



# STD12N65M5, STF12N65M5 STP12N65M5, STU12N65M5

N-channel 650 V, 0.370  $\Omega$ , 8.5 A MDmesh™ V Power MOSFET  
DPAK, TO-220FP, TO-220, IPAK

Preliminary Data

## Features

| Type       | $V_{DS} @ T_{Jmax}$ | $R_{DS(on) max}$ | $I_D$                | $P_W$ |
|------------|---------------------|------------------|----------------------|-------|
| STD12N65M5 | 710 V               | < 0.41 $\Omega$  | 8.5 A                | 70 W  |
| STF12N65M5 |                     |                  | 8.5 A <sup>(1)</sup> | 25 W  |
| STP12N65M5 |                     |                  | 8.5 A                | 70 W  |
| STU12N65M5 |                     |                  | 8.5 A                | 70 W  |

1. Limited only by maximum temperature allowed

- Worldwide best  $R_{DS(on)}$  \* area
- Higher  $V_{DS}$  rating
- High dv/dt capability
- Excellent switching performance
- Easy to drive
- 100% Avalanche tested

## Application

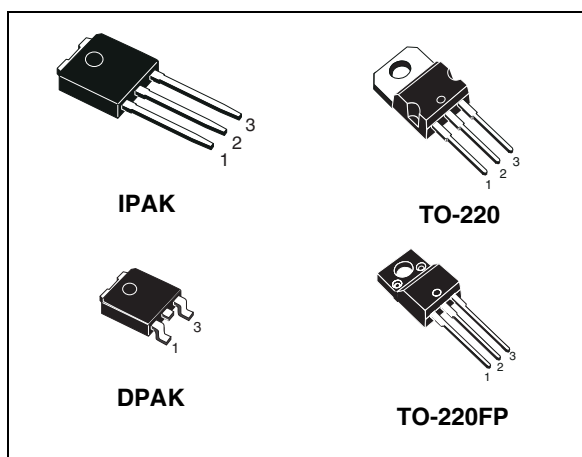
- Switching applications

## Description

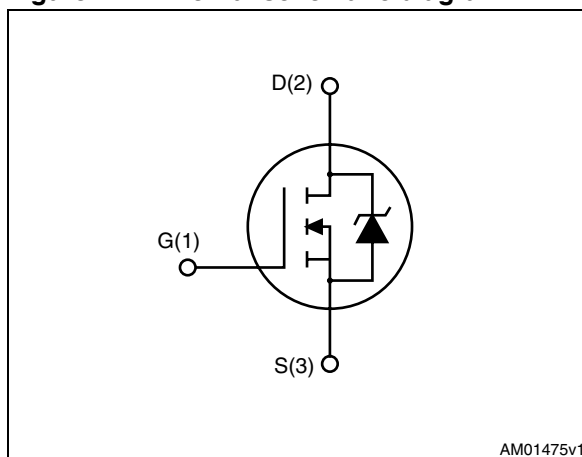
MDmesh V is a revolutionary Power MOSFET technology, which combines an innovative proprietary vertical process with the well known company's PowerMESH™ horizontal layout. The resulting product has an extremely low on-resistance, unmatched among silicon-based Power MOSFETs, making it especially suited for applications which require superior power density and outstanding efficiencies.

**Table 1. Device summary**

| Order codes | Marking | Package  | Packaging     |
|-------------|---------|----------|---------------|
| STD12N65M5  | 12N65M5 | DPAK     | Tape and reel |
| STF12N65M5  | 12N65M5 | TO-220FP | Tube          |
| STP12N65M5  | 12N65M5 | TO-220   | Tube          |
| STU12N65M5  | 12N65M5 | IPAK     | Tube          |



**Figure 1. Internal schematic diagram**



AM01475v1

## Contents

|          |                                         |           |
|----------|-----------------------------------------|-----------|
| <b>1</b> | <b>Electrical ratings .....</b>         | <b>3</b>  |
| <b>2</b> | <b>Electrical characteristics .....</b> | <b>4</b>  |
| <b>3</b> | <b>Test circuits .....</b>              | <b>6</b>  |
| <b>4</b> | <b>Package mechanical data .....</b>    | <b>7</b>  |
| <b>5</b> | <b>Packaging mechanical data .....</b>  | <b>12</b> |
| <b>6</b> | <b>Revision history .....</b>           | <b>13</b> |

# 1 Electrical ratings (a)

**Table 2. Absolute maximum ratings**

| Symbol                  | Parameter                                                                                                                 | Value              |                    | Unit |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------|--------------------|------|
|                         |                                                                                                                           | TO-220, IPAK, DPAK | TO-220FP           |      |
| $V_{DS}$                | Drain-source voltage ( $V_{GS} = 0$ )                                                                                     | 650                |                    | V    |
| $V_{GS}$                | Gate-source voltage                                                                                                       | 25                 |                    | V    |
| $I_D$                   | Drain current (continuous) at $T_C = 25\text{ °C}$                                                                        | 8.5                | 8.5 <sup>(1)</sup> | A    |
| $I_D$                   | Drain current (continuous) at $T_C = 100\text{ °C}$                                                                       | 5.4                | 5.4 <sup>(1)</sup> | A    |
| $I_{DM}$ <sup>(2)</sup> | Drain current (pulsed)                                                                                                    | 34                 | 34 <sup>(1)</sup>  | A    |
| $P_{TOT}$               | Total dissipation at $T_C = 25\text{ °C}$                                                                                 | 70                 | 25                 | W    |
| $I_{AR}$                | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)                                        | TBD                |                    | A    |
| $E_{AS}$                | Single pulse avalanche energy (starting $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )                  | TBD                |                    | mJ   |
| $dv/dt$ <sup>(3)</sup>  | Peak diode recovery voltage slope                                                                                         | 15                 |                    | V/ns |
| $V_{ISO}$               | Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ ; $T_C = 25\text{ °C}$ ) |                    | 2500               | V    |
| $T_{stg}$               | Storage temperature                                                                                                       | - 55 to 150        |                    | °C   |
| $T_j$                   | Max. operating junction temperature                                                                                       | 150                |                    | °C   |

1. Limited only by maximum temperature allowed

2. Pulse width limited by safe operating area

3.  $I_{SD} \leq 8.5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{Peak} < V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol         | Parameter                                      | Value |      |        |          | Unit |
|----------------|------------------------------------------------|-------|------|--------|----------|------|
|                |                                                | DPAK  | IPAK | TO-220 | TO-220FP |      |
| $R_{thj-case}$ | Thermal resistance junction-case max           | 1.79  |      |        | 5        | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max        |       | 100  | 62.5   |          | °C/W |
| $R_{thj-pcb}$  | Thermal resistance junction-pcb max            | 50    |      |        |          |      |
| $T_l$          | Maximum lead temperature for soldering purpose | 300   |      |        |          | °C   |

a. All data which refers solely to the TO-220FP package is preliminary



## 2 Electrical characteristics

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

**Table 4. On /off states**

| Symbol        | Parameter                                        | Test conditions                                                                                    | Min. | Typ. | Max.     | Unit                           |
|---------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------|------|------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                                                                 | 650  |      |          | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{Max rating}$<br>$V_{DS} = \text{Max rating}$ , $T_C = 125\text{ }^{\circ}\text{C}$ |      |      | 1<br>100 | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$                                                                         |      |      | 100      | nA                             |
| $V_{GS(th)}$  | 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                | $V_{GS} = 10\text{ V}$ , $I_D = 4.3\text{ A}$                                                      |      | 0.37 | 0.41     | $\Omega$                       |

**Table 5. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                                               | Min. | Typ.              | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------|-------------------|------|----------------|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$                                                |      | 1000<br>24<br>3.2 |      | pF<br>pF<br>pF |
| $C_{o(tr)}^{(1)}$                   | Equivalent capacitance time related                                     | $V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0$                                                            |      | TBD               |      | pF             |
| $C_{o(er)}^{(2)}$                   | Equivalent capacitance energy related                                   |                                                                                                               |      | TBD               |      | pF             |
| $R_G$                               | Intrinsic gate resistance                                               | $f = 1\text{ MHz}$ open drain                                                                                 |      | TBD               |      | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 520\text{ V}$ , $I_D = 4.3\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 3</a> ) |      | 19<br>TBD<br>TBD  |      | nC<br>nC<br>nC |

1.  $C_{oss\text{ eq}}$  time related is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$
2.  $C_{oss\text{ eq}}$  energy related is defined as a constant equivalent capacitance giving the same stored energy as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

Table 6. Switching times

| Symbol       | Parameter           | Test conditions                                                                                                                   | Min. | Typ. | Max | Unit |
|--------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------|------|------|-----|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 400\text{ V}$ , $I_D = 5\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 4</a> ) |      | TBD  |     | ns   |
| $t_r$        | Rise time           |                                                                                                                                   |      | TBD  |     | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                   |      | TBD  |     | ns   |
| $t_f$        | Fall time           |                                                                                                                                   |      | TBD  |     | ns   |

Table 7. Source drain diode

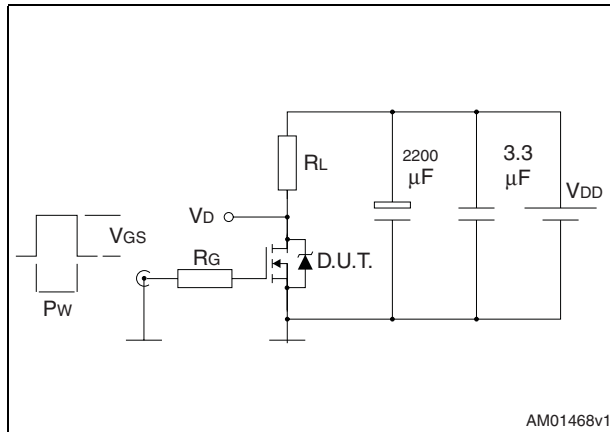
| Symbol          | Parameter                     | Test conditions                                                                                                                                                | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                |      |      | 8.5  | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                |      |      | 34   | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 8.5\text{ A}$ , $V_{GS} = 0$                                                                                                                         |      |      | 1.5  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 8.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ (see <a href="#">Figure 7</a> )                                        |      | TBD  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                |      | TBD  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                |      | TBD  |      | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 8.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 7</a> ) |      | TBD  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                |      | TBD  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                |      | TBD  |      | A    |

1. Pulse width limited by safe operating area

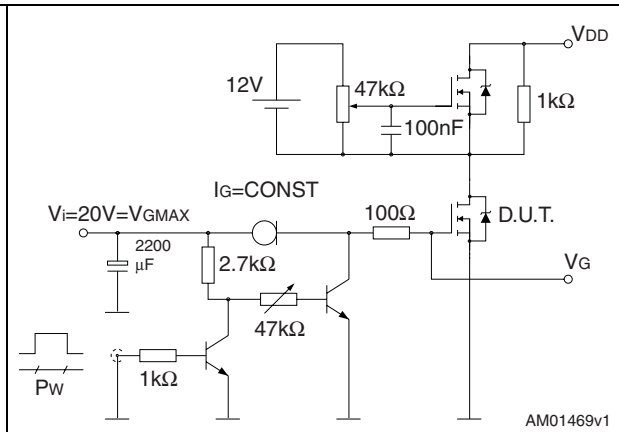
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

### 3 Test circuits

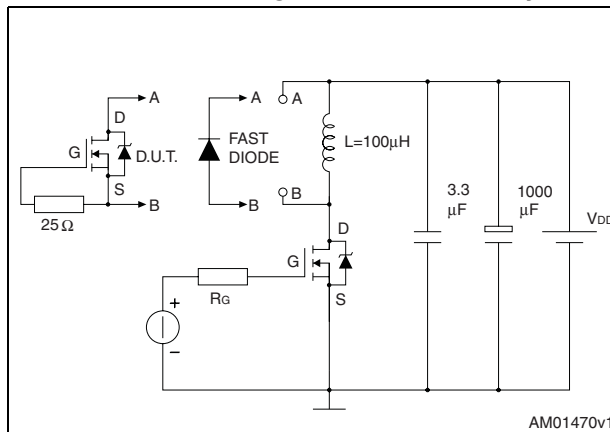
**Figure 2. Switching times test circuit for resistive load**



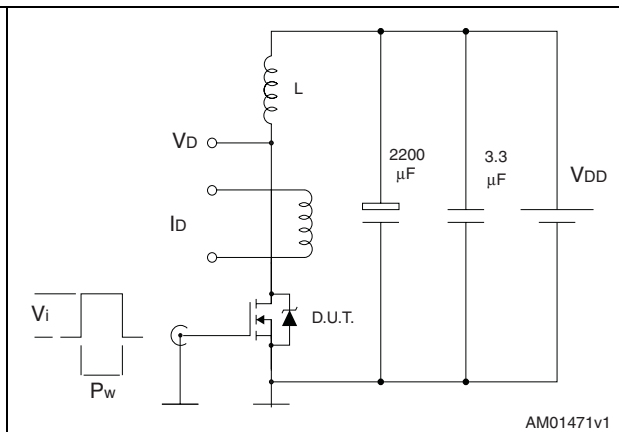
**Figure 3. Gate charge test circuit**



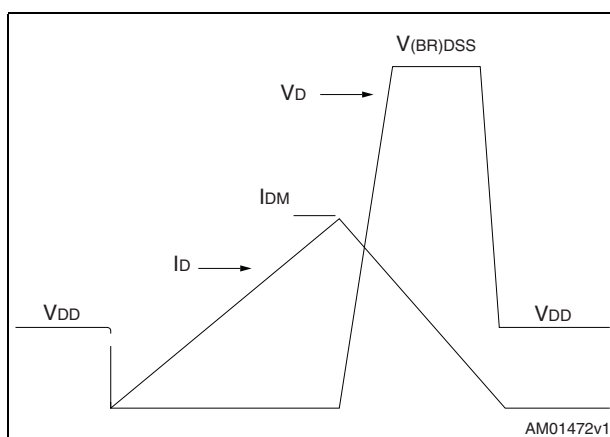
**Figure 4. Test circuit for inductive load switching and diode recovery times**



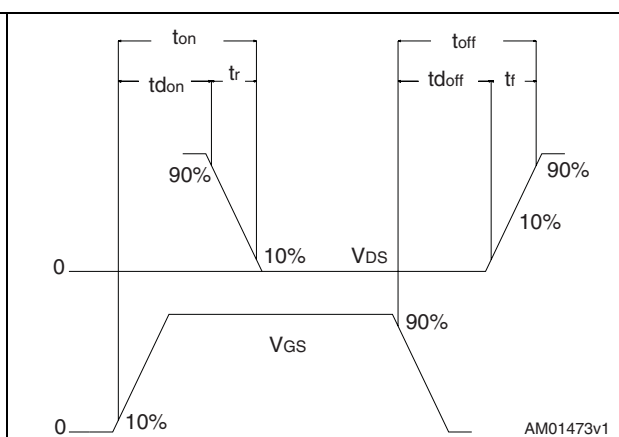
**Figure 5. Unclamped inductive load test circuit**



**Figure 6. Unclamped inductive waveform**



**Figure 7. Switching time waveform**

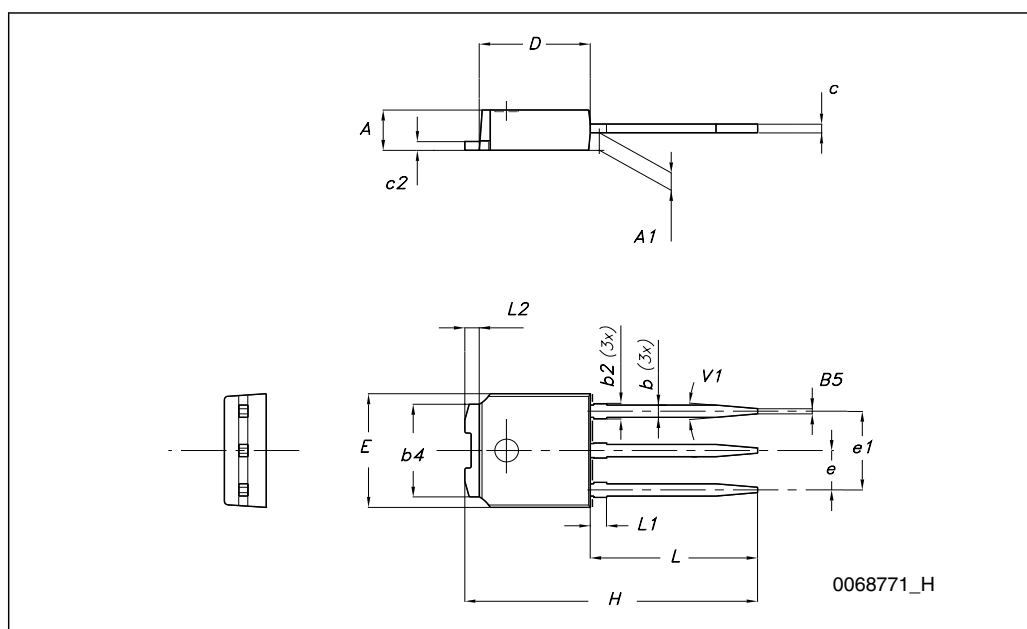


## 4 Package mechanical data

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.

### TO-251 (IPAK) mechanical data

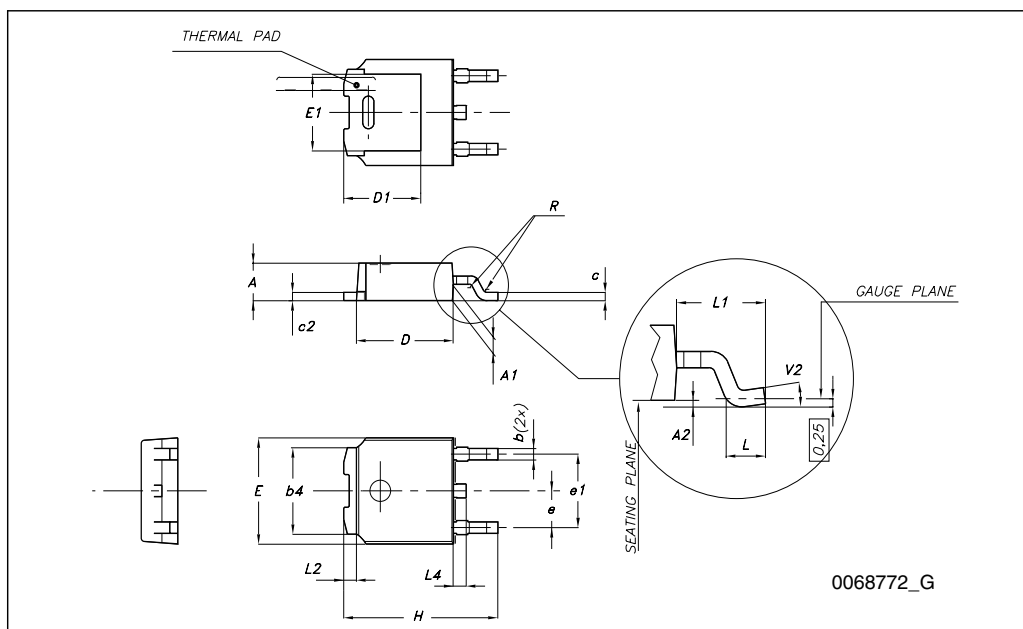
| DIM. | mm.  |                 |      |
|------|------|-----------------|------|
|      | min. | typ             | max. |
| A    | 2.20 |                 | 2.40 |
| A1   | 0.90 |                 | 1.10 |
| b    | 0.64 |                 | 0.90 |
| b2   |      |                 | 0.95 |
| b4   | 5.20 |                 | 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 <sup>°</sup> |      |





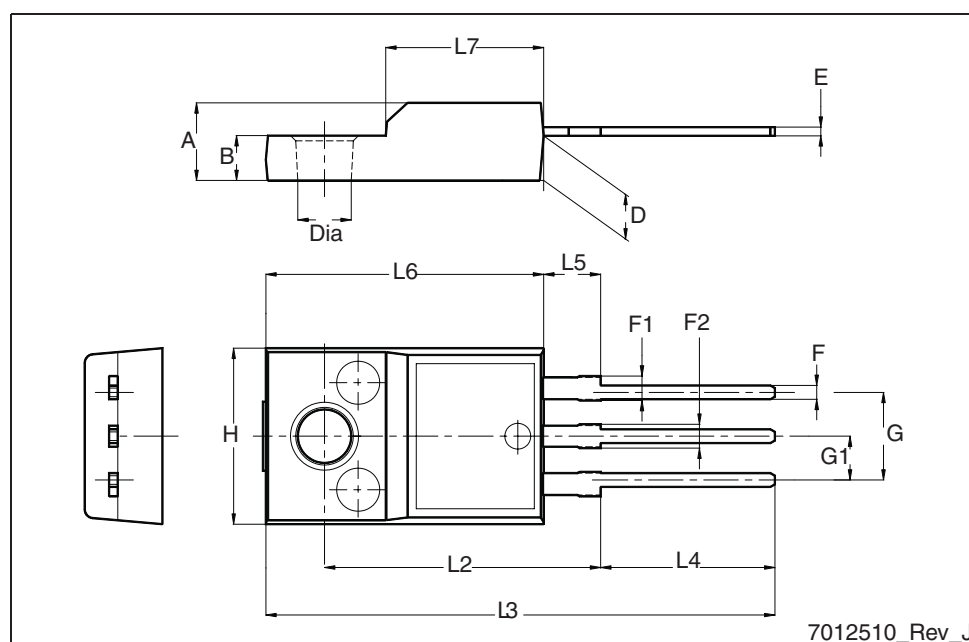
## TO-252 (DPAK) mechanical data

| 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°    |



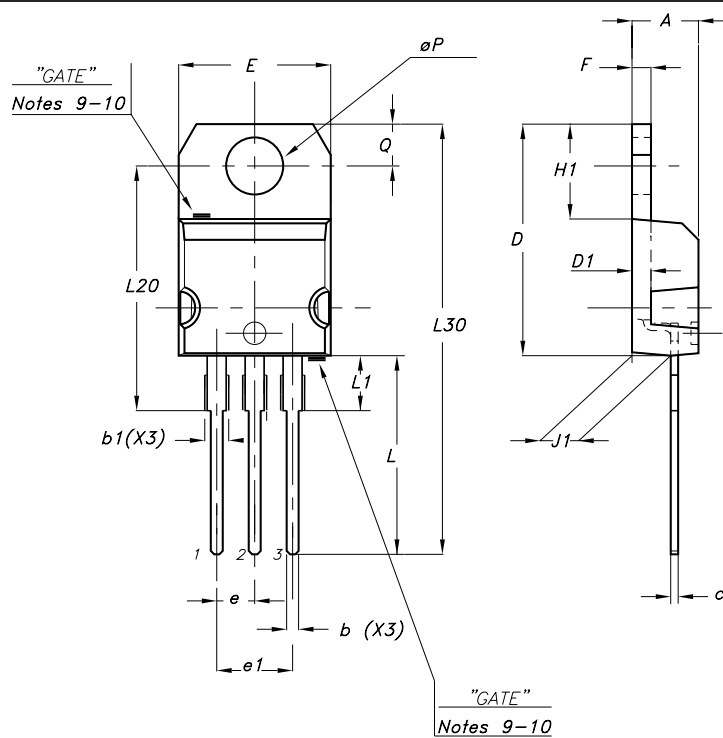
TO-220FP mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 4.4  |      | 4.6  |
| B    | 2.5  |      | 2.7  |
| D    | 2.5  |      | 2.75 |
| E    | 0.45 |      | 0.7  |
| F    | 0.75 |      | 1    |
| F1   | 1.15 |      | 1.70 |
| F2   | 1.15 |      | 1.5  |
| G    | 4.95 |      | 5.2  |
| G1   | 2.4  |      | 2.7  |
| H    | 10   |      | 10.4 |
| L2   |      | 16   |      |
| L3   | 28.6 |      | 30.6 |
| L4   | 9.8  |      | 10.6 |
| L5   | 2.9  |      | 3.6  |
| L6   | 15.9 |      | 16.4 |
| L7   | 9    |      | 9.3  |
| Dia  | 3    |      | 3.2  |



## TO-220 mechanical data

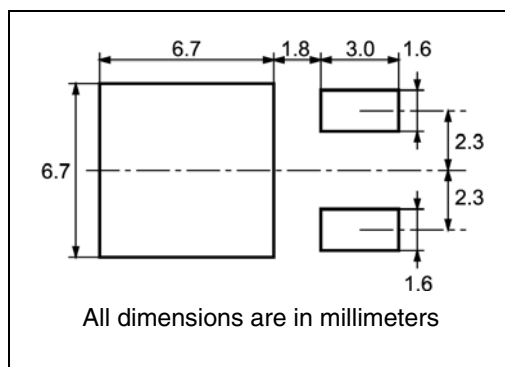
| Dim | mm    |       |       | inch  |       |       |
|-----|-------|-------|-------|-------|-------|-------|
|     | Min   | Typ   | Max   | Min   | Typ   | Max   |
| A   | 4.40  |       | 4.60  | 0.173 |       | 0.181 |
| b   | 0.61  |       | 0.88  | 0.024 |       | 0.034 |
| b1  | 1.14  |       | 1.70  | 0.044 |       | 0.066 |
| c   | 0.48  |       | 0.70  | 0.019 |       | 0.027 |
| D   | 15.25 |       | 15.75 | 0.6   |       | 0.62  |
| D1  |       | 1.27  |       |       | 0.050 |       |
| 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 |       | 0.051 |
| 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 |



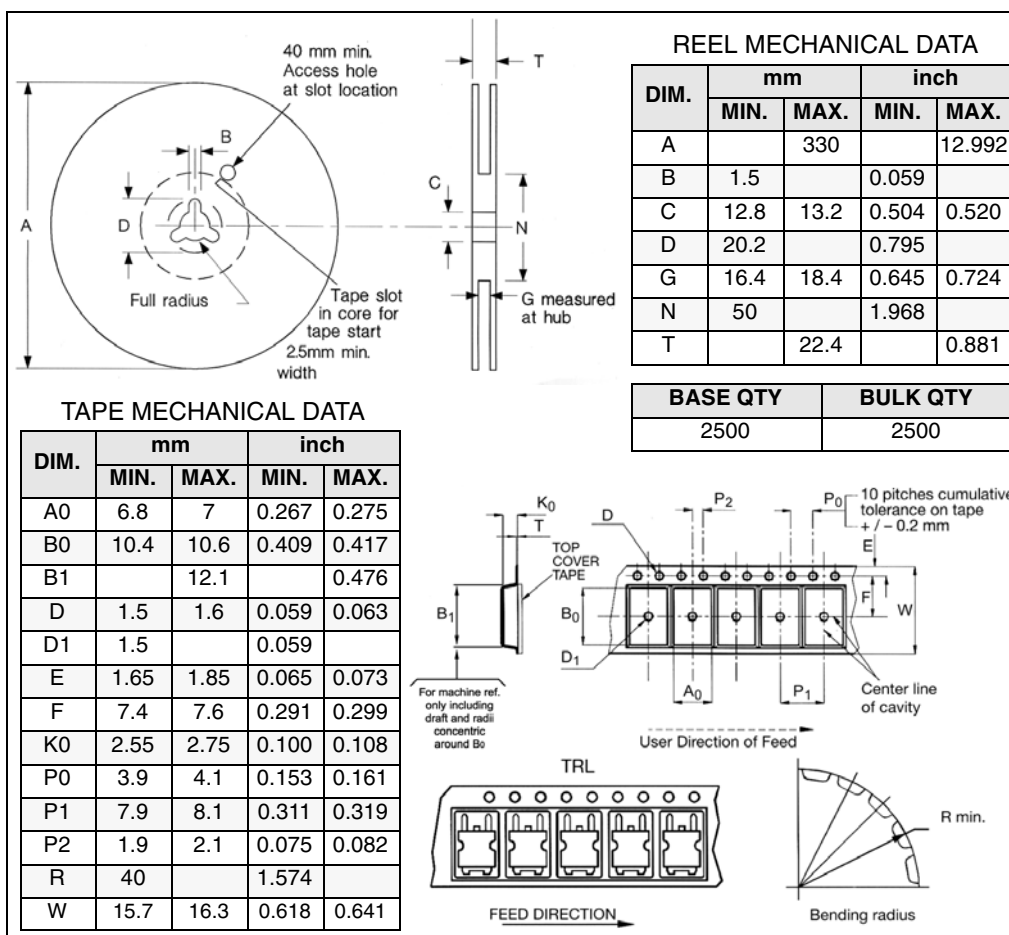
0015988\_Rev\_R

## 5 Packaging mechanical data

### DPAK FOOTPRINT



### TAPE AND REEL SHIPMENT



## 6 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                      |
|-------------|----------|----------------------------------------------|
| 24-Feb-2009 | 1        | First release                                |
| 27-Feb-2009 | 2        | Corrected package information on first page. |

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2009 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

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