

N-channel 800 V, 1.3  $\Omega$  typ., 4.5 A MDmesh™ K5  
Power MOSFETs in D<sup>2</sup>PAK, DPAK, I<sup>2</sup>PAK and TO-220 packages

Datasheet - production data

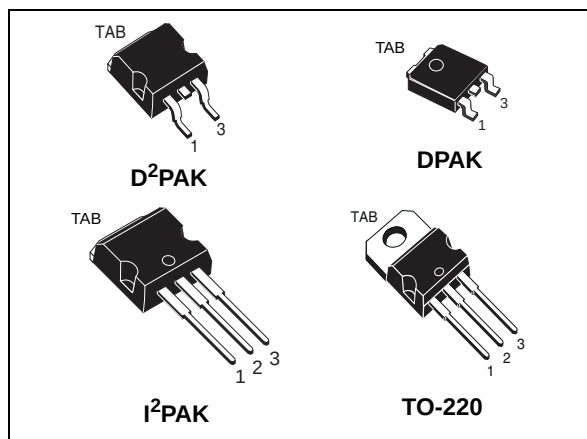
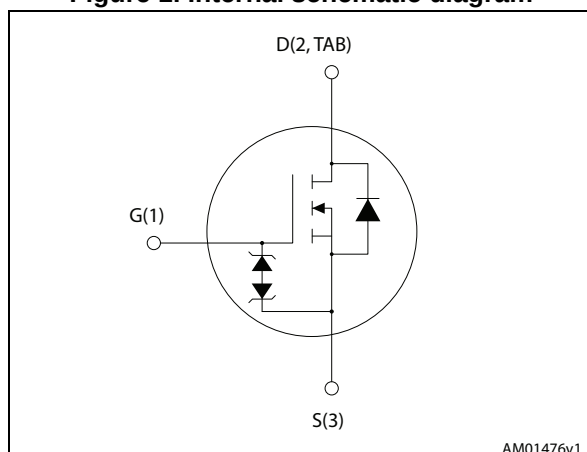


Figure 1. Internal schematic diagram



## Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub> max | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|-----------------|-------------------------|----------------|------------------|
| STB6N80K5   | 800 V           | 1.6 $\Omega$            | 4.5 A          | 85 W             |
| STD6N80K5   |                 |                         |                |                  |
| STI6N80K5   |                 |                         |                |                  |
| STP6N80K5   |                 |                         |                |                  |

- Industry's lowest R<sub>DS(on)</sub>
- Industry's best figure of merit (FoM)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications

## Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1. Device summary

| Order code | Marking | Package            | Packaging     |
|------------|---------|--------------------|---------------|
| STB6N80K5  | 6N80K5  | D <sup>2</sup> PAK | Tape and reel |
| STD6N80K5  |         | DPAK               |               |
| STI6N80K5  |         | I <sup>2</sup> PAK | Tube          |
| STP6N80K5  |         | TO-220             |               |

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# 1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol             | Parameter                                                                                                              | Value      | Unit               |
|--------------------|------------------------------------------------------------------------------------------------------------------------|------------|--------------------|
| $V_{GS}$           | Gate- source voltage                                                                                                   | 30         | V                  |
| $I_D$              | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$                                                       | 4.5        | A                  |
| $I_D$              | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$                                                      | 2.8        | A                  |
| $I_{DM}^{(1)}$     | Drain current (pulsed)                                                                                                 | 18         | A                  |
| $P_{TOT}$          | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$                                                                | 85         | W                  |
| $I_{AR}$           | Max current during repetitive or single pulse avalanche (pulse width limited by $T_{jmax}$ )                           | 1.5        | A                  |
| $E_{AS}$           | Single pulse avalanche energy (starting $T_J = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ ) | 85         | mJ                 |
| $dv/dt^{(2)}$      | Peak diode recovery voltage slope                                                                                      | 4.5        | V/ns               |
| $T_j$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature                                                                  | -55 to 150 | $^{\circ}\text{C}$ |

1. Pulse width limited by safe operating area.

2.  $I_{SD} \leq 4.5\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ , peak  $V_{DS} \leq V_{(BR)DSS}$

Table 3. Thermal data

| Symbol              | Parameter                        | Value              |      |                    |        | Unit                        |
|---------------------|----------------------------------|--------------------|------|--------------------|--------|-----------------------------|
|                     |                                  | D <sup>2</sup> PAK | DPAK | I <sup>2</sup> PAK | TO-220 |                             |
| $R_{thj-case}$      | Thermal resistance junction-case | 1.47               |      |                    |        | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$       | Thermal resistance junction-amb  |                    |      | 62.50              | 62.50  |                             |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb  | 30                 | 50   |                    |        |                             |

1. When mounted on FR-4 board of 1 inch<sup>2</sup>, 2 oz Cu

## 2 Electrical characteristics

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

**Table 4. On/off states**

| Symbol        | Parameter                                        | Test conditions                                                         | Min. | Typ. | Max.     | Unit                           |
|---------------|--------------------------------------------------|-------------------------------------------------------------------------|------|------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage ( $V_{GS} = 0$ )  | $I_D = 1\text{ mA}$                                                     | 800  |      |          | V                              |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 800\text{ V}$<br>$V_{DS} = 800\text{ V}, T_j = 125\text{ °C}$ |      |      | 1<br>50  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$                                              |      |      | $\pm 10$ | $\mu\text{A}$                  |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 100\text{ }\mu\text{A}$                         | 3    | 4    | 5        | V                              |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}, I_D = 2\text{ A}$                                |      | 1.3  | 1.6      | $\Omega$                       |

**Table 5. Dynamic**

| Symbol            | Parameter                             | Test conditions                                                       | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|-----------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{DS} = 100\text{ V}, f = 1\text{ MHz},$<br>$V_{GS} = 0$            | -    | 270  | -    | pF       |
| $C_{oss}$         | Output capacitance                    |                                                                       | -    | 25   | -    | pF       |
| $C_{rss}$         | Reverse transfer capacitance          |                                                                       | -    | 0.7  | -    | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{GS} = 0,$<br>$V_{DS} = \text{from } 0 \text{ to } 640\text{ V}$   | -    | 38   | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related |                                                                       | -    | 16   | -    | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz}, I_D = 0$                                           | -    | 7.5  | -    | $\Omega$ |
| $Q_g$             | Total gate charge                     | $V_{DD} = 640\text{ V}, I_D = 4.5\text{ A}$<br>$V_{GS} = 10\text{ V}$ | -    | 13   | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    |                                                                       | -    | 2.1  | -    | nC       |
| $Q_{gd}$          | Gate-drain charge                     |                                                                       | -    | 9.6  | -    | nC       |

1. 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. 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  | $V_{DD} = 400\text{ V}$ , $I_D = 2.25\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ | -    | 16   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                   | -    | 7.5  | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                   | -    | 28.5 | -    | ns   |
| $t_f$        | Fall time           |                                                                                                   | -    | 16   | -    | ns   |

Table 7. Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                               | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                               | -    |      | 4.5  | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                               | -    |      | 18   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 4.5\text{ A}$ , $V_{GS} = 0$                                                                                        | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 4.5\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,                                      | -    | 280  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                               | -    | 2.2  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                               | -    | 15.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 4.5\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$T_J = 150\text{ }^\circ\text{C}$ | -    | 450  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                               | -    | 3.15 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                               | -    | 14   |      | A             |

1. Pulse width limited by safe operating area

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

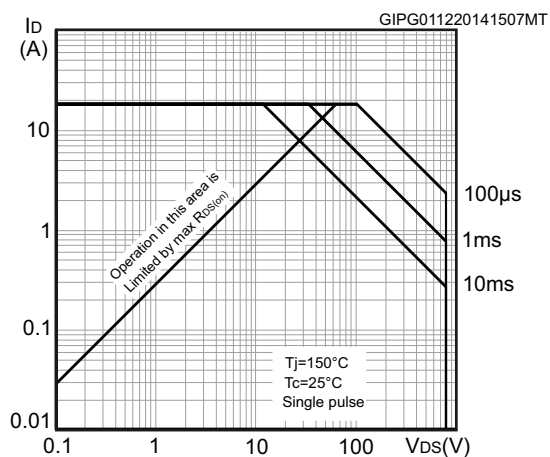
Table 8. Gate-source Zener diode

| Symbol        | Parameter                     | Test conditions                        | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|----------------------------------------|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1\text{ mA}$ , $I_D = 0$ | 30   | -    | -    | V    |

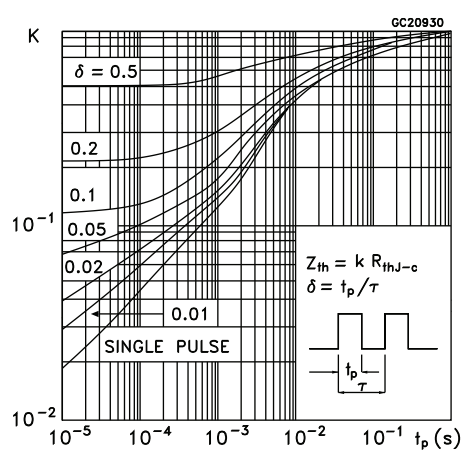
The built-in back-to-back Zener diodes have been specifically designed to enhance the ESD capability of the device. The Zener voltage is appropriate for efficient and cost-effective intervention to protect the device integrity. These integrated Zener diodes thus eliminate the need for external components.

## 2.1 Electrical characteristics (curves)

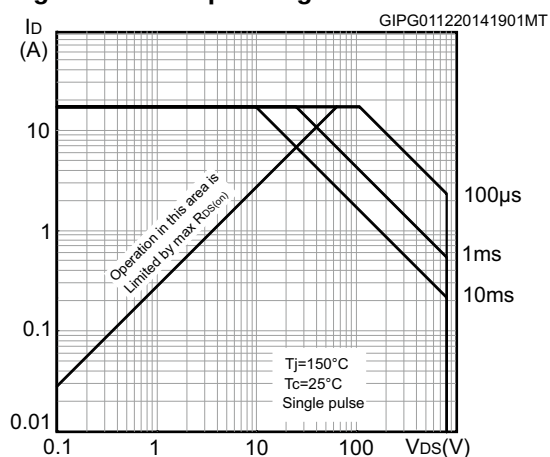
**Figure 2. Safe operating area for D<sup>2</sup>PAK, TO-220 and I<sup>2</sup>PAK**



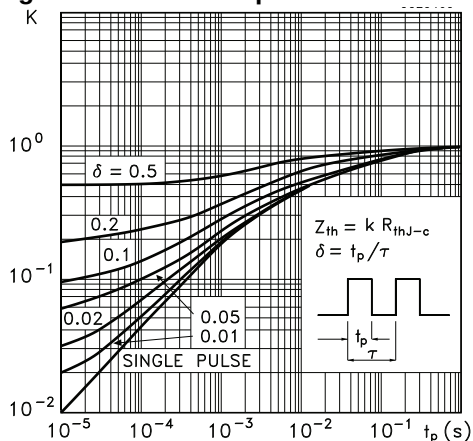
**Figure 3. Thermal impedance for D<sup>2</sup>PAK, TO-220 and I<sup>2</sup>PAK**



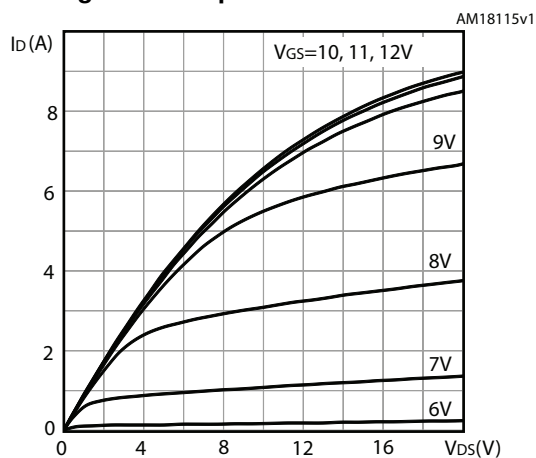
**Figure 4. Safe operating area for DPAK**



**Figure 5. Thermal impedance for DPAK**



**Figure 6. Output characteristics**



**Figure 7. Transfer characteristics**

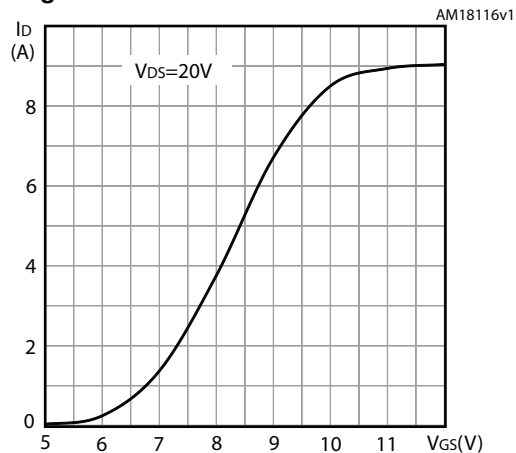


Figure 8. Gate charge vs gate-source voltage

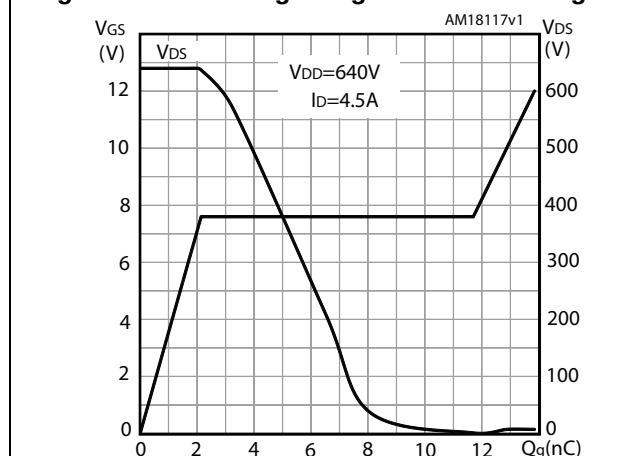


Figure 9. Static drain-source on-resistance

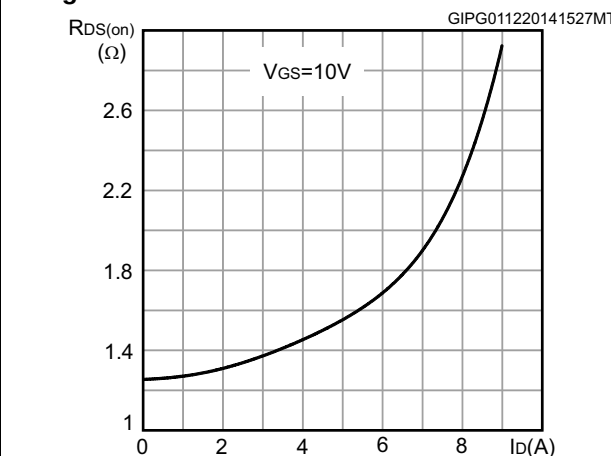


Figure 10. Capacitance variations

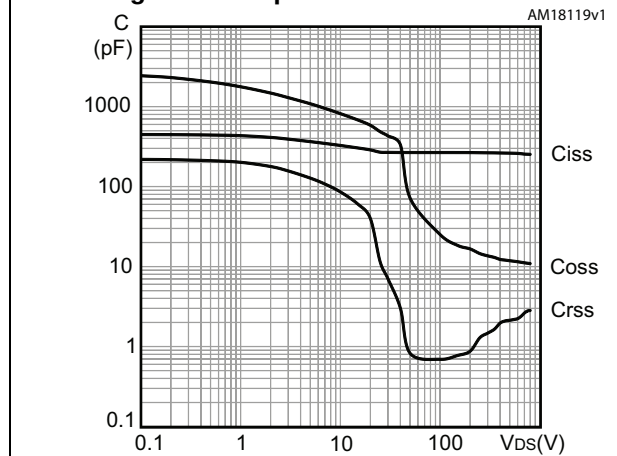


Figure 11. Output capacitance stored energy

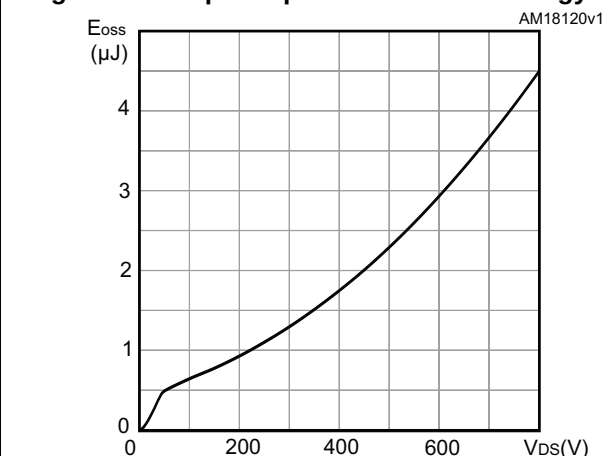


Figure 12. Normalized gate threshold voltage vs temperature

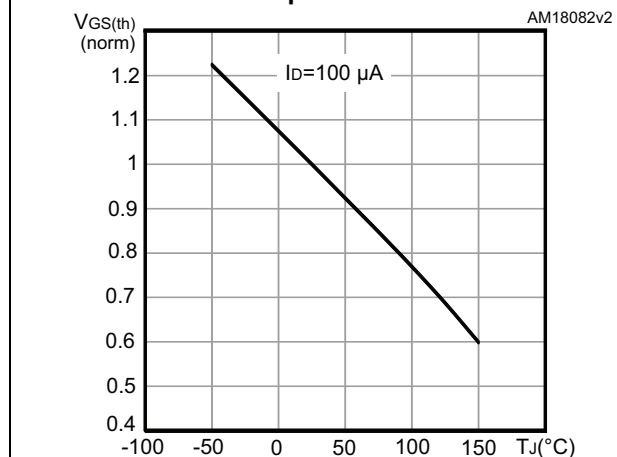


Figure 13. Normalized on-resistance vs temperature

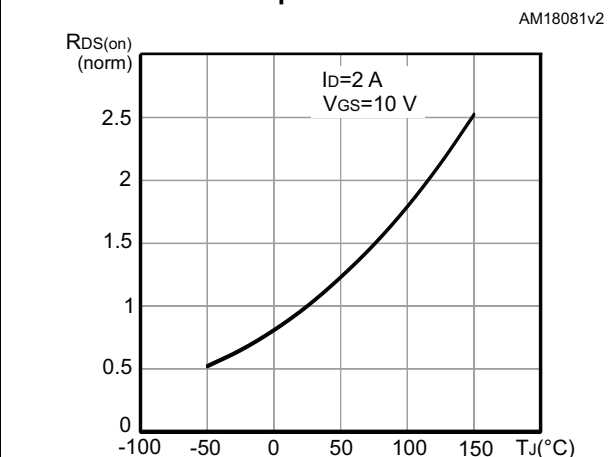


Figure 14. Normalized  $V_{(BR)DSS}$  vs temperature

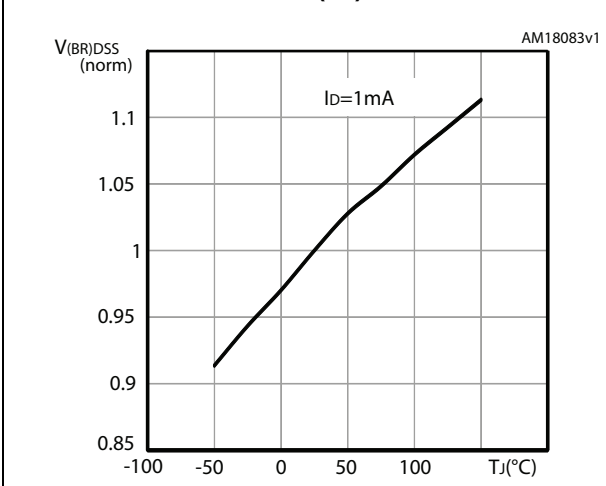
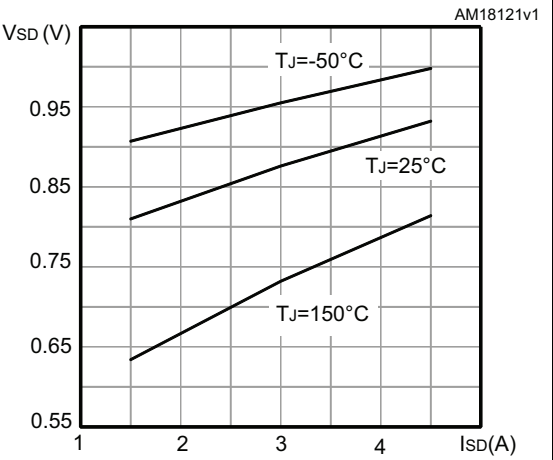


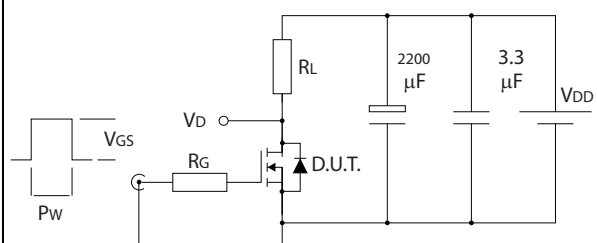
Figure 15. Source-drain diode forward characteristics





### 3 Test circuits

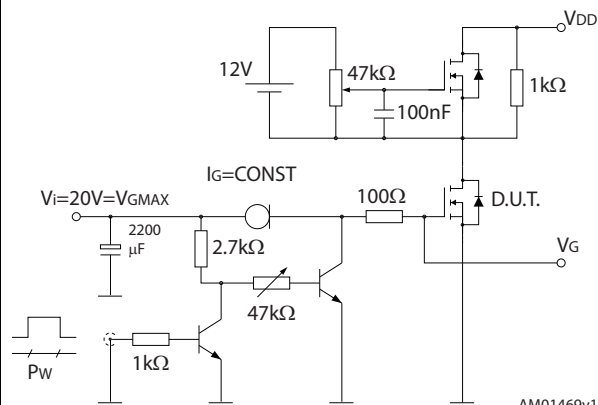
Figure 16. Switching times test circuit for



resistive load

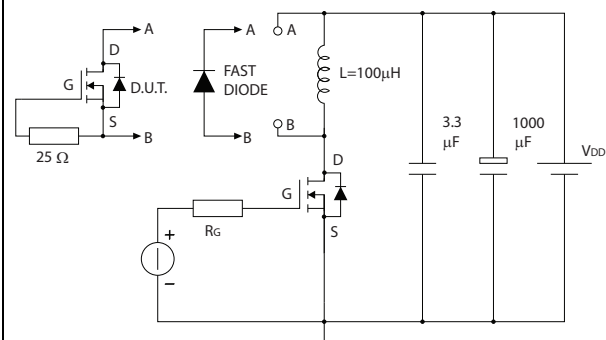
AM01468v1

Figure 17. Gate charge test circuit



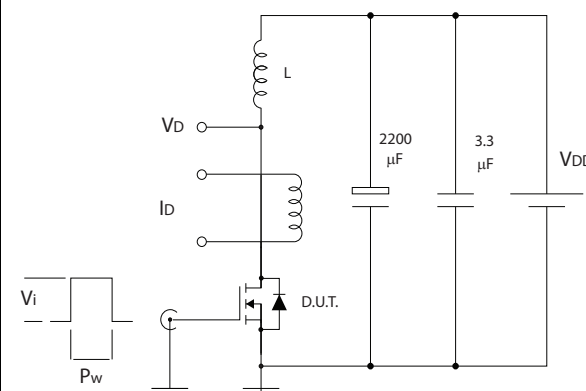
AM01469v1

Figure 18. Test circuit for inductive load switching and diode recovery times



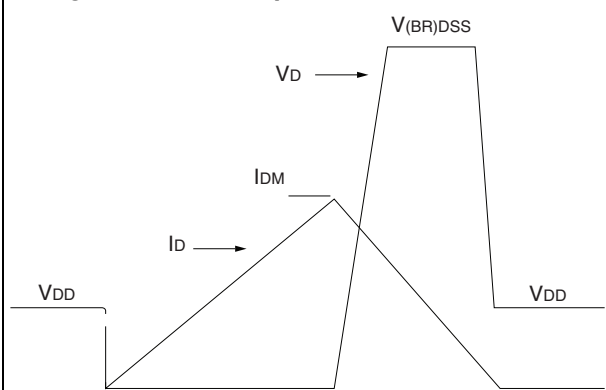
AM01470v1

Figure 19. Unclamped inductive load test circuit



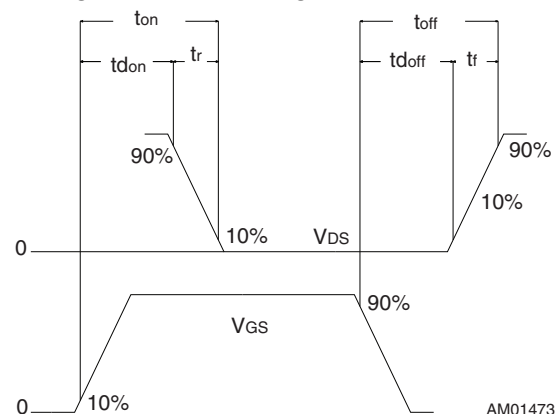
AM01471v1

Figure 20. Unclamped inductive waveform



AM01472v1

Figure 21. Switching time waveform



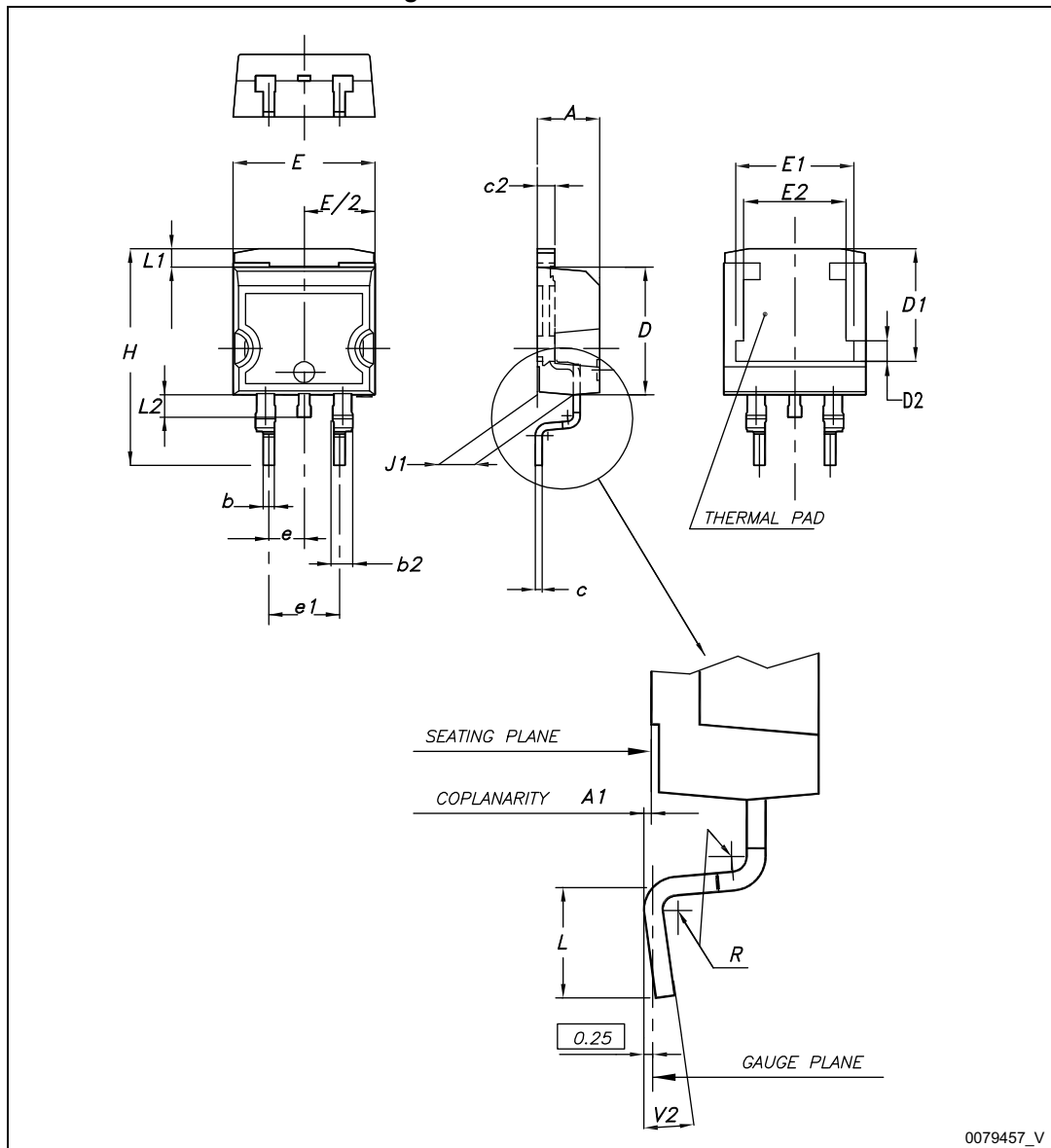
AM01473v1

## 4 Package information

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.

### 4.1 D<sup>2</sup>PAK package information

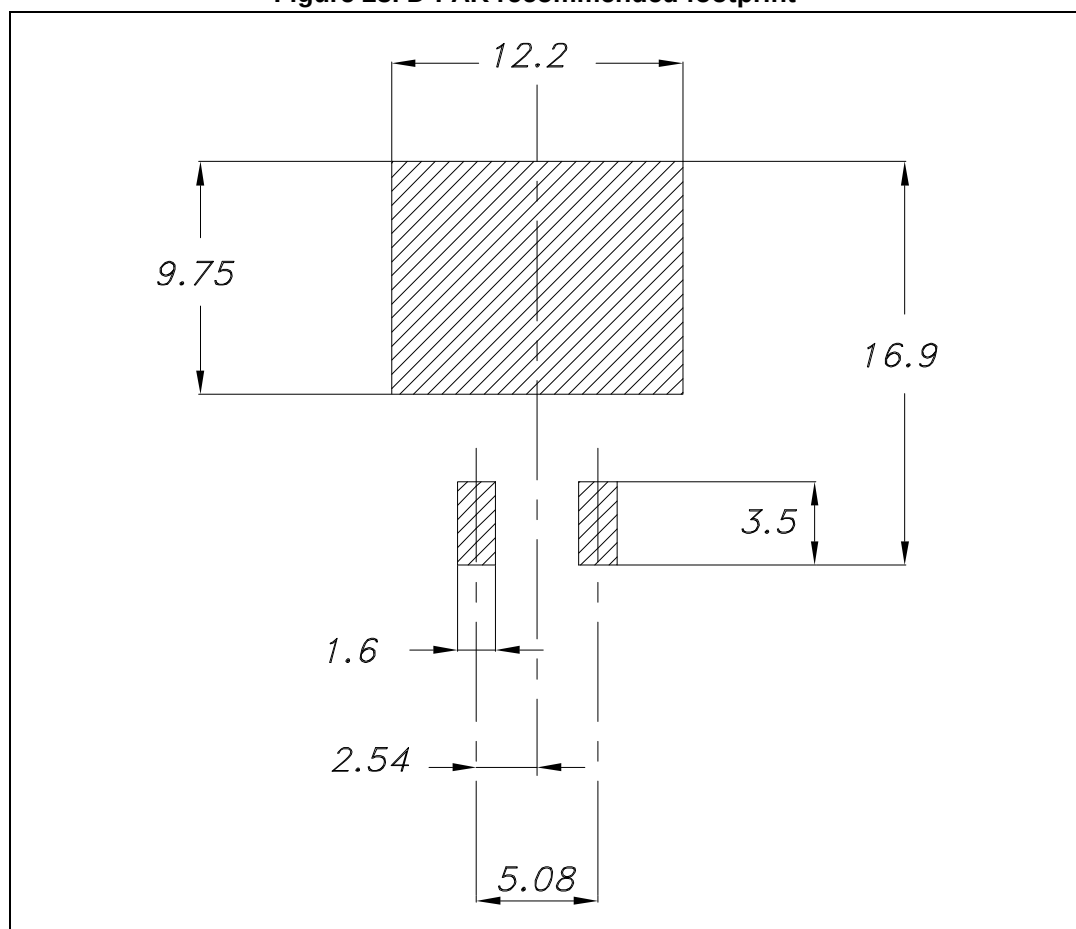
Figure 22. D<sup>2</sup>PAK outline



0079457\_V

Table 9. D<sup>2</sup>PAK mechanical data

| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 4.40 |      | 4.60  |
| A1   | 0.03 |      | 0.23  |
| b    | 0.70 |      | 0.93  |
| b2   | 1.14 |      | 1.70  |
| c    | 0.45 |      | 0.60  |
| c2   | 1.23 |      | 1.36  |
| D    | 8.95 |      | 9.35  |
| D1   | 7.50 | 7.75 | 8.00  |
| D2   | 1.10 | 1.30 | 1.50  |
| E    | 10   |      | 10.40 |
| E1   | 8.50 | 8.70 | 8.90  |
| E2   | 6.85 | 7.05 | 7.25  |
| e    |      | 2.54 |       |
| e1   | 4.88 |      | 5.28  |
| H    | 15   |      | 15.85 |
| J1   | 2.49 |      | 2.69  |
| L    | 2.29 |      | 2.79  |
| L1   | 1.27 |      | 1.40  |
| L2   | 1.30 |      | 1.75  |
| R    |      | 0.4  |       |
| V2   | 0°   |      | 8°    |

Figure 23. D<sup>2</sup>PAK recommended footprint<sup>(a)</sup>

a. All dimension are in millimeters

## 4.2 DPAK package information

Figure 24. DPAK (TO-252) type A2 outline

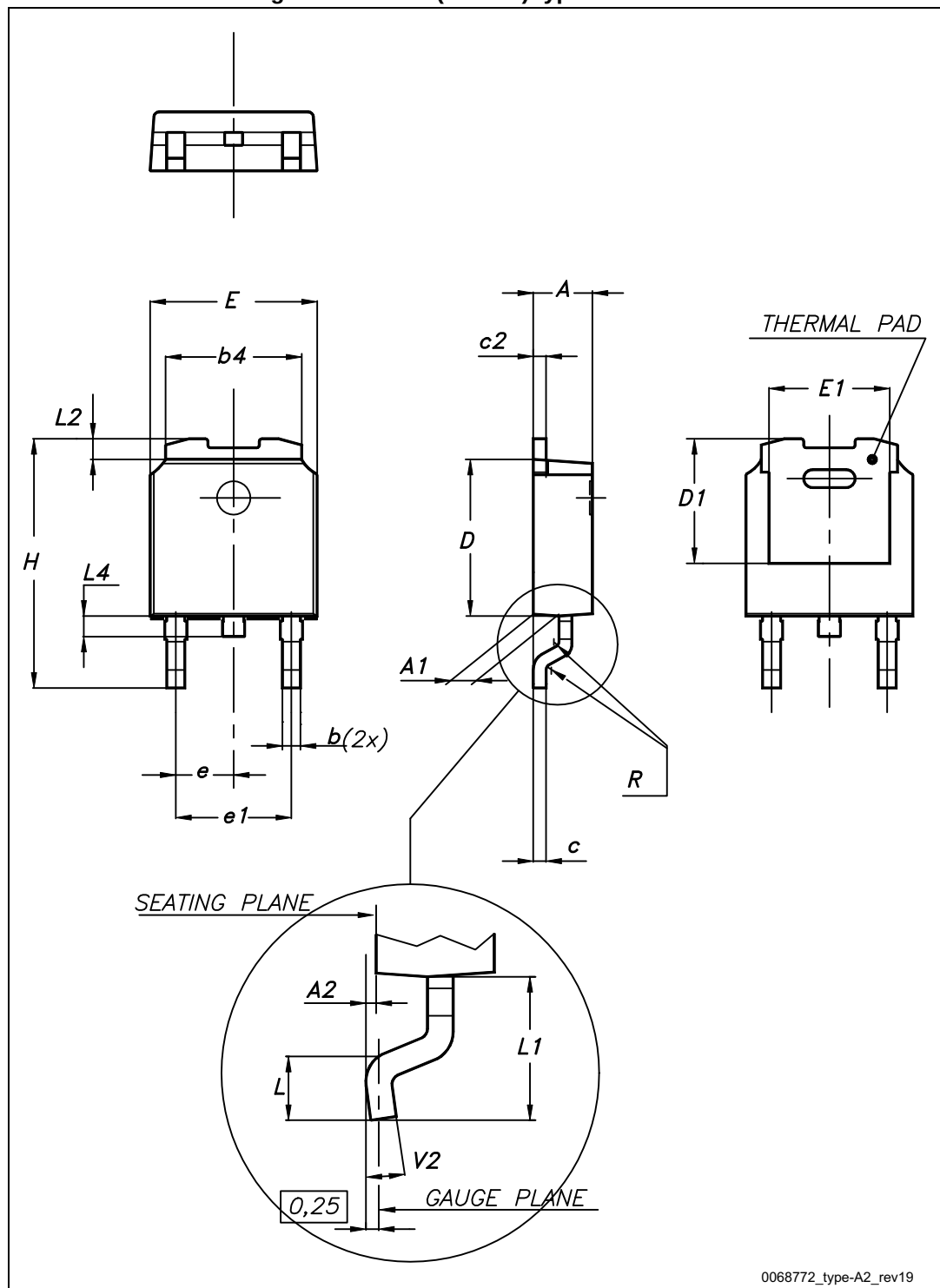
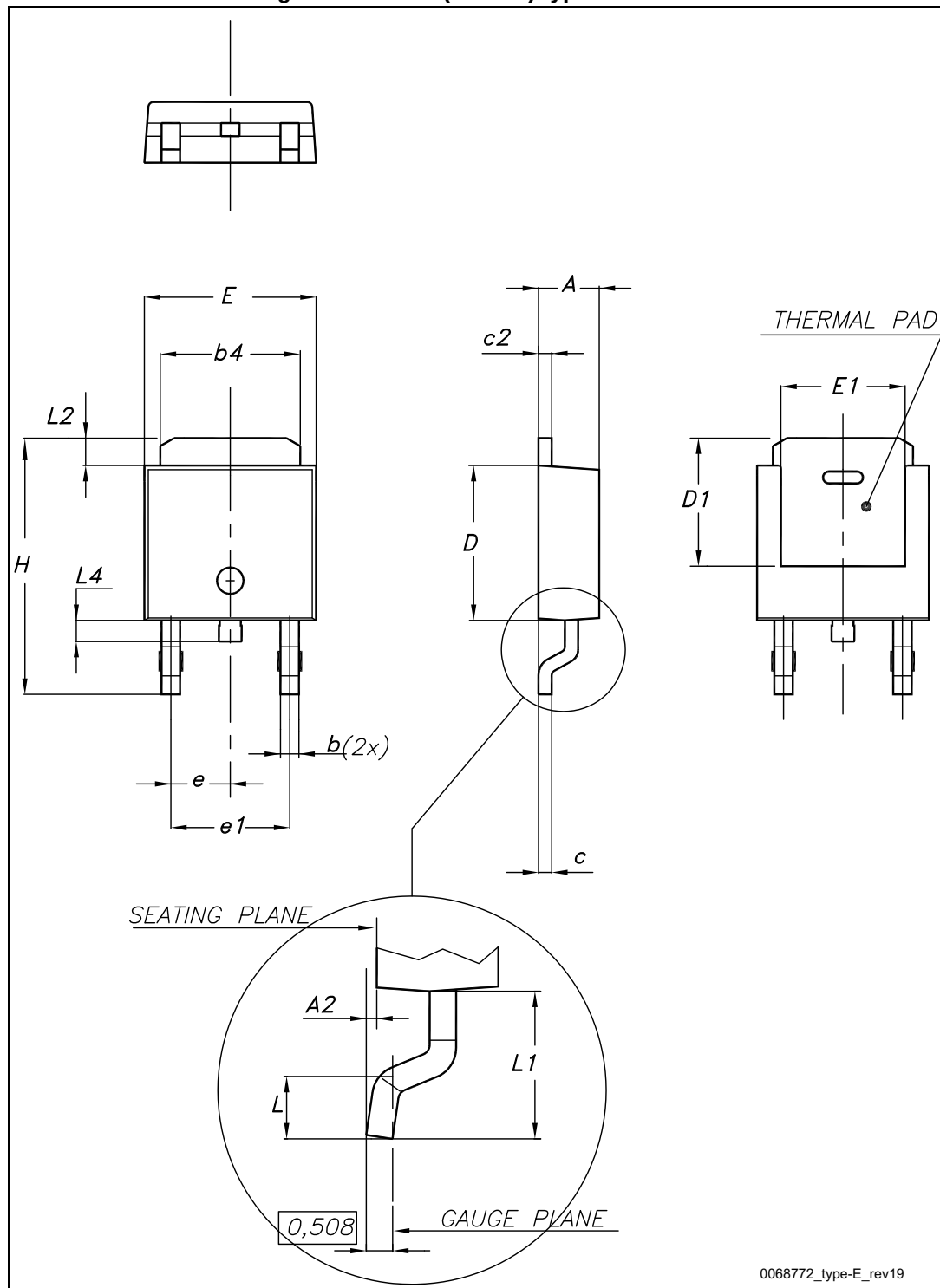


Table 10. DPAK (TO-252) type A2 mechanical data

| 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   | 4.95 | 5.10 | 5.25  |
| E    | 6.40 |      | 6.60  |
| E1   | 5.10 | 5.20 | 5.30  |
| e    | 2.16 | 2.28 | 2.40  |
| e1   | 4.40 |      | 4.60  |
| H    | 9.35 |      | 10.10 |
| L    | 1.00 |      | 1.50  |
| L1   | 2.60 | 2.80 | 3.00  |
| L2   | 0.65 | 0.80 | 0.95  |
| L4   | 0.60 |      | 1.00  |
| R    |      | 0.20 |       |
| V2   | 0°   |      | 8°    |

Figure 25. DPAK (TO-252) type E outline



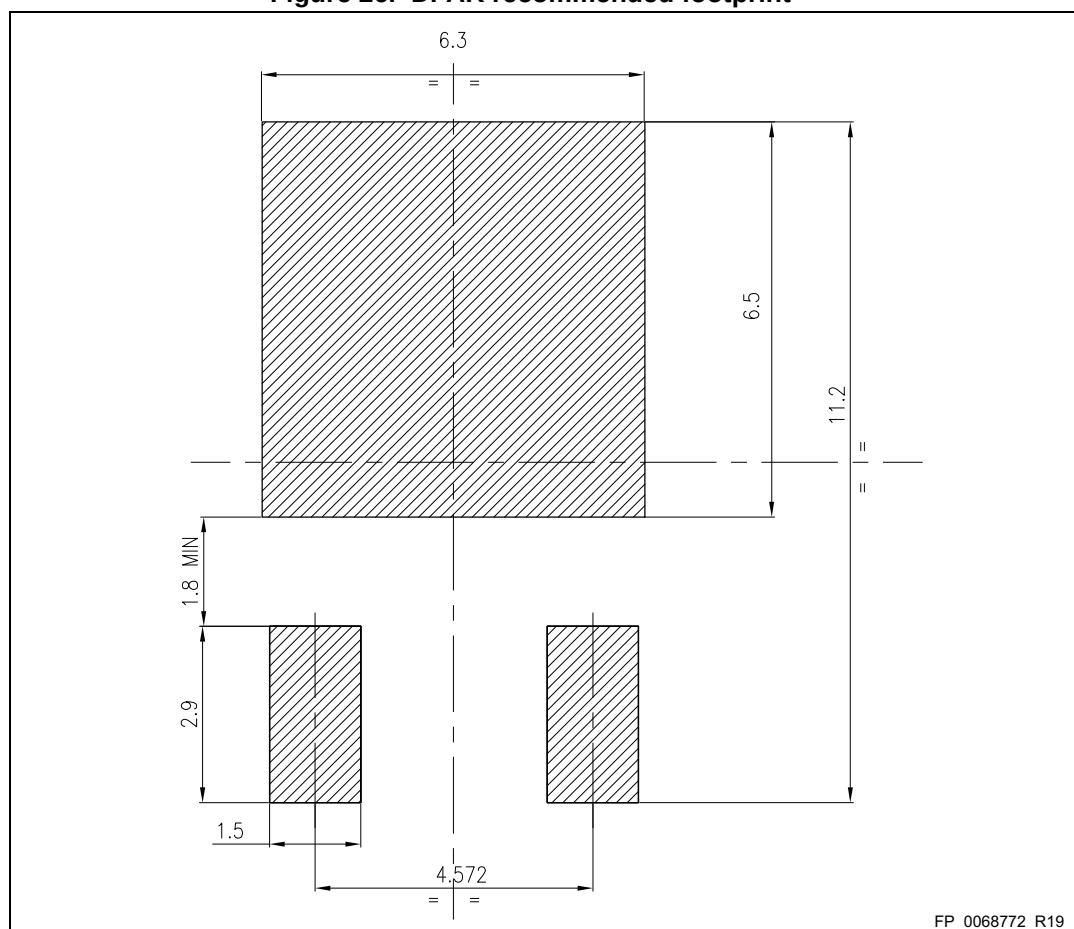
0068772\_type-E\_rev19

Table 11. DPAK (TO-252) type E mechanical data

| Dim. | mm   |       |       |
|------|------|-------|-------|
|      | Min. | Typ.  | Max.  |
| A    | 2.18 |       | 2.39  |
| A2   |      |       | 0.13  |
| b    | 0.65 |       | 0.884 |
| b4   | 4.95 |       | 5.46  |
| c    | 0.46 |       | 0.61  |
| c2   | 0.46 |       | 0.60  |
| D    | 5.97 |       | 6.22  |
| D1   | 5.21 |       |       |
| E    | 6.35 |       | 6.73  |
| E1   | 4.32 |       |       |
| e    |      | 2.286 |       |
| e1   |      | 4.572 |       |
| H    | 9.94 |       | 10.34 |
| L    | 1.50 |       | 1.78  |
| L1   |      | 2.74  |       |
| L2   | 0.89 |       | 1.27  |
| L4   |      |       | 1.02  |



Figure 26. DPAK recommended footprint (b)



b. All dimensions are in millimeters

### 4.3 I<sup>2</sup>PAK package information

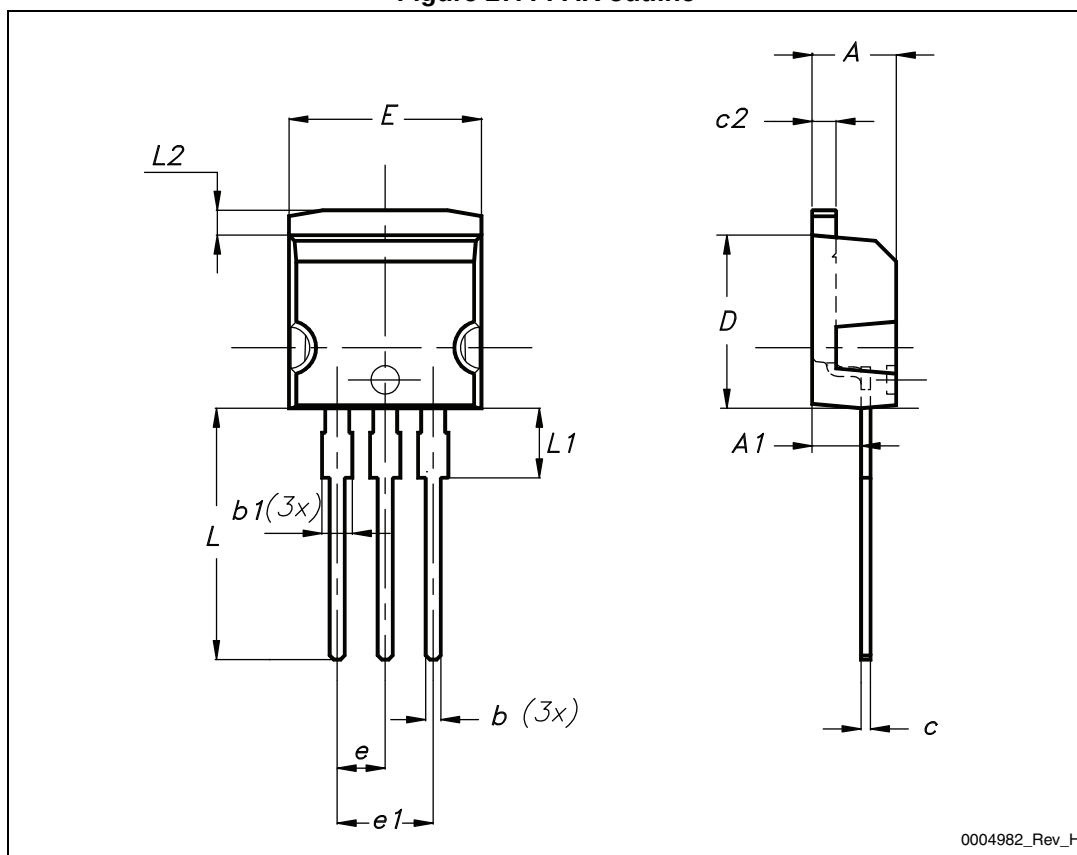
Figure 27. I<sup>2</sup>PAK outline

Table 12. I<sup>2</sup>PAK mechanical data

| DIM. | mm.  |      |       |
|------|------|------|-------|
|      | min. | typ. | max.  |
| A    | 4.40 |      | 4.60  |
| A1   | 2.40 |      | 2.72  |
| b    | 0.61 |      | 0.88  |
| b1   | 1.14 |      | 1.70  |
| c    | 0.49 |      | 0.70  |
| c2   | 1.23 |      | 1.32  |
| D    | 8.95 |      | 9.35  |
| e    | 2.40 |      | 2.70  |
| e1   | 4.95 |      | 5.15  |
| E    | 10   |      | 10.40 |
| L    | 13   |      | 14    |
| L1   | 3.50 |      | 3.93  |
| L2   | 1.27 |      | 1.40  |

## 4.4 TO-220 package information

Figure 28. TO-220 type A outline

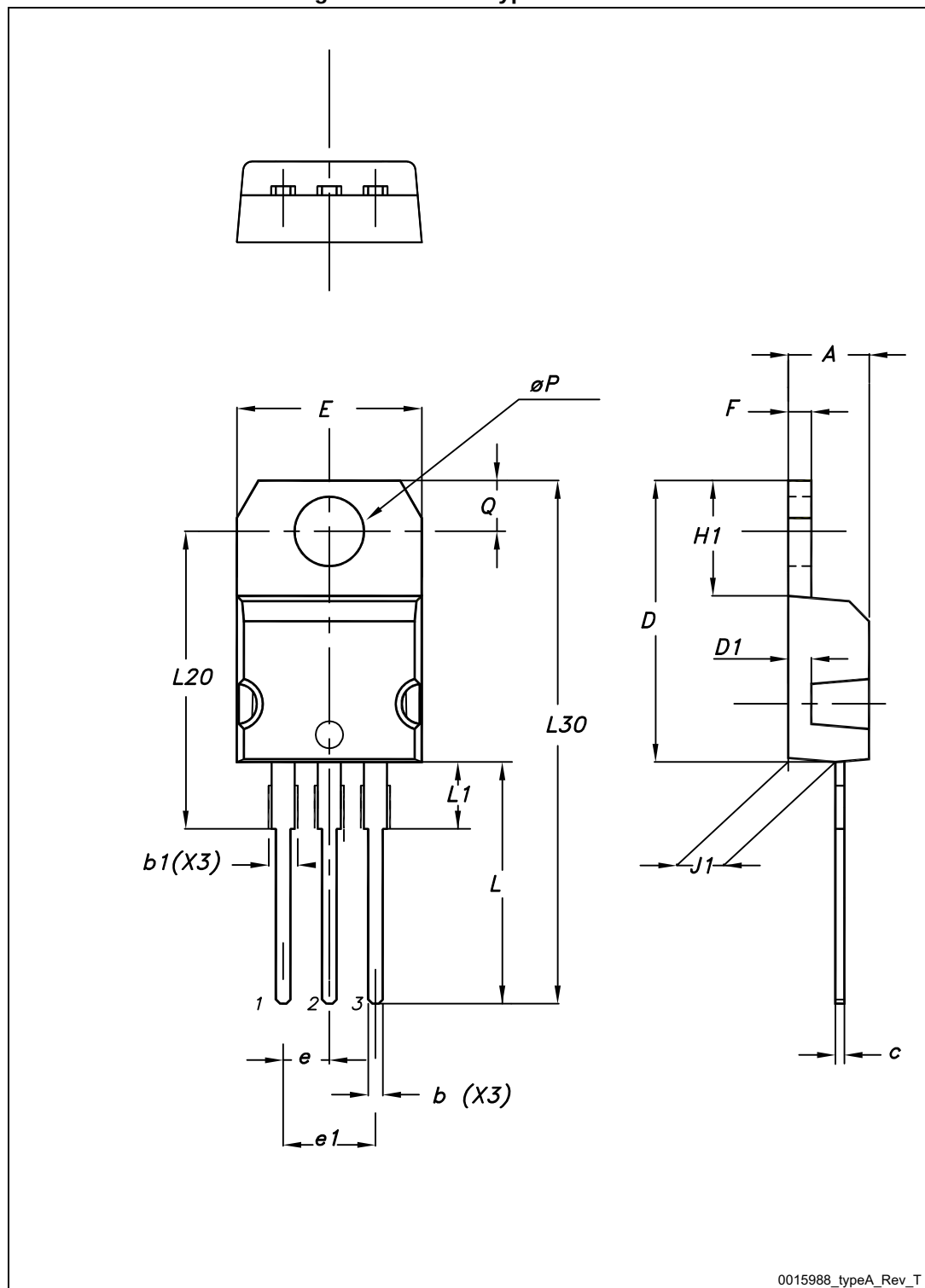


Table 13. TO-220 type A mechanical data

| 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  |

## 5 Packing information

### 5.1 D<sup>2</sup>PAK and DPAK tape and reel packing information

Figure 29. Tape for D<sup>2</sup>PAK and DPAK

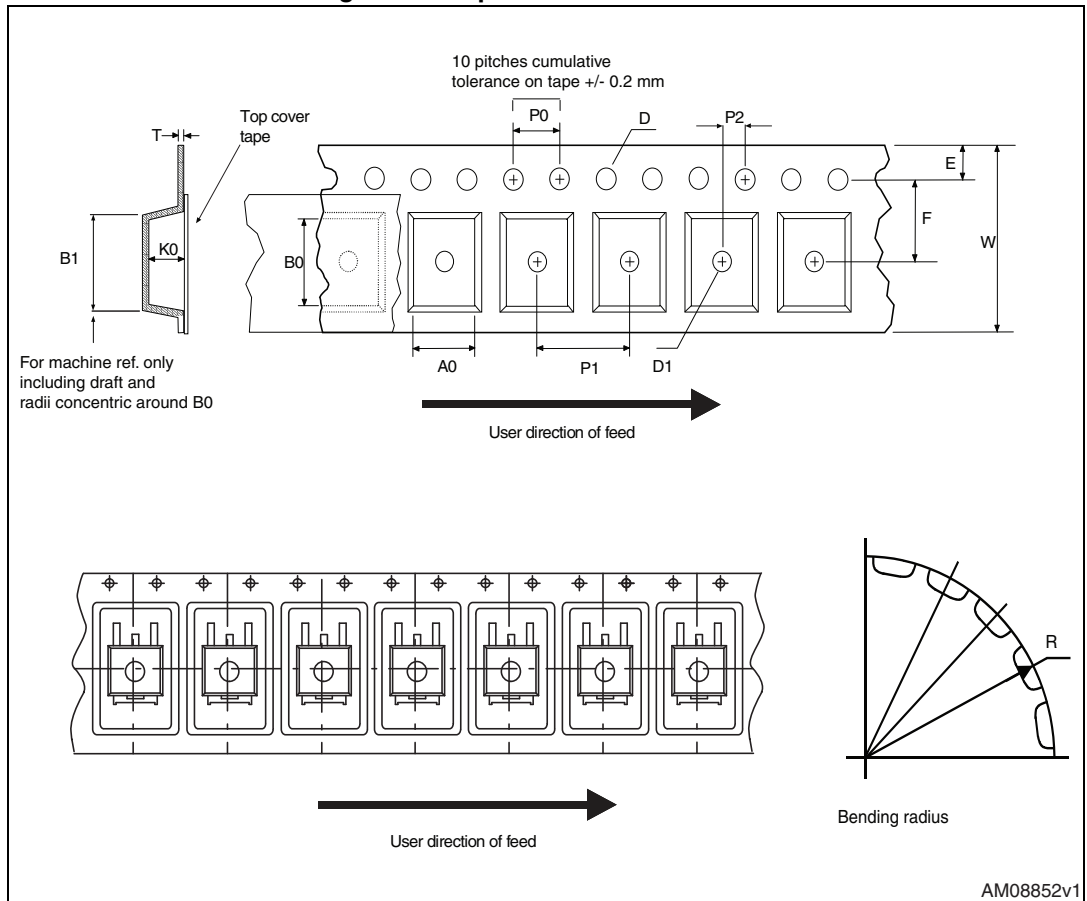
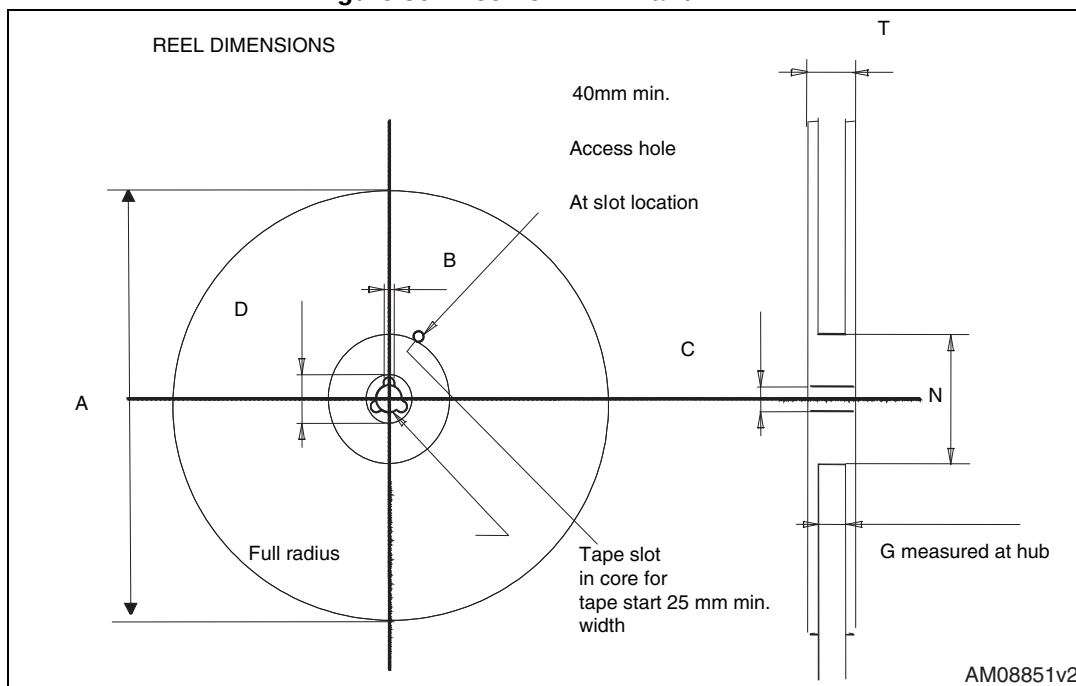


Figure 30. Reel for D<sup>2</sup>PAK and DPAKTable 14. D<sup>2</sup>PAK tape and reel mechanical data

| Tape |      |      | Reel     |      |      |
|------|------|------|----------|------|------|
| Dim. | mm   |      | Dim.     | mm   |      |
|      | Min. | Max. |          | Min. | Max. |
| A0   | 10.5 | 10.7 | A        |      | 330  |
| B0   | 15.7 | 15.9 | B        | 1.5  |      |
| D    | 1.5  | 1.6  | C        | 12.8 | 13.2 |
| D1   | 1.59 | 1.61 | D        | 20.2 |      |
| E    | 1.65 | 1.85 | G        | 24.4 | 26.4 |
| F    | 11.4 | 11.6 | N        | 100  |      |
| K0   | 4.8  | 5.0  | T        |      | 30.4 |
| P0   | 3.9  | 4.1  |          |      |      |
| P1   | 11.9 | 12.1 | Base qty |      | 1000 |
| P2   | 1.9  | 2.1  | Bulk qty |      | 1000 |
| R    | 50   |      |          |      |      |
| T    | 0.25 | 0.35 |          |      |      |
| W    | 23.7 | 24.3 |          |      |      |

Table 15. DPAK tape and reel mechanical data

| Tape |      |      | Reel      |      |      |
|------|------|------|-----------|------|------|
| Dim. | mm   |      | Dim.      | mm   |      |
|      | Min. | Max. |           | Min. | Max. |
| A0   | 6.8  | 7    | A         |      | 330  |
| B0   | 10.4 | 10.6 | B         | 1.5  |      |
| B1   |      | 12.1 | C         | 12.8 | 13.2 |
| D    | 1.5  | 1.6  | D         | 20.2 |      |
| D1   | 1.5  |      | G         | 16.4 | 18.4 |
| E    | 1.65 | 1.85 | N         | 50   |      |
| F    | 7.4  | 7.6  | T         |      | 22.4 |
| K0   | 2.55 | 2.75 |           |      |      |
| P0   | 3.9  | 4.1  | Base qty. |      | 2500 |
| P1   | 7.9  | 8.1  | Bulk qty. |      | 2500 |
| P2   | 1.9  | 2.1  |           |      |      |
| R    | 40   |      |           |      |      |
| T    | 0.25 | 0.35 |           |      |      |
| W    | 15.7 | 16.3 |           |      |      |



## 6 Revision history

**Table 16. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                               |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 28-May-2013 | 1        | First release.                                                                                                                                                                                                        |
| 05-Dec-2014 | 2        | Updated title, features and description in cover page.<br>Added <a href="#">Section 2.1: Electrical characteristics (curves)</a> .<br>Updated <a href="#">Section 4: Package information</a> .<br>Minor text changes. |
| 27-Mar-2015 | 3        | Updated <a href="#">Section 4: Package information</a> .<br>Minor text changes.                                                                                                                                       |

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