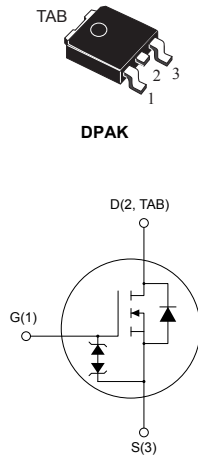


## N-channel 525 V, 1 $\Omega$ typ., 6.5 A MDmesh™ K3 Power MOSFET in DPAK package



### Features

| Order codes | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ | $P_{TOT}$ |
|-------------|----------|-------------------|-------|-----------|
| STD6N52K3   | 525 V    | 1.2 $\Omega$      | 5 A   | 70 W      |

- 100% avalanche tested
- Extremely high dv/dt capability
- Very low intrinsic capacitance
- Improved diode reverse recovery characteristics
- Zener-protected

### Applications

- Switching applications

### Description

This MDmesh™ K3 Power MOSFET is the result of improvements applied to STMicroelectronics' MDmesh™ technology, combined with a new optimized vertical structure. This device boasts an extremely low on-resistance, superior dynamic performance and high avalanche capability, rendering it suitable for the most demanding applications.

#### Product status link

[STD6N52K3](#)

#### Product summary

|                   |               |
|-------------------|---------------|
| <b>Order code</b> | STD6N52K3     |
| <b>Marking</b>    | 6N52K3        |
| <b>Package</b>    | DPAK          |
| <b>Packing</b>    | Tape and reel |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter   | Value      | Unit             |
|----------------|---|------------|------------------|
| $V_{GS}$       | Gate- source voltage  | $\pm 30$   | V                |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$  | 5          | A                |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 3          | A                |
| $I_{DM}^{(1)}$ | Drain current (pulsed)  | 20         | A                |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$           | 70         | W                |
| $I_{AR}$       | Avalanche current, repetitive or not-repetitive                 | 2.5        | A                |
| $E_{AS}^{(2)}$ | Single pulse avalanche energy                                   | 110        | mJ               |
| $dv/dt^{(3)}$  | Peak diode recovery voltage slope                               | 12         | V/ns             |
| $T_{stg}$      | Storage temperature range                                       | -55 to 150 | $^\circ\text{C}$ |
| $T_j$          | Operating junction temperature range                            |            |                  |

1. Pulse width limited by safe operating area.
2. Starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$ .
3.  $I_{SD} \leq 5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ ,  $V_{DS\ peak} \leq V_{(BR)DSS}$ .

**Table 2. Thermal data**

| Symbol              | Parameter                        | Value | Unit                      |
|---------------------|----------------------------------|-------|---------------------------|
| $R_{thj-case}$      | Thermal resistance junction-case | 1.79  | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb  | 50    | $^\circ\text{C}/\text{W}$ |

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

## 2 Electrical characteristics

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

**Table 3. On /off states**

| Symbol        | Parameter                         | Test conditions   | Min. | Typ. | Max.     | Unit          |
|---------------|-----------------------------------|---|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$   | 525  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 525\text{ V}$   |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 525\text{ V}$<br>$T_C = 125\text{ °C}$ <sup>(1)</sup> |      |      | 50       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current         | $V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$                                      |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 50\text{ }\mu\text{A}$                                       | 3    | 3.75 | 4.5      | V             |
| $R_{DS(on)}$  | Static drain-source on resistance | $V_{GS} = 10\text{ V}$ , $I_D = 2.5\text{ A}$   |      | 1    | 1.2      | $\Omega$      |

1. Defined by design, not subject to production test.

**Table 4. Dynamic**

| Symbol                     | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|----------------------------|-------------------------------|--|------|------|------|---------------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0\text{ V}$   | -    | 670  | -    | $\mu\text{F}$ |
| $C_{oss}$                  | Output capacitance            |  |      | 54   |      |               |
| $C_{rss}$                  | Reverse transfer capacitance  |  |      | 10   |      |               |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 0\text{ to }420\text{ V}$   |      | 40   |      | $\mu\text{F}$ |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ open drain  | -    | 4    | -    | $\Omega$      |
| $Q_g$                      | Total gate charge             | $V_{DD} = 420\text{ V}$ , $I_D = 5\text{ A}$ ,<br>$V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 15. Test circuit for gate charge behavior) | -    | 26   | -    | nC            |
| $Q_{gs}$                   | Gate-source charge            |  |      | 4    |      |               |
| $Q_{gd}$                   | Gate-drain charge             |  |      | 15   |      |               |

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

**Table 5. Switching times**

| Symbol       | Parameter           | Test conditions   | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 260\text{ V}$ , $I_D = 2.5\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 14. Test circuit for resistive load switching times and Figure 19. Switching time waveform) | -    | 10   | -    | ns   |
| $t_r$        | Rise time           |   |      | 11   |      |      |
| $t_{d(off)}$ | Turn-off delay time |   |      | 31   |      |      |
| $t_f$        | Fall time           |   |      | 18   |      |      |

**Table 6. Source drain diode**

| Symbol          | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit |    |
|-----------------|-------------------------------|---|------|------|------|------|----|
| $I_{SD}$        | Source-drain current          |   | -    |      | 5    | A    |    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |   |      |      | 20   |      |    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 5\text{ A}$ , $V_{GS} = 0\text{ V}$   | -    |      | 1.5  | V    |    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ (see Figure 16. Test circuit for inductive load switching and diode recovery times)                            | -    | 206  |      | ns   |    |
| $Q_{rr}$        | Reverse recovery charge       |   |      | 1.4  |      |      | μC |
| $I_{RRM}$       | Reverse recovery current      |   |      | 14   |      |      |    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ °C}$<br>(see Figure 16. Test circuit for inductive load switching and diode recovery times) | -    | 233  |      | ns   |    |
| $Q_{rr}$        | Reverse recovery charge       |   |      | 1.7  |      |      | μC |
| $I_{RRM}$       | Reverse recovery current      |   |      | 15   |      |      |    |

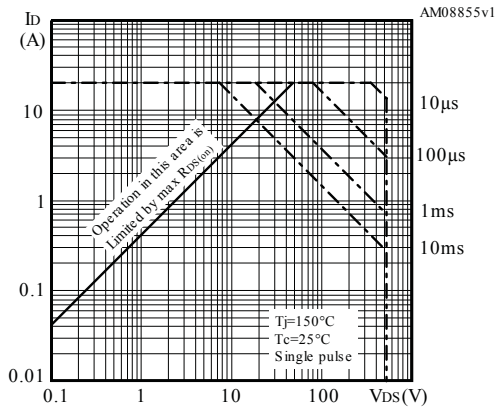
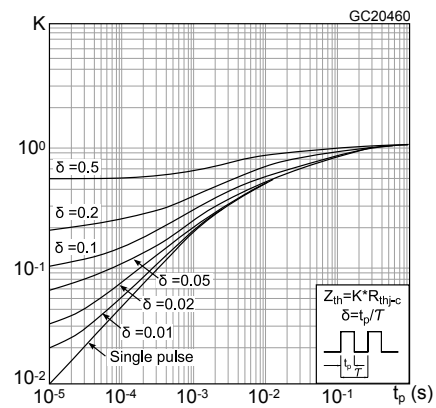
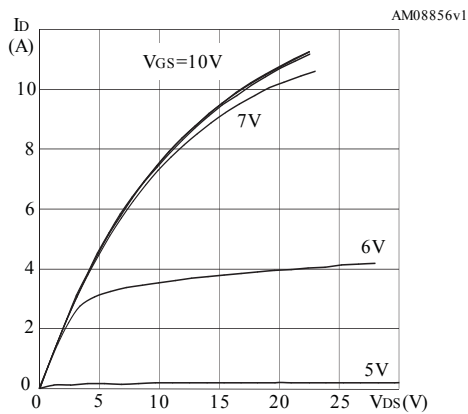
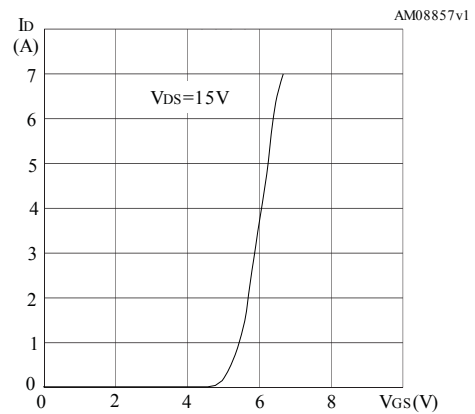
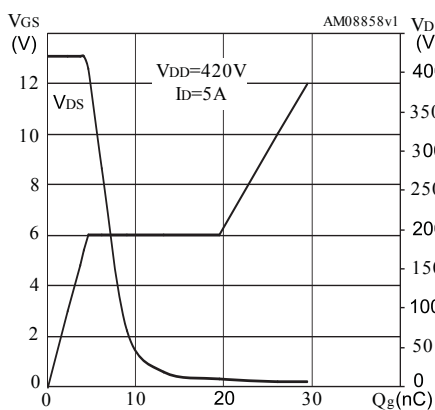
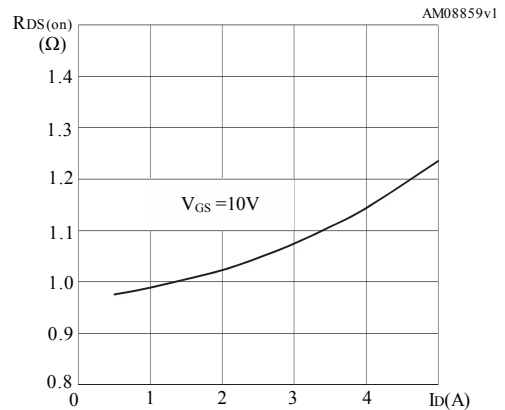
1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300 μs, duty cycle 1.5%.

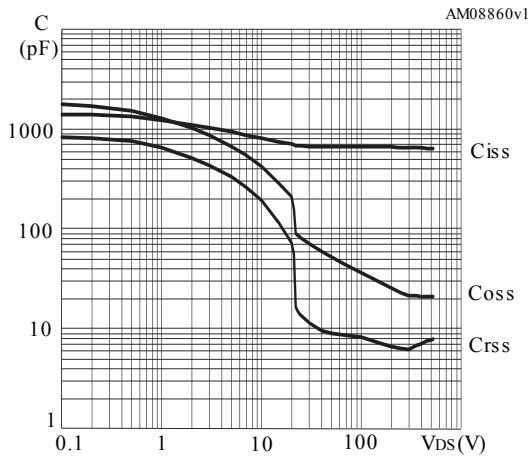
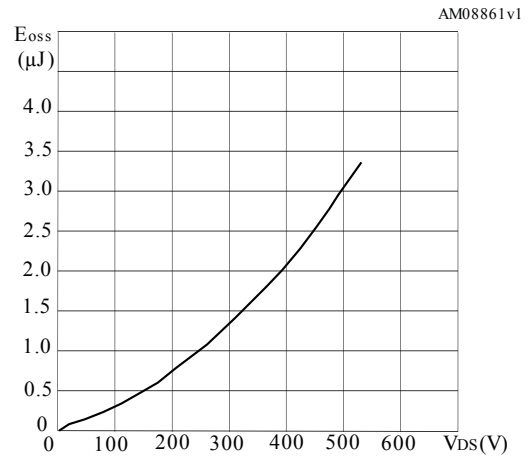
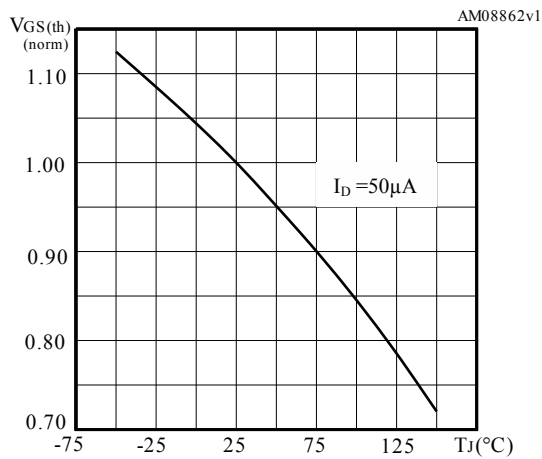
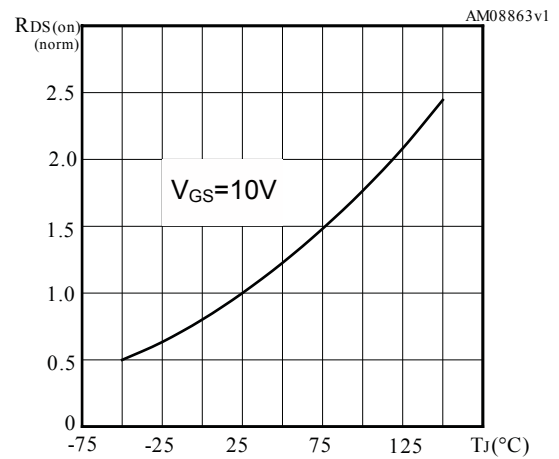
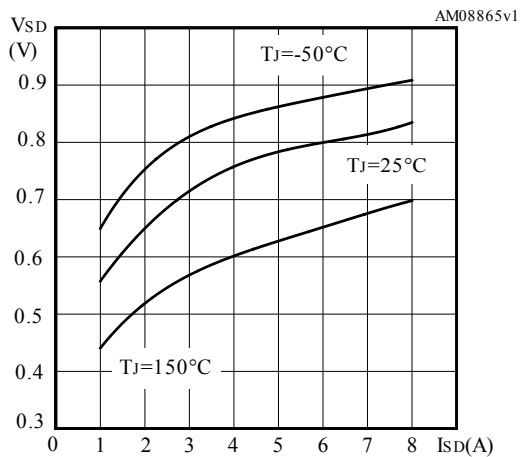
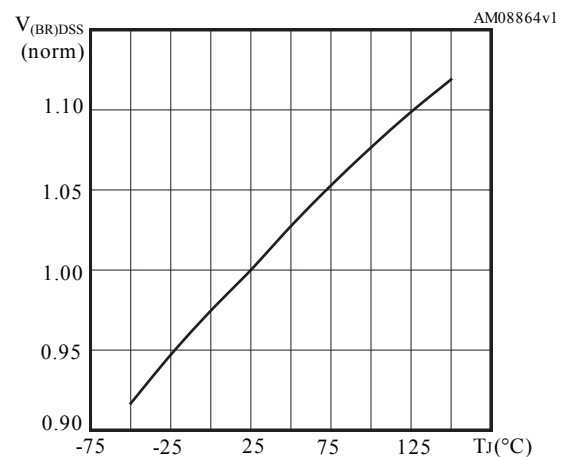
**Table 7. Gate-source Zener diode**

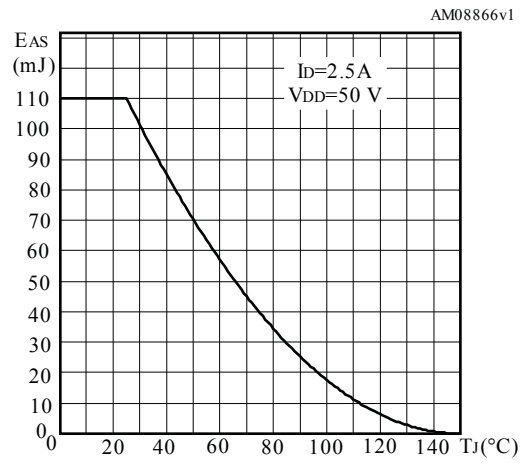
| Symbol        | Parameter                     | Test conditions                                 | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|---|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_D = 0\text{ A}$ , $I_{GS} = \pm 1\text{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

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics curves

**Figure 1. Safe operating area**

**Figure 2. Thermal impedance**

**Figure 3. Output characteristics**

**Figure 4. Transfer characteristics**

**Figure 5. Gate charge vs gate-source voltage**

**Figure 6. Static drain-source on resistance**


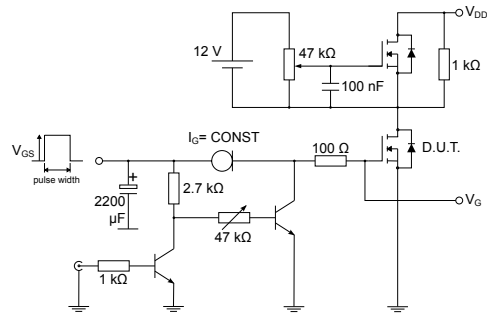
**Figure 7. Capacitance variations**

**Figure 8. Output capacitance stored energy**

**Figure 9. Normalized gate threshold voltage vs temperature**

**Figure 10. Normalized on resistance vs temperature**

**Figure 11. Source-drain diode forward characteristics**

**Figure 12. Normalized  $V_{(BR)DSS}$  vs temperature**


**Figure 13. Maximum avalanche energy vs temperature**


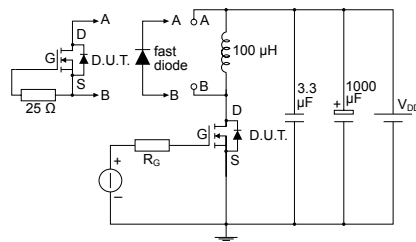
### 3 Test circuits

**Figure 14. Test circuit for resistive load switching times**

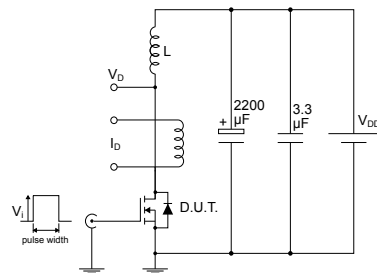

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**Figure 15. Test circuit for gate charge behavior**


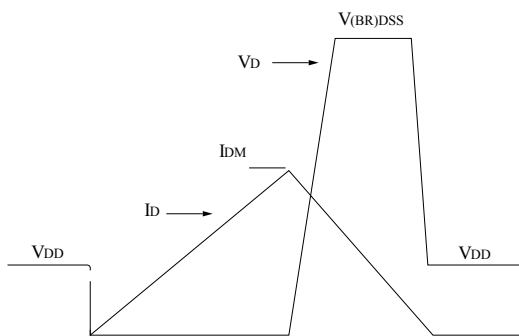
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**Figure 16. Test circuit for inductive load switching and diode recovery times**


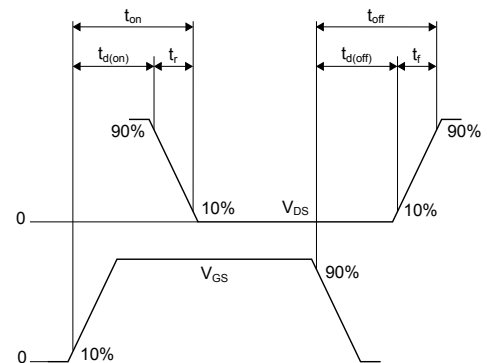
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**Figure 17. Unclamped inductive load test circuit**


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**Figure 18. Unclamped inductive waveform**


AM01472v1

**Figure 19. Switching time waveform**


AM01473v1



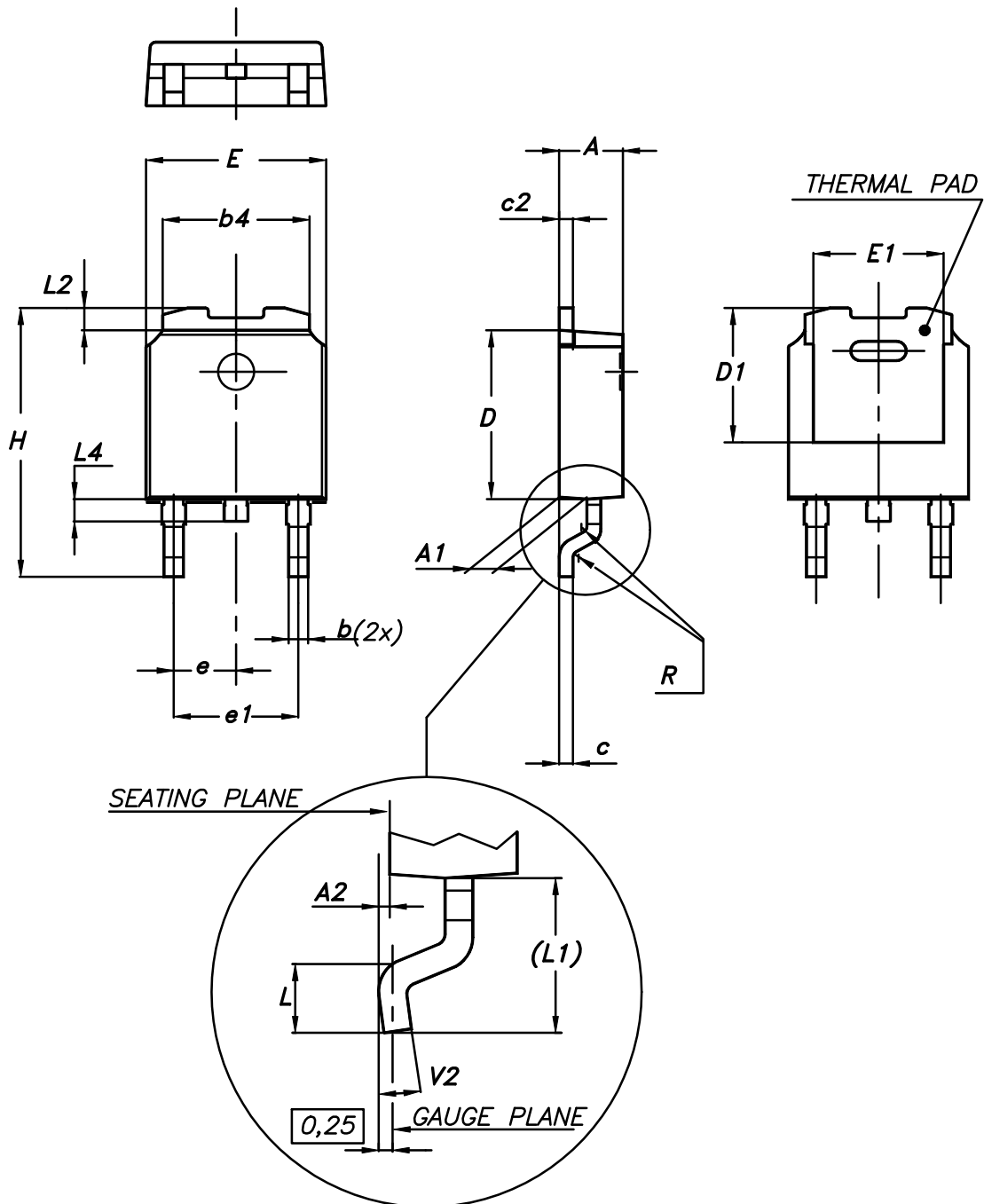
## 4 Package information

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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 DPAK (TO-252) type A package information

Figure 20. DPAK (TO-252) type A package outline



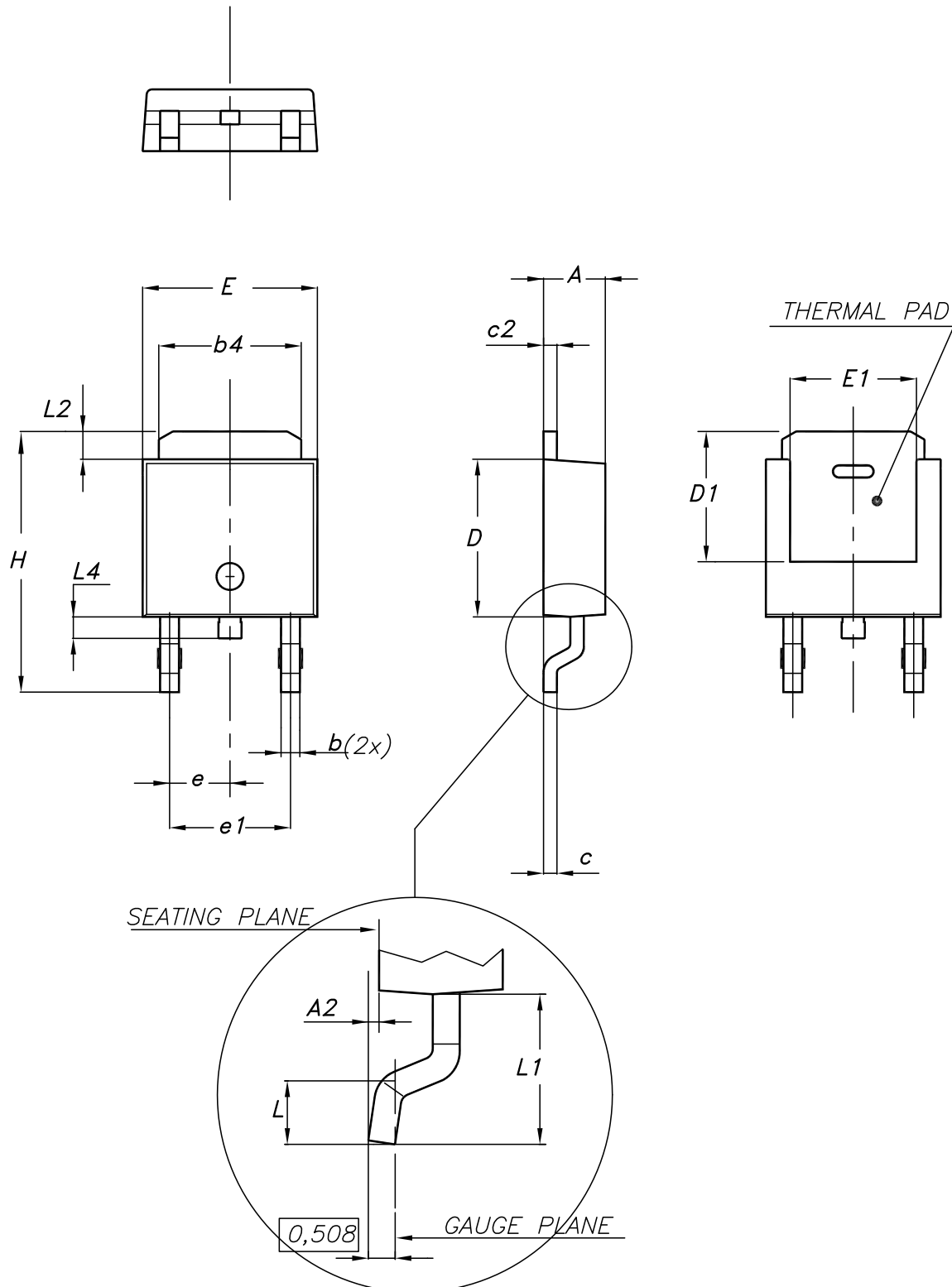
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**Table 8. DPAK (TO-252) type A mechanical data**

| 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   | 4.60  | 4.70  | 4.80  |
| e    | 2.159 | 2.286 | 2.413 |
| e1   | 4.445 | 4.572 | 4.699 |
| 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°    |

## 4.2 DPAK (TO-252) type E package information

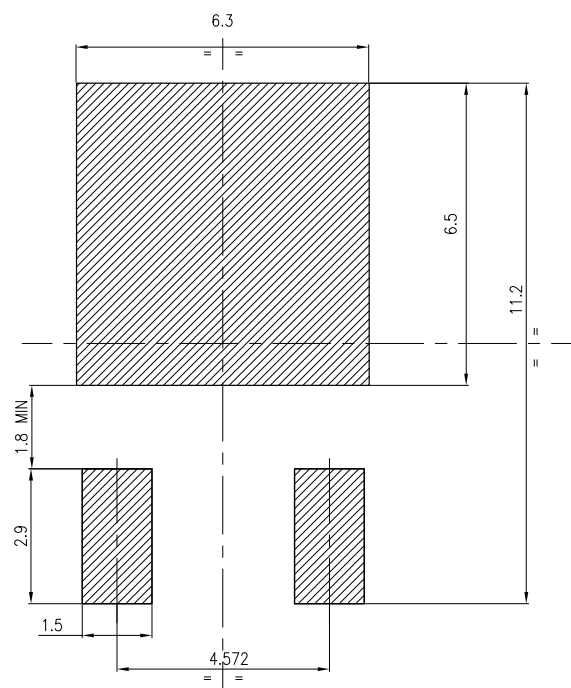
Figure 21. DPAK (TO-252) type E package outline



**Table 9. 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  |

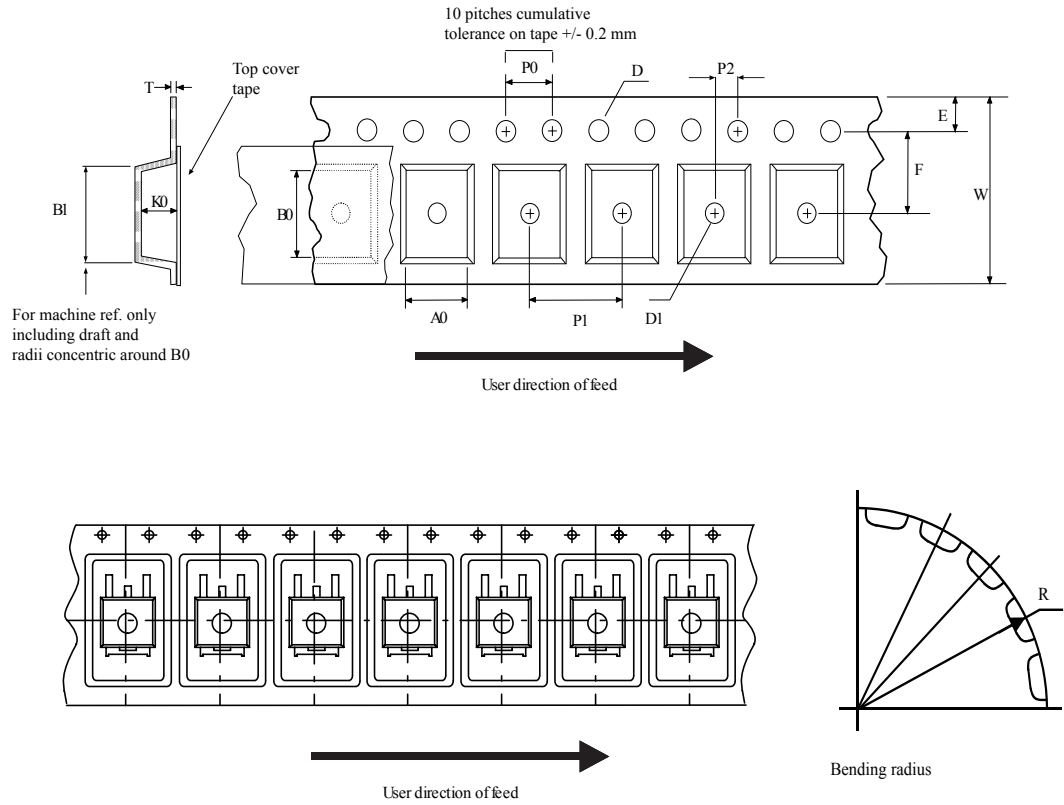
**Figure 22. DPAK (TO-252) recommended footprint (dimensions are in mm)**



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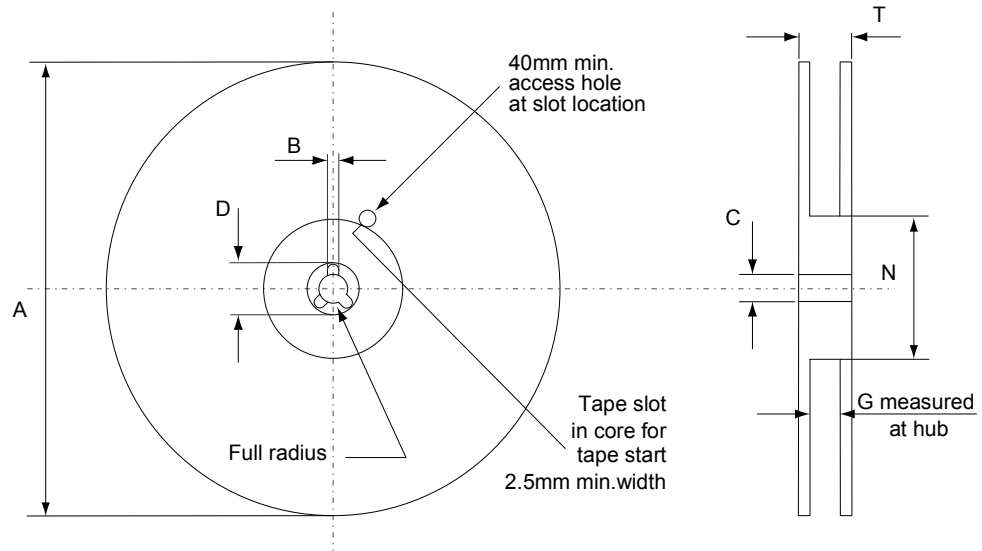
### 4.3 DPAK (TO-252) packing information

Figure 23. DPAK (TO-252) tape outline



AM08852v1

**Figure 24. DPAK (TO-252) reel outline**



AM06038v1

**Table 10. DPAK (TO-252) 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 |           |      |      |

## Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 03-Sep-2008 | 1        | Initial release.  |
| 21-Feb-2011 | 2        | <ul style="list-style-type: none"> <li>– Added new package, mechanical data: D<sup>2</sup>PAK;</li> <li>– Added new package, mechanical data: TO-220;</li> <li>– Document status promoted from preliminary data to datasheet.</li> </ul>  |
| 05-Sep-2018 | 3        | <p>The part numbers STB6N52K3, STF6N52K3 and STP6N52K3 have been moved to a separate datasheet.</p> <p>Removed maturity status indication from cover page. The document status is production data.</p> <p>Updated title and features in cover page.</p> <p>Updated <a href="#">Section 1 Electrical ratings</a>, <a href="#">Section 2 Electrical characteristics</a> and <a href="#">Section 4 Package information</a>.</p> <p>Minor text changes.</p> |



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