">Table 4</a> )                                                                                                                                                                                                                                                                         |
| 25-Sep-2008 | 5        | $V_{GS}$ values has been changed on <a href="#">Table 2</a> and <a href="#">Table 4</a>                                                                                                                                                                                                                                             |
| 22-Jan-2009 | 6        | Corrected value on <a href="#">Table 3: Thermal resistance</a>                                                                                                                                                                                                                                                                      |
| 01-Jul-2010 | 7        | $V_{DS}$ values has been changed on <a href="#">Table 4</a>                                                                                                                                                                                                                                                                         |

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