



# STx42N65M5

N-channel 650 V, 0.070  $\Omega$ , 33 A MDmesh™ V Power MOSFET  
in I<sup>2</sup>PAK, TO-220, TO-220FP, D<sup>2</sup>PAK and TO-247

## Features

| Type       | V <sub>DSS</sub> @<br>T <sub>Jmax</sub> | R <sub>DS(on)</sub><br>max | I <sub>D</sub>      |
|------------|-----------------------------------------|----------------------------|---------------------|
| STB42N65M5 | 710 V                                   | < 0.079 $\Omega$           | 33 A                |
| STF42N65M5 | 710 V                                   | < 0.079 $\Omega$           | 33 A <sup>(1)</sup> |
| STI42N65M5 | 710 V                                   | < 0.079 $\Omega$           | 33 A                |
| STP42N65M5 | 710 V                                   | < 0.079 $\Omega$           | 33 A                |
| STW42N65M5 | 710 V                                   | < 0.079 $\Omega$           | 33 A                |

1. Limited only by maximum temperature allowed

- TO-220 worldwide best R<sub>DS(on)</sub>
- Higher V<sub>DSS</sub> rating
- High dv/dt capability
- Excellent switching performance
- Easy to drive
- 100% avalanche tested

## Application

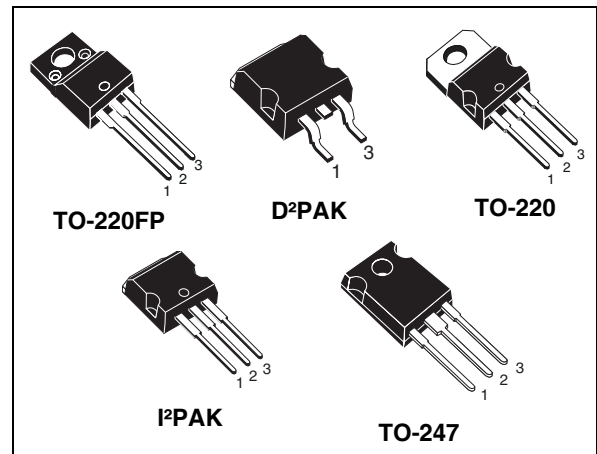
- Switching applications

## Description

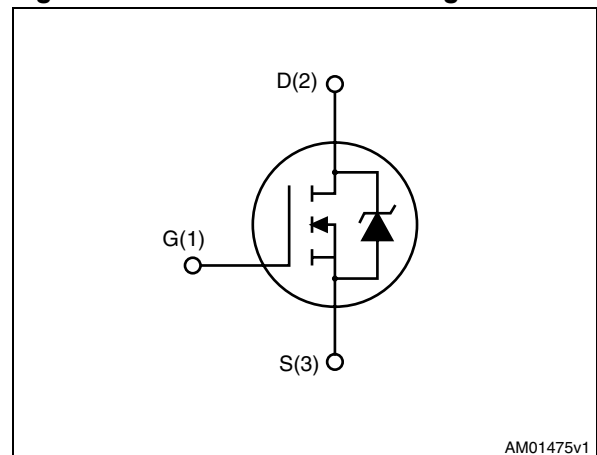
MDmesh™ V is a revolutionary Power MOSFET technology based on an innovative proprietary vertical process, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs,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

**Table 1. Device summary**

| Order codes | Marking | Package            | Packaging     |
|-------------|---------|--------------------|---------------|
| STB42N65M5  | 42N65M5 | D <sup>2</sup> PAK | Tape and reel |
| STF42N65M5  | 42N65M5 | TO-220FP           | Tube          |
| STI42N65M5  | 42N65M5 | I <sup>2</sup> PAK | Tube          |
| STP42N65M5  | 42N65M5 | TO-220             | Tube          |
| STW42N65M5  | 42N65M5 | TO-247             | Tube          |



**Figure 1. Internal schematic diagram**



AM01475v1

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol                         | Parameter                                                                                                                | Value                                                    |                     | Unit |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------|------|
|                                |                                                                                                                          | TO-220, TO-247<br>D <sup>2</sup> PAK, I <sup>2</sup> PAK | TO-220FP            |      |
| V <sub>GS</sub>                | Gate- source voltage                                                                                                     | ± 25                                                     |                     | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                                     | 33                                                       | 33 <sup>(1)</sup>   | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                                    | 20.8                                                     | 20.8 <sup>(1)</sup> | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                                   | 132                                                      | 132 <sup>(1)</sup>  | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                              | 190                                                      | 40                  | W    |
| I <sub>AR</sub>                | Max current during repetitive or single pulse avalanche (pulse width limited by T <sub>JMAX</sub> )                      | 11                                                       |                     | A    |
| E <sub>AS</sub>                | Single pulse avalanche energy (starting T <sub>J</sub> = 25°C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50V) | 950                                                      |                     | mJ   |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope                                                                                        | 15                                                       |                     | V/ns |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T <sub>C</sub> = 25 °C)          | --                                                       | 2500                | V    |
| T <sub>stg</sub>               | Storage temperature                                                                                                      | -55 to 150                                               |                     | °C   |
| T <sub>j</sub>                 | Max. operating junction temperature                                                                                      | 150                                                      |                     | °C   |

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I<sub>SD</sub> ≤ 33 A, di/dt ≤ 400 A/μs, V<sub>Peak</sub> < V<sub>(BR)DSS</sub>

**Table 3. Thermal data**

| Symbol                | Parameter                                      | Value              |                    |        |        |          | Unit |
|-----------------------|------------------------------------------------|--------------------|--------------------|--------|--------|----------|------|
|                       |                                                | D <sup>2</sup> PAK | I <sup>2</sup> PAK | TO-220 | TO-247 | TO-220FP |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case max           | 0.66               |                    |        |        | 3.1      | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max        | --                 | 62.5               |        | 50     | 62.5     | °C/W |
| R <sub>thj-pcb</sub>  | Thermal resistance junction-pcb max            | 30                 | --                 | --     | --     | --       | °C/W |
| T <sub>I</sub>        | Maximum lead temperature for soldering purpose | 300                |                    |        |        |          | °C   |

## 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 ( $V_{DS} = 0$ )       | $V_{GS} = \pm 25\text{ V}$                                                                         |      |       | 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                | $V_{GS} = 10\text{ V}$ , $I_D = 16.5\text{ A}$                                                     |      | 0.070 | 0.079    | $\Omega$                       |

**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>$V_{GS} = 0$                                                  | -    | 4650<br>110<br>3.2 | -    | pF<br>pF<br>pF |
| $C_{o(er)}^{(1)}$                   | Equivalent output capacitance energy related                            | $V_{GS} = 0$ , $V_{DS} = 0$ to 80%<br>$V_{(BR)DSS}$                                                             | -    | 100                | -    | pF             |
| $C_{o(tr)}^{(2)}$                   | Equivalent output capacitance time related                              | $V_{GS} = 0$ , $V_{DS} = 0$ to 80%<br>$V_{(BR)DSS}$                                                             | -    | 285                | -    | pF             |
| $R_G$                               | Intrinsic gate resistance                                               | $f = 1\text{ MHz}$ open drain                                                                                   | -    | 1.1                | -    | $\Omega$       |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$       | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 520\text{ V}$ , $I_D = 16.5\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 20</a> ) | -    | 100<br>26<br>38    | -    | nC<br>nC<br>nC |

1.  $C_{o(er)}$  is a constant capacitance value that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$
2.  $C_{o(tr)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising 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  | $V_{DD} = 400\text{ V}$ , $I_D = 20\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 19</a> ) | -    | 61   | -   | ns   |
| $t_r$        | Rise time           |                                                                                                                                     |      | 24   |     | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                     |      | 65   |     | ns   |
| $t_f$        | Fall time           |                                                                                                                                     |      | 13   |     | ns   |

**Table 7. Source drain diode**

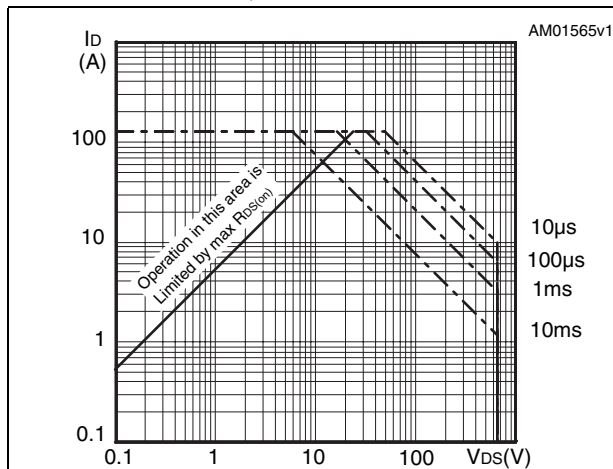
| Symbol          | Parameter                     | Test conditions                                                                                                                                                | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                | -    |      | 33   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                |      |      | 132  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 33\text{ A}$ , $V_{GS} = 0$                                                                                                                          | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 33\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ (see <a href="#">Figure 24</a> )                                        | -    | 400  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                |      | 7    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                |      | 35   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 33\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 24</a> ) | -    | 532  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                |      | 10   |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                |      | 38   |      | A             |

1. Pulse width limited by safe operating area

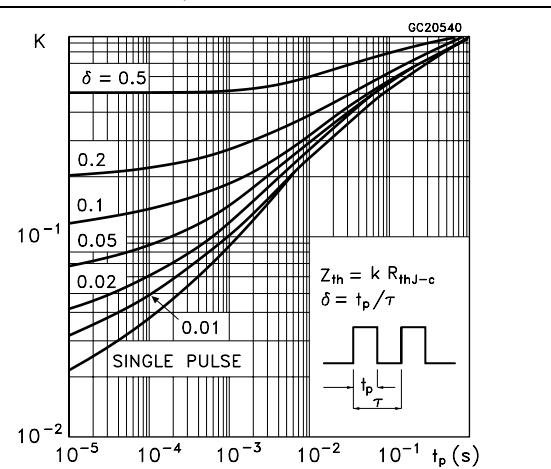
2. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

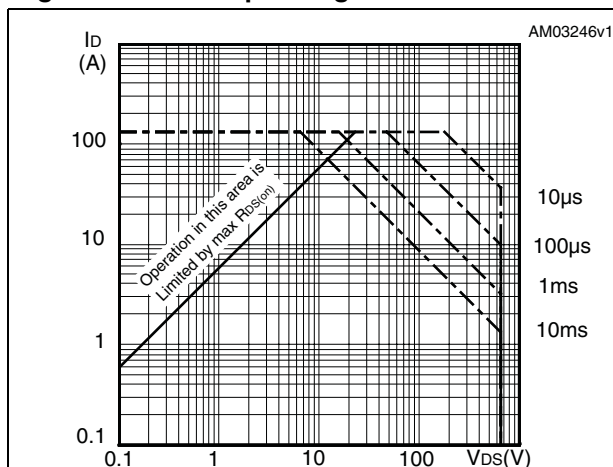
**Figure 2. Safe operating area for TO-220, D<sup>2</sup>PAK, I<sup>2</sup>PAK**



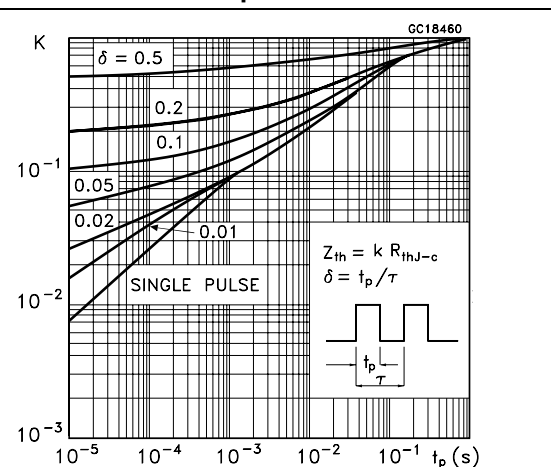
**Figure 3. Thermal impedance for TO-220, D<sup>2</sup>PAK, I<sup>2</sup>PAK**



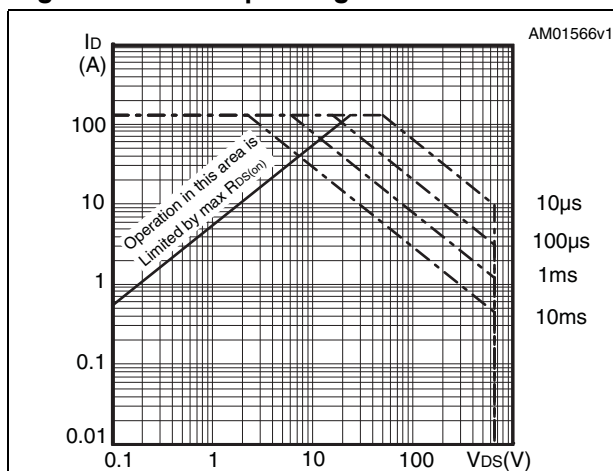
**Figure 4. Safe operating area for TO-247**



**Figure 5. Thermal impedance for TO-247**



**Figure 6. Safe operating area for TO-220FP**



**Figure 7. Thermal impedance for TO-220FP**

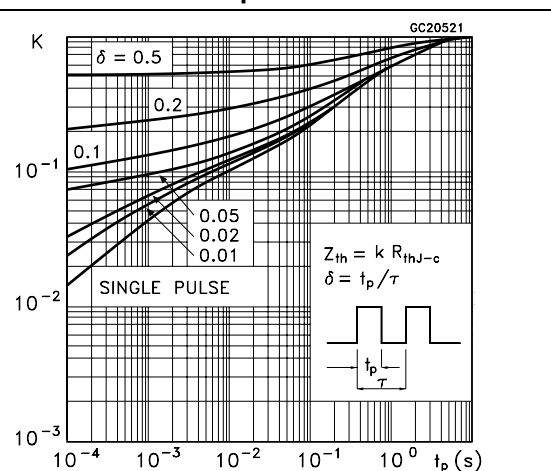


Figure 8. Output characteristics

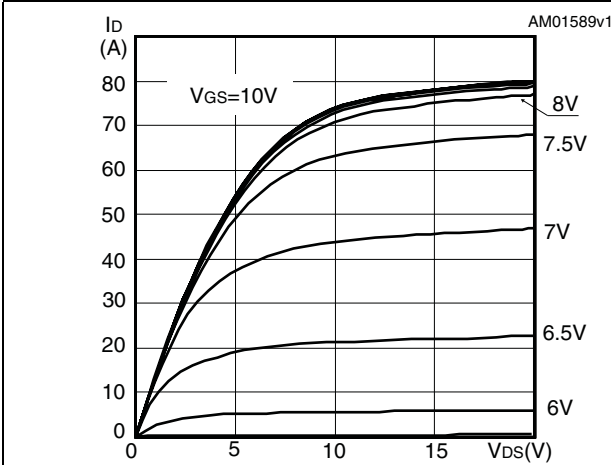


Figure 9. Transfer characteristics

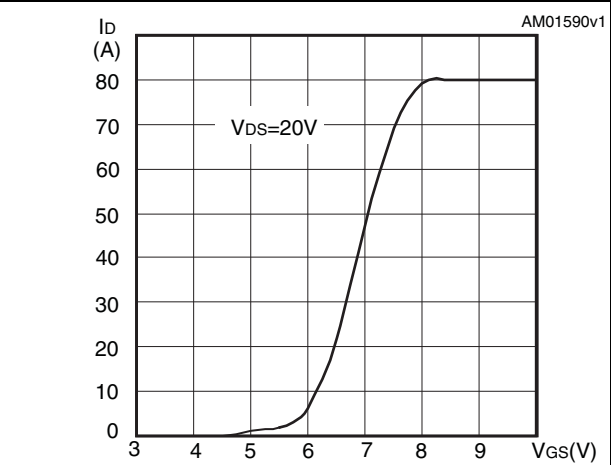


Figure 10. Gate charge vs gate-source voltage

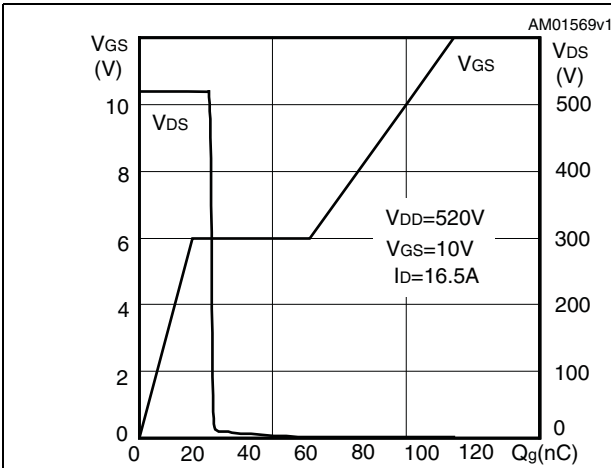


Figure 11. Static drain-source on resistance

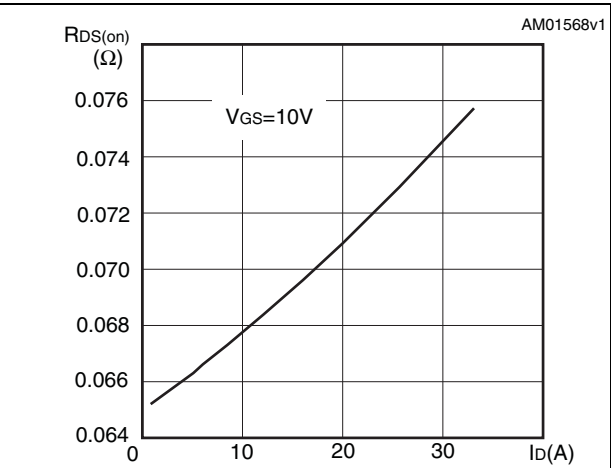


Figure 12. Capacitance variations

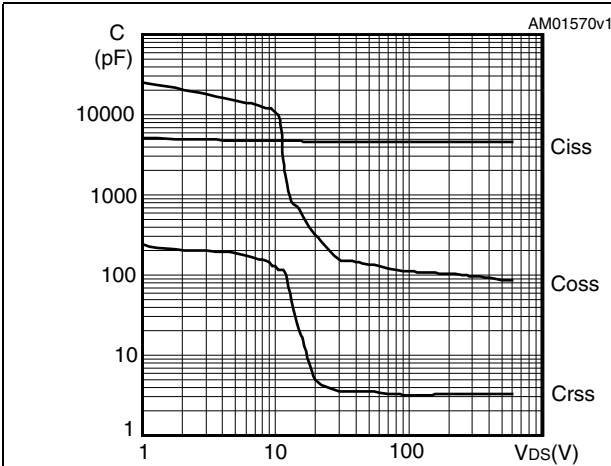


Figure 13. Output capacitance stored energy

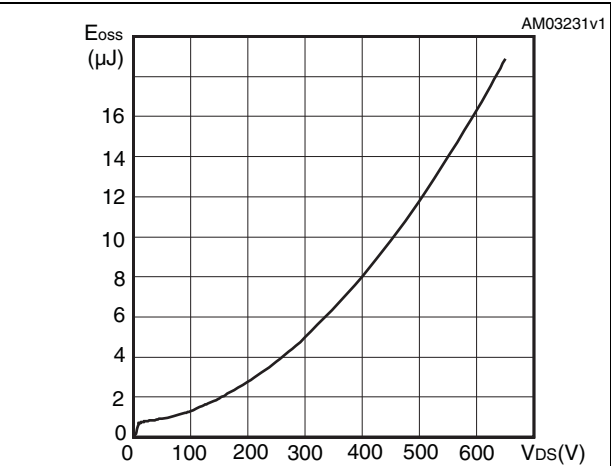


Figure 14. Normalized gate threshold voltage vs temperature

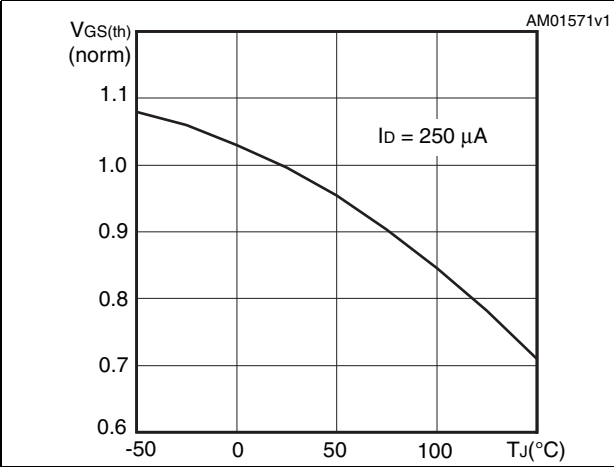


Figure 15. Normalized on resistance vs temperature

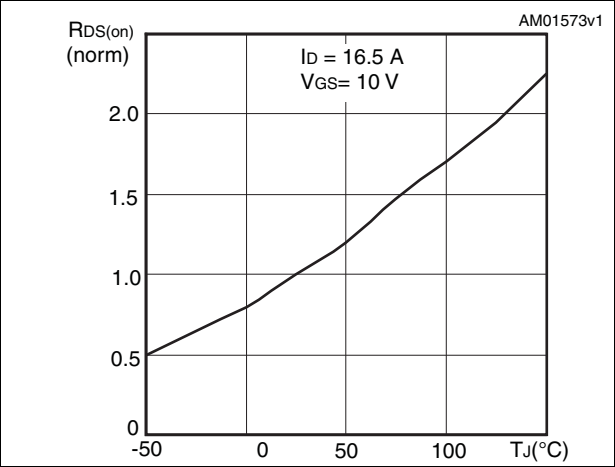


Figure 16. Source-drain diode forward characteristics

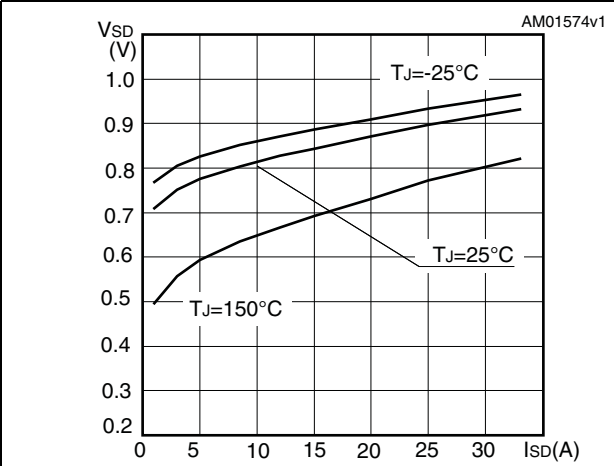


Figure 17. Normalized  $B_{VDSS}$  vs temperature

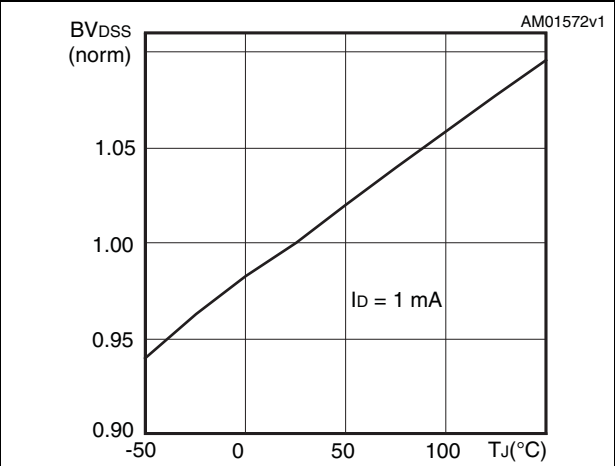
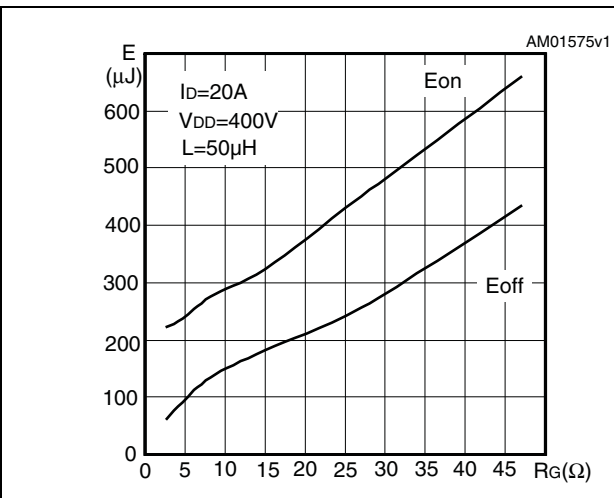


Figure 18. Switching losses vs gate resistance (1)

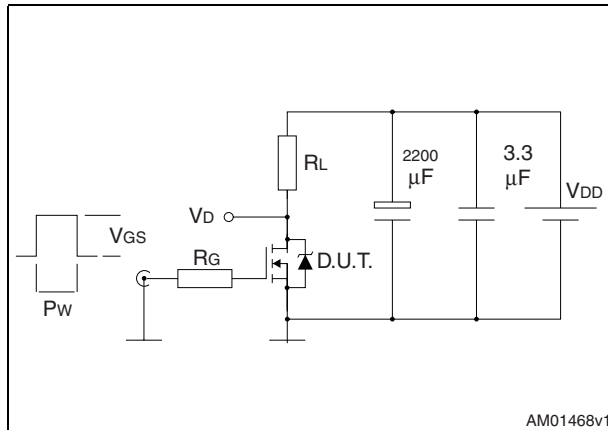


1.  $E_{on}$  including reverse recovery of a SiC diode

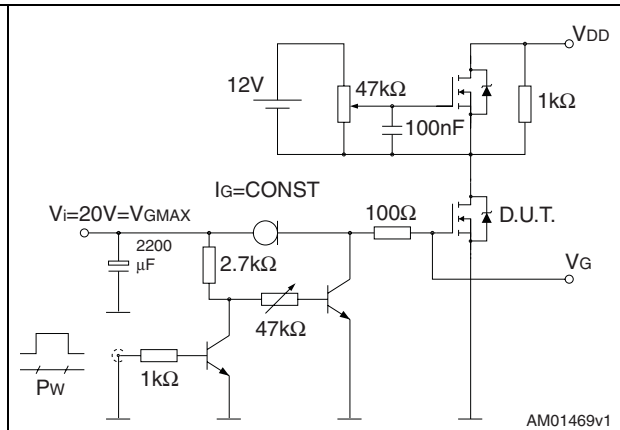


### 3 Test circuits

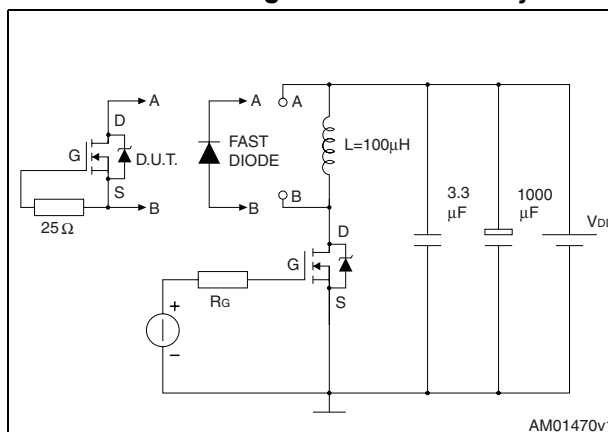
**Figure 19. Switching times test circuit for resistive load**



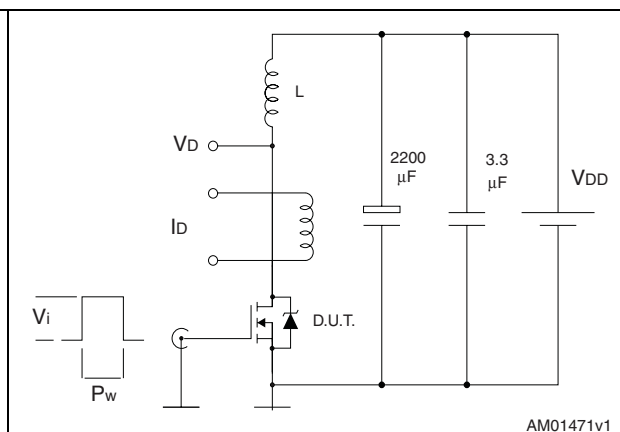
**Figure 20. Gate charge test circuit**



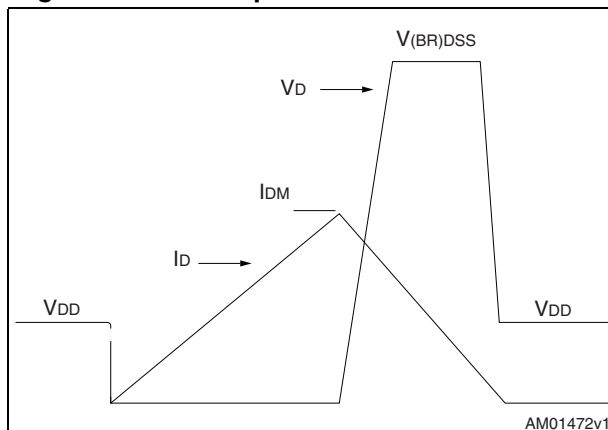
**Figure 21. Test circuit for inductive load switching and diode recovery times**



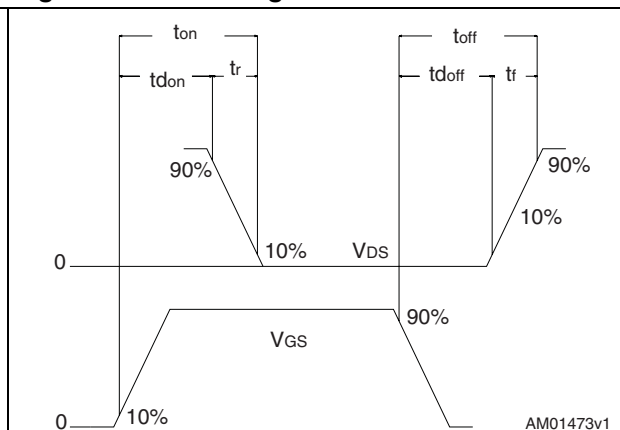
**Figure 22. Unclamped inductive load test circuit**



**Figure 23. Unclamped inductive waveform**



**Figure 24. Switching time waveform**

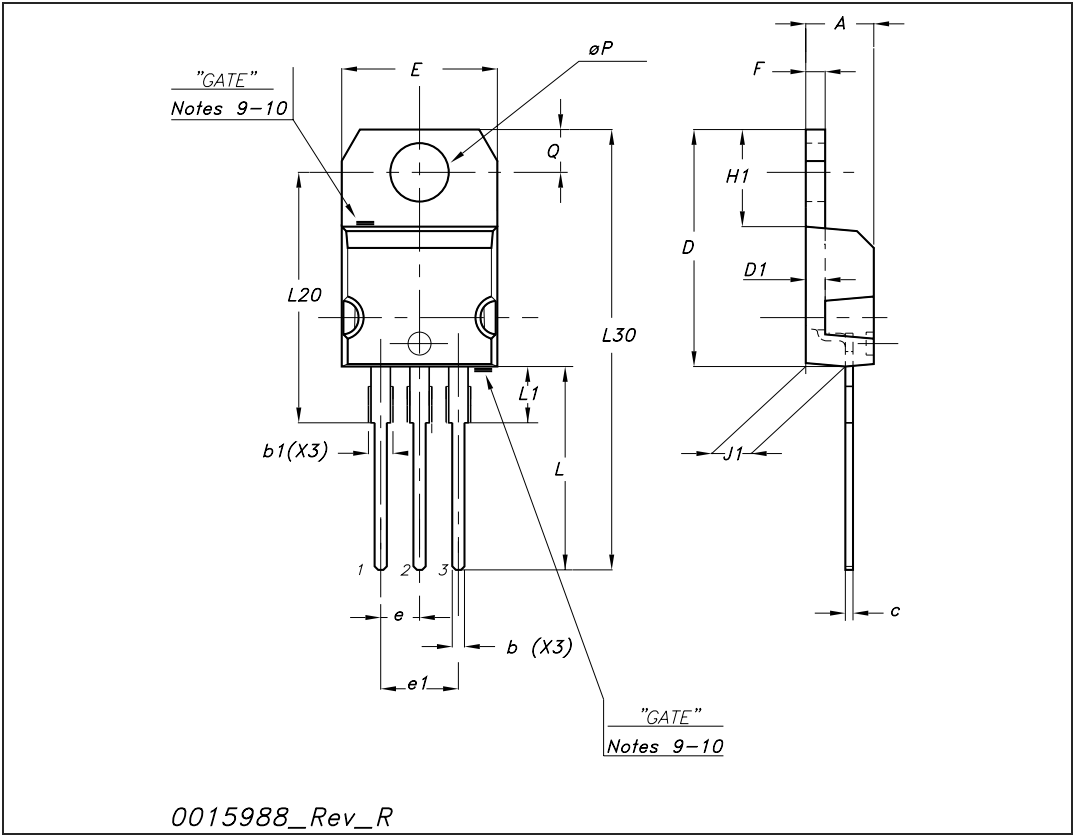


## 4 Package mechanical data

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.

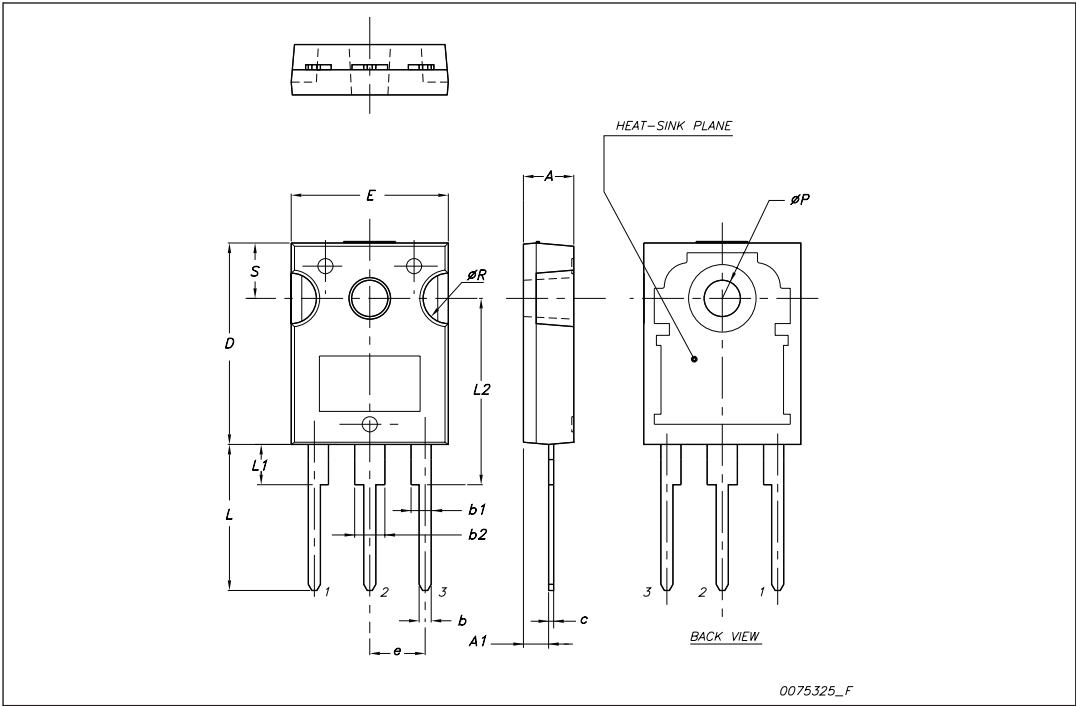
TO-220 mechanical data

| 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 |



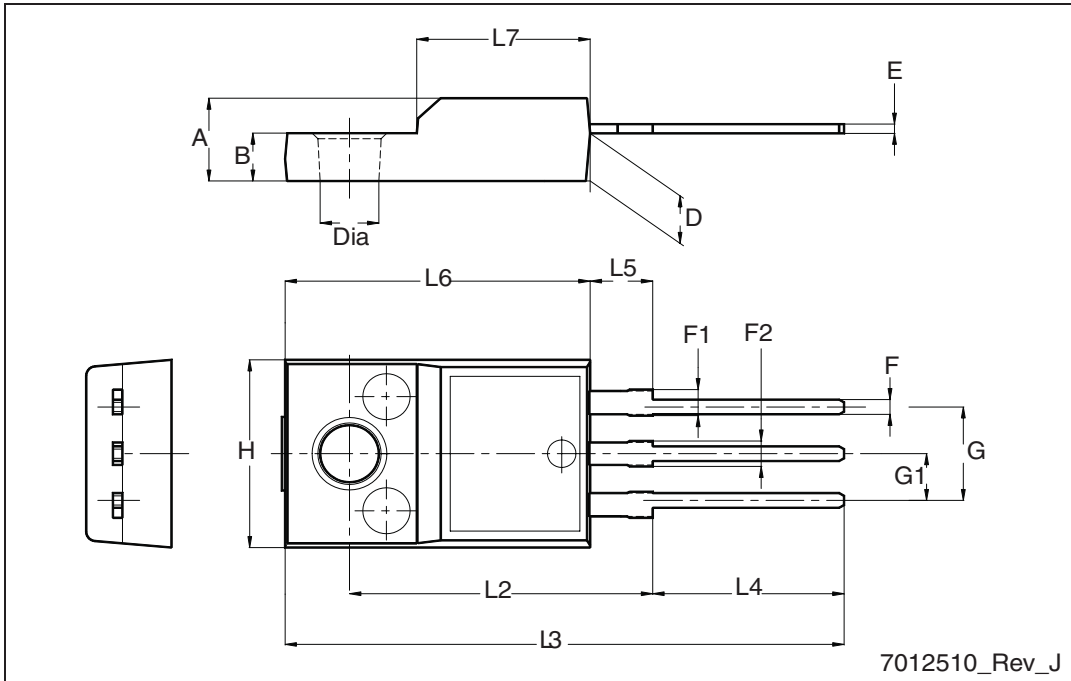
TO-247 mechanical data

| Dim. | mm.   |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.85  |       | 5.15  |
| A1   | 2.20  |       | 2.60  |
| b    | 1.0   |       | 1.40  |
| b1   | 2.0   |       | 2.40  |
| b2   | 3.0   |       | 3.40  |
| c    | 0.40  |       | 0.80  |
| D    | 19.85 |       | 20.15 |
| E    | 15.45 |       | 15.75 |
| e    |       | 5.45  |       |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| øP   | 3.55  |       | 3.65  |
| øR   | 4.50  |       | 5.50  |
| S    |       | 5.50  |       |



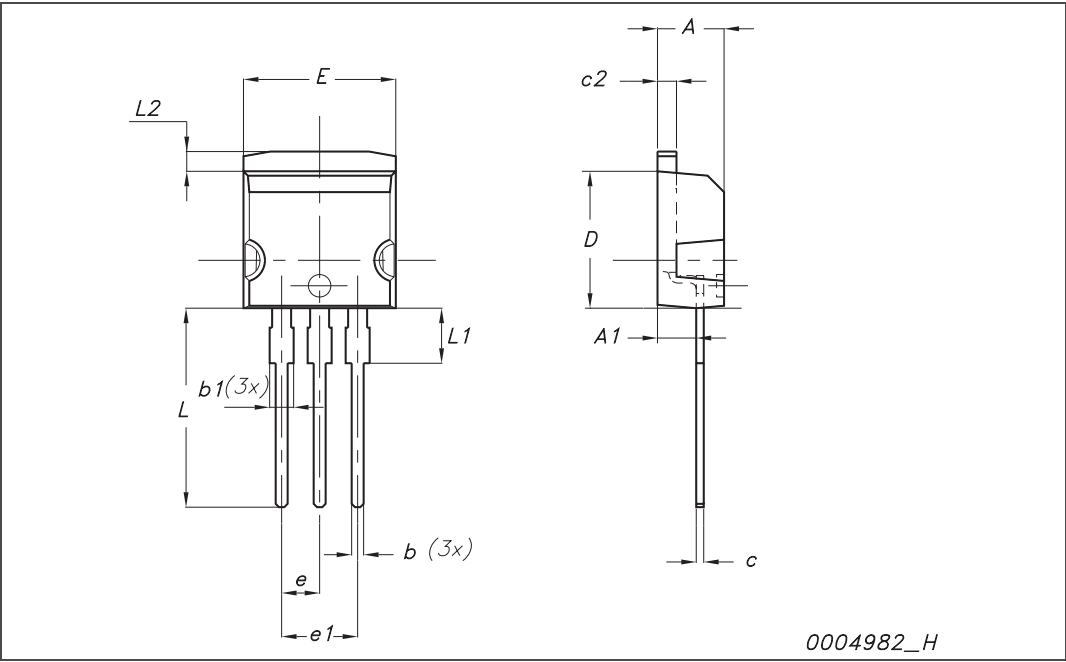
TO-220FP mechanical data

| 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  |



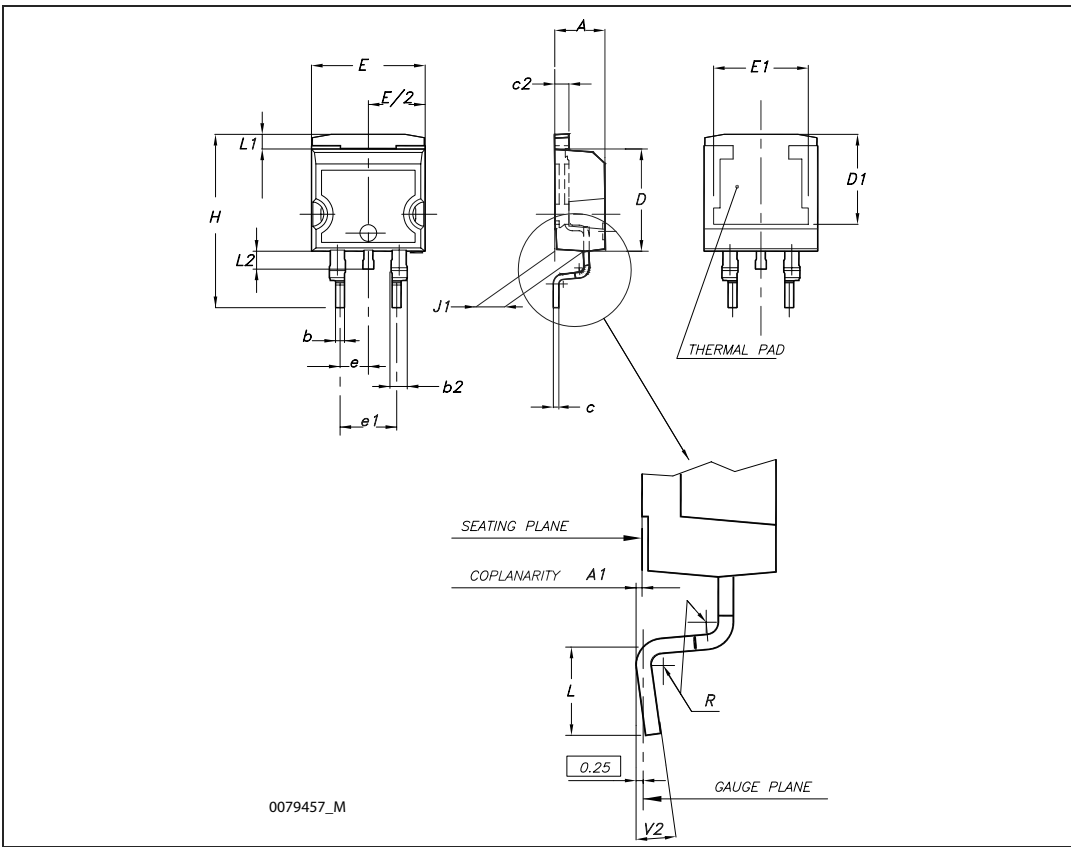
I<sup>2</sup>PAK (TO-262) mechanical data

| Dim | mm   |     |       | inch  |     |       |
|-----|------|-----|-------|-------|-----|-------|
|     | Min  | Typ | Max   | Min   | Typ | Max   |
| A   | 4.40 |     | 4.60  | 0.173 |     | 0.181 |
| A1  | 2.40 |     | 2.72  | 0.094 |     | 0.107 |
| b   | 0.61 |     | 0.88  | 0.024 |     | 0.034 |
| b1  | 1.14 |     | 1.70  | 0.044 |     | 0.066 |
| c   | 0.49 |     | 0.70  | 0.019 |     | 0.027 |
| c2  | 1.23 |     | 1.32  | 0.048 |     | 0.052 |
| D   | 8.95 |     | 9.35  | 0.352 |     | 0.368 |
| e   | 2.40 |     | 2.70  | 0.094 |     | 0.106 |
| e1  | 4.95 |     | 5.15  | 0.194 |     | 0.202 |
| E   | 10   |     | 10.40 | 0.393 |     | 0.410 |
| L   | 13   |     | 14    | 0.511 |     | 0.551 |
| L1  | 3.50 |     | 3.93  | 0.137 |     | 0.154 |
| L2  | 1.27 |     | 1.40  | 0.050 |     | 0.055 |



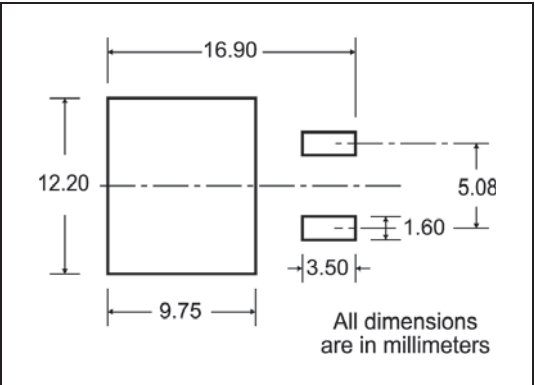
D<sup>2</sup>PAK (TO-263) mechanical data

| Dim | mm   |      |       | inch  |       |       |
|-----|------|------|-------|-------|-------|-------|
|     | Min  | Typ  | Max   | Min   | Typ   | Max   |
| A   | 4.40 |      | 4.60  | 0.173 |       | 0.181 |
| A1  | 0.03 |      | 0.23  | 0.001 |       | 0.009 |
| b   | 0.70 |      | 0.93  | 0.027 |       | 0.037 |
| b2  | 1.14 |      | 1.70  | 0.045 |       | 0.067 |
| c   | 0.45 |      | 0.60  | 0.017 |       | 0.024 |
| c2  | 1.23 |      | 1.36  | 0.048 |       | 0.053 |
| D   | 8.95 |      | 9.35  | 0.352 |       | 0.368 |
| D1  | 7.50 |      |       | 0.295 |       |       |
| E   | 10   |      | 10.40 | 0.394 |       | 0.409 |
| E1  | 8.50 |      |       | 0.334 |       |       |
| e   |      | 2.54 |       |       | 0.1   |       |
| e1  | 4.88 |      | 5.28  | 0.192 |       | 0.208 |
| H   | 15   |      | 15.85 | 0.590 |       | 0.624 |
| J1  | 2.49 |      | 2.69  | 0.099 |       | 0.106 |
| L   | 2.29 |      | 2.79  | 0.090 |       | 0.110 |
| L1  | 1.27 |      | 1.40  | 0.05  |       | 0.055 |
| L2  | 1.30 |      | 1.75  | 0.051 |       | 0.069 |
| R   |      | 0.4  |       |       | 0.016 |       |
| V2  | 0°   |      | 8°    | 0°    |       | 8°    |

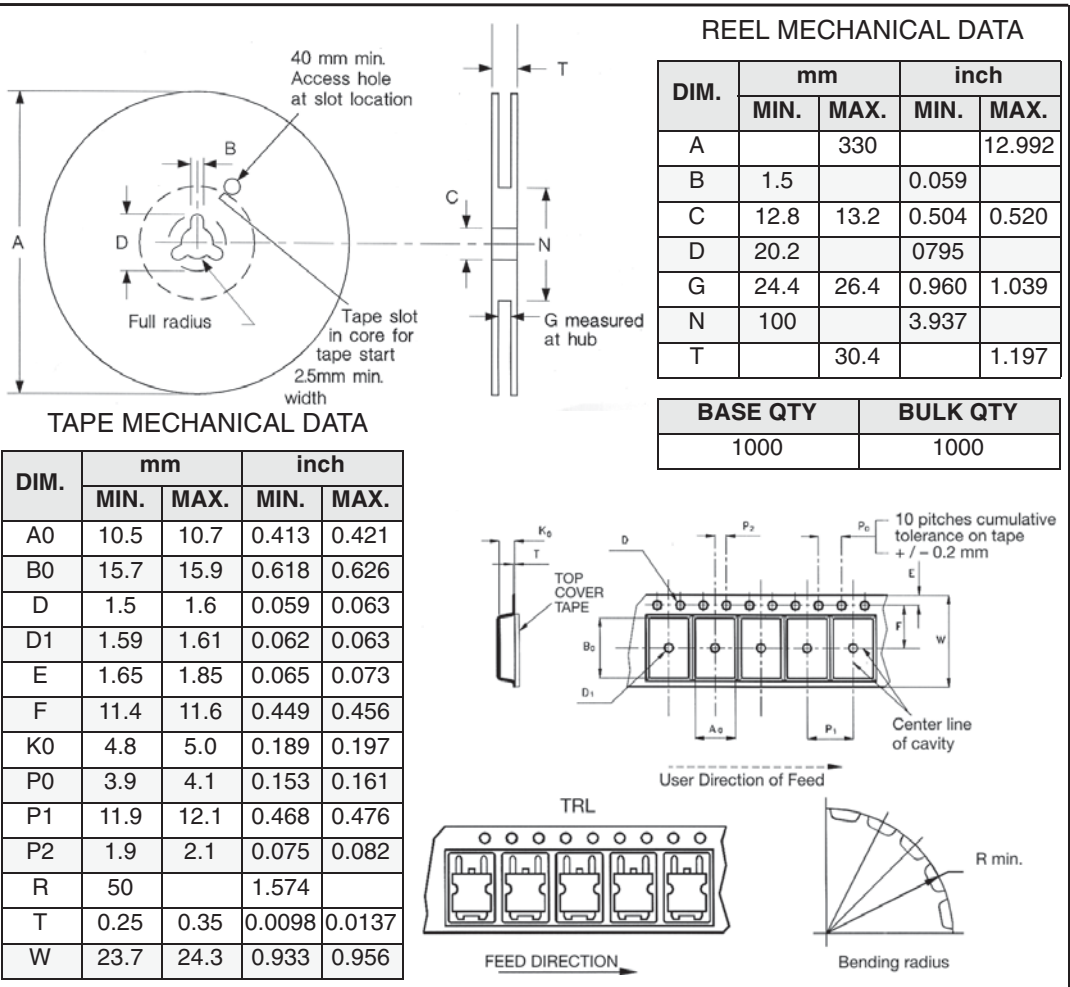


# 5 Packaging mechanical data

D<sup>2</sup>PAK FOOTPRINT



TAPE AND REEL SHIPMENT





## 6 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                                                                            |
|-------------|----------|----------------------------------------------------------------------------------------------------|
| 16-Jan-2009 | 1        | First release                                                                                      |
| 15-May-2009 | 2        | Updated figures <a href="#">9</a> , <a href="#">10</a> , <a href="#">11</a> and <a href="#">17</a> |
| 12-Jun-2009 | 3        | <a href="#">Figure 15</a> has been updated                                                         |

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