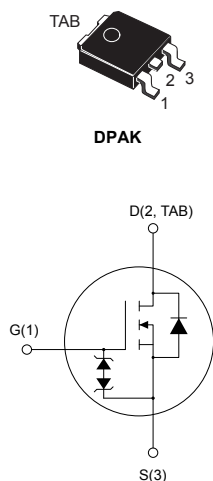


## N-channel 400 V, 0.85 $\Omega$ typ., 5.4 A SuperMESH Power MOSFET in a DPAK package



AM01476v1\_tab



### Features

| Order code  | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|-------------|----------|-------------------|-------|
| STD7NK40ZT4 | 400 V    | 1 $\Omega$        | 5.4 A |

- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance
- Zener-protected

### Applications

- Switching applications

### Description

This high-voltage device is a Zener-protected N-channel Power MOSFET developed using the SuperMESH technology by STMicroelectronics, an optimization of the well-established PowerMESH. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

#### Product status link

[STD7NK40ZT4](#)

#### Product summary

|            |               |
|------------|---------------|
| Order code | STD7NK40ZT4   |
| Marking    | D7NK40Z       |
| Package    | DPAK          |
| Packing    | Tape and reel |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter                                                                        | Value      | Unit             |
|----------------|----------------------------------------------------------------------------------|------------|------------------|
| $V_{DS}$       | Drain-source voltage                                                             | 400        | V                |
| $V_{DGR}$      | Drain-gate voltage ( $R_{GS} = 20\text{ k}\Omega$ )                              | 400        | V                |
| $V_{GS}$       | Gate-source voltage                                                              | $\pm 30$   | V                |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$                   | 5.4        | A                |
|                | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$                  | 3.4        |                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                                           | 21.6       | A                |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$                      | 70         | W                |
| ESD            | Gate-source, human body model ( $R = 1.5\text{ k}\Omega$ , $C = 100\text{ pF}$ ) | 3          | kV               |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                                                | 4.5        | V/ns             |
| $T_{stg}$      | Storage temperature range                                                        | -55 to 150 | $^\circ\text{C}$ |
| $T_J$          | Operating junction temperature range                                             |            | $^\circ\text{C}$ |

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 5.4\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} < V_{(BR)DSS}$ .

**Table 2. Thermal data**

| Symbol           | Parameter                               | Value | Unit                      |
|------------------|-----------------------------------------|-------|---------------------------|
| $R_{thJC}$       | Thermal resistance, junction-to-case    | 1.78  | $^\circ\text{C}/\text{W}$ |
| $R_{thJA}^{(1)}$ | Thermal resistance, junction-to-ambient | 50    | $^\circ\text{C}/\text{W}$ |

1. When mounted on an 1-inch<sup>2</sup> FR-4, 2 Oz copper board.

**Table 3. Avalanche characteristics**

| Symbol   | Parameter                                                                                                            | Value | Unit |
|----------|----------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width is limited by $T_J$ max.)                               | 5.4   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 130   | mJ   |

## 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    | $I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$                                                 | 400  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 400\text{ V}$                                             |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 400\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}^{(1)}$ |      |      | 50       |               |
| $I_{GSS}$     | 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            | $V_{DS} = V_{GS}$ , $I_D = 50\text{ }\mu\text{A}$                                           | 3.00 | 3.75 | 4.50     | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 2.7\text{ A}$                                               |      | 0.85 | 1        | $\Omega$      |

1. Specified by design, not tested in production.

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                               | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$                                                                           | -    | 535  |      | pF   |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                               | -    | 82   |      | pF   |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                               | -    | 18   |      | pF   |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }320\text{ V}$                                                                                   | -    | 53   |      | pF   |
| $Q_g$                      | Total gate charge             | $V_{DD} = 320\text{ V}$ , $I_D = 5.4\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 19   | 26   | nC   |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                               | -    | 4    |      | nC   |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                               | -    | 10   |      | nC   |

1.  $C_{oss\text{ eq.}}$  is defined as the constant equivalent capacitance giving the same charging time 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    | $V_{DD} = 200\text{ V}$ , $I_D = 2.7\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$  | -    | 15   | -    | ns   |
| $t_r$         | Rise time             |                                                                                                         | -    | 15   | -    | ns   |
| $t_{d(off)}$  | Turn-off delay time   | (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | -    | 30   | -    | ns   |
| $t_f$         | Fall time             |                                                                                                         | -    | 12   | -    | ns   |
| $t_{r(Voff)}$ | Off-voltage rise time | $V_{DD} = 320\text{ V}$ , $I_D = 5.4\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$  | -    | 12   | -    | ns   |
| $t_f$         | Fall time             |                                                                                                         | -    | 10   | -    | ns   |
| $t_c$         | Crossover time        | (see Figure 15. Test circuit for inductive load switching and diode recovery times)                     | -    | 20   | -    | ns   |

**Table 7. Source-drain diode**

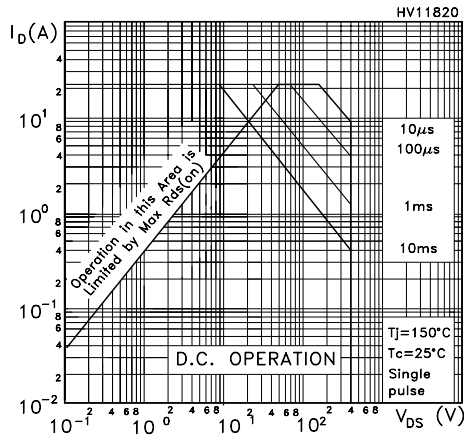
| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                         | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                         | -    |      | 5.4  | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                         | -    |      | 21.6 | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 5.4 \text{ A}$ , $V_{GS} = 0 \text{ V}$                                                                                                                                                                       | -    |      | 1.6  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 5.4 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 50 \text{ V}$ , $T_J = 150 \text{ }^\circ\text{C}$<br>(see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 220  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                         | -    | 990  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                         | -    | 9    |      | A    |

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

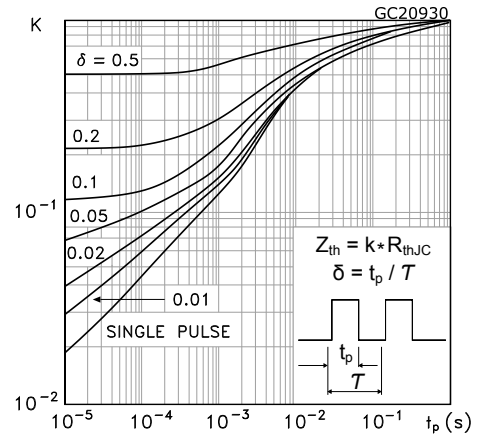
2. Pulse width is limited by safe operating area.

## 2.1 Electrical characteristics (curves)

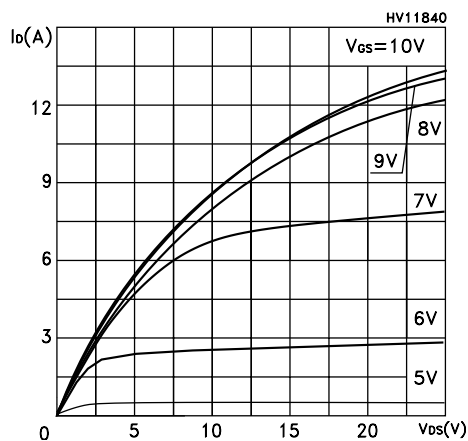
**Figure 1. Safe operating area**



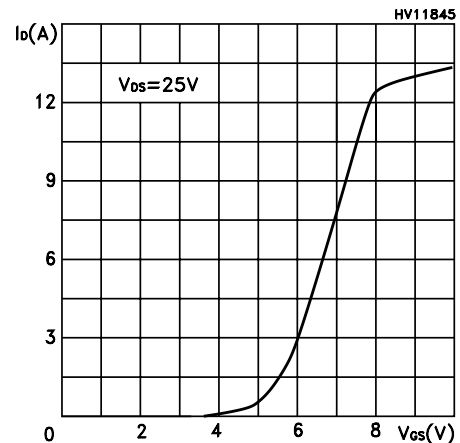
**Figure 2. Thermal impedance**



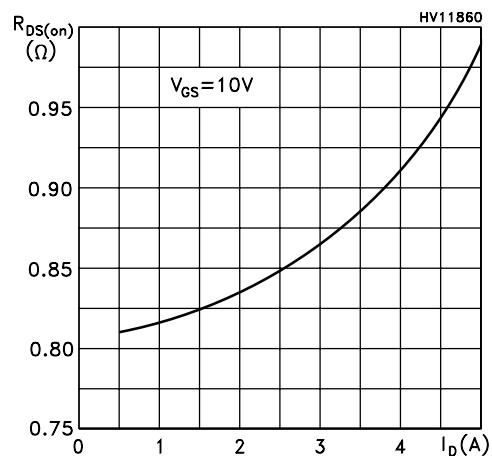
**Figure 3. Output characteristics**



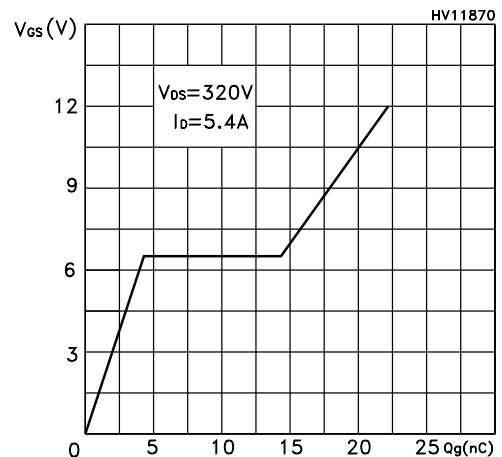
**Figure 4. Transfer characteristics**



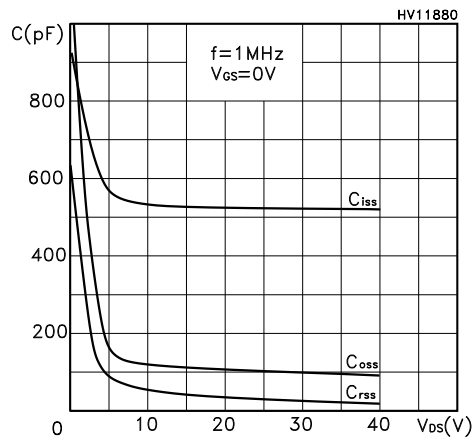
**Figure 5. Static drain-source on-resistance**



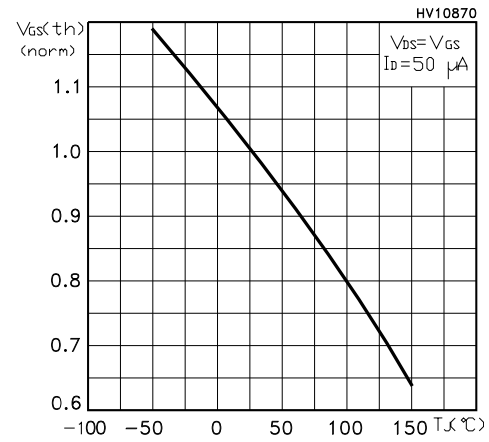
**Figure 6. Gate charge vs gate-source voltage**



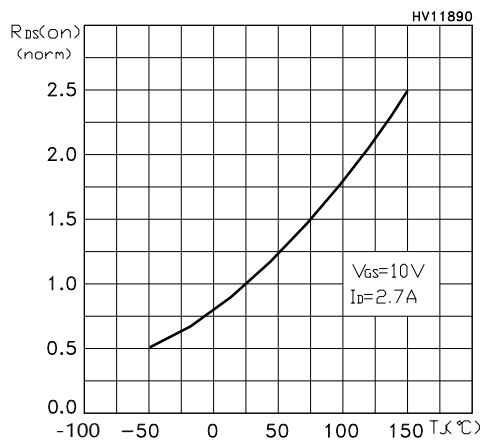
**Figure 7. Capacitance variations**



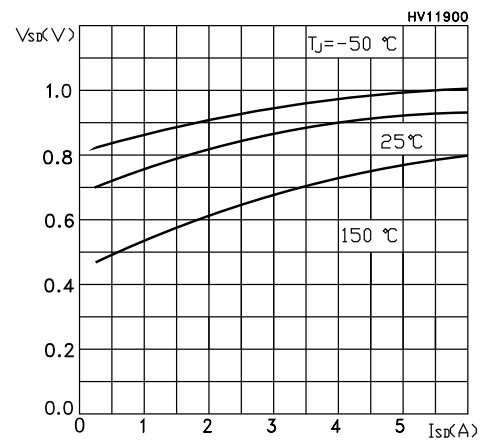
**Figure 8. Normalized gate threshold voltage vs temperature**



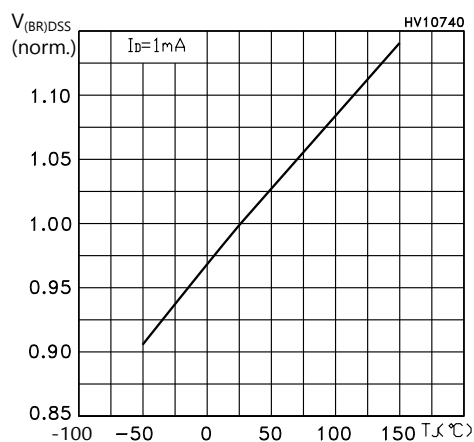
**Figure 9. Normalized on-resistance vs temperature**



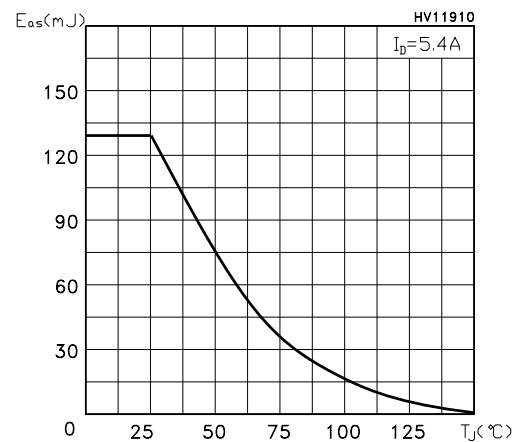
**Figure 10. Source-drain diode forward characteristics**



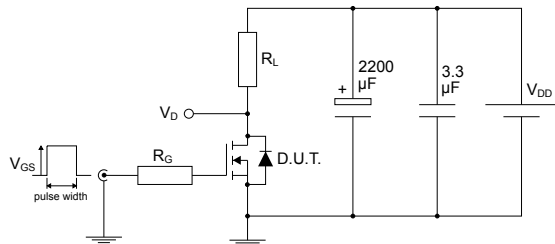
**Figure 11. Normalized V(BR)DSS vs temperature**



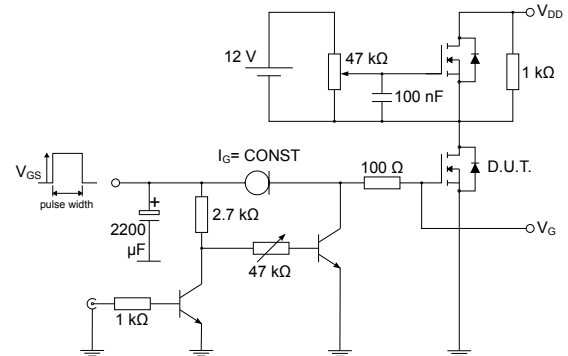
**Figure 12. Maximum avalanche energy vs temperature**



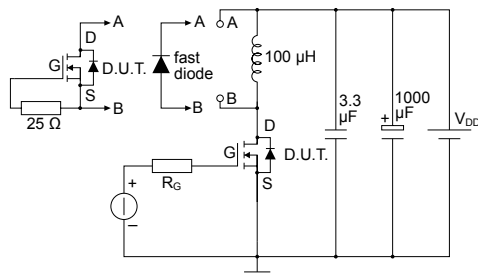
### 3 Test circuits

**Figure 13. Test circuit for resistive load switching times**


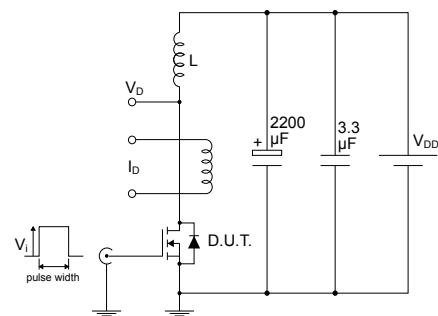
AM01468v1

**Figure 14. Test circuit for gate charge behavior**


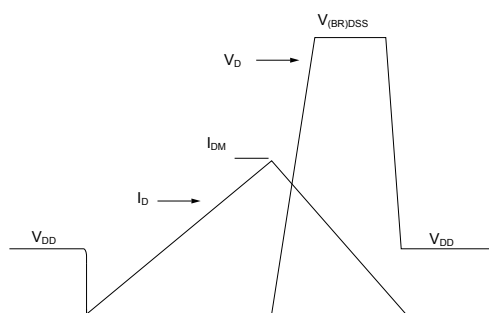
AM01469v1

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


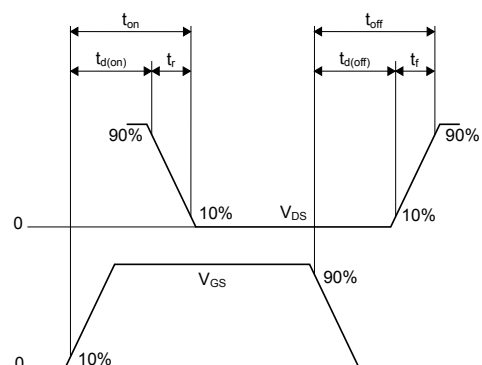
AM01470v1

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


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


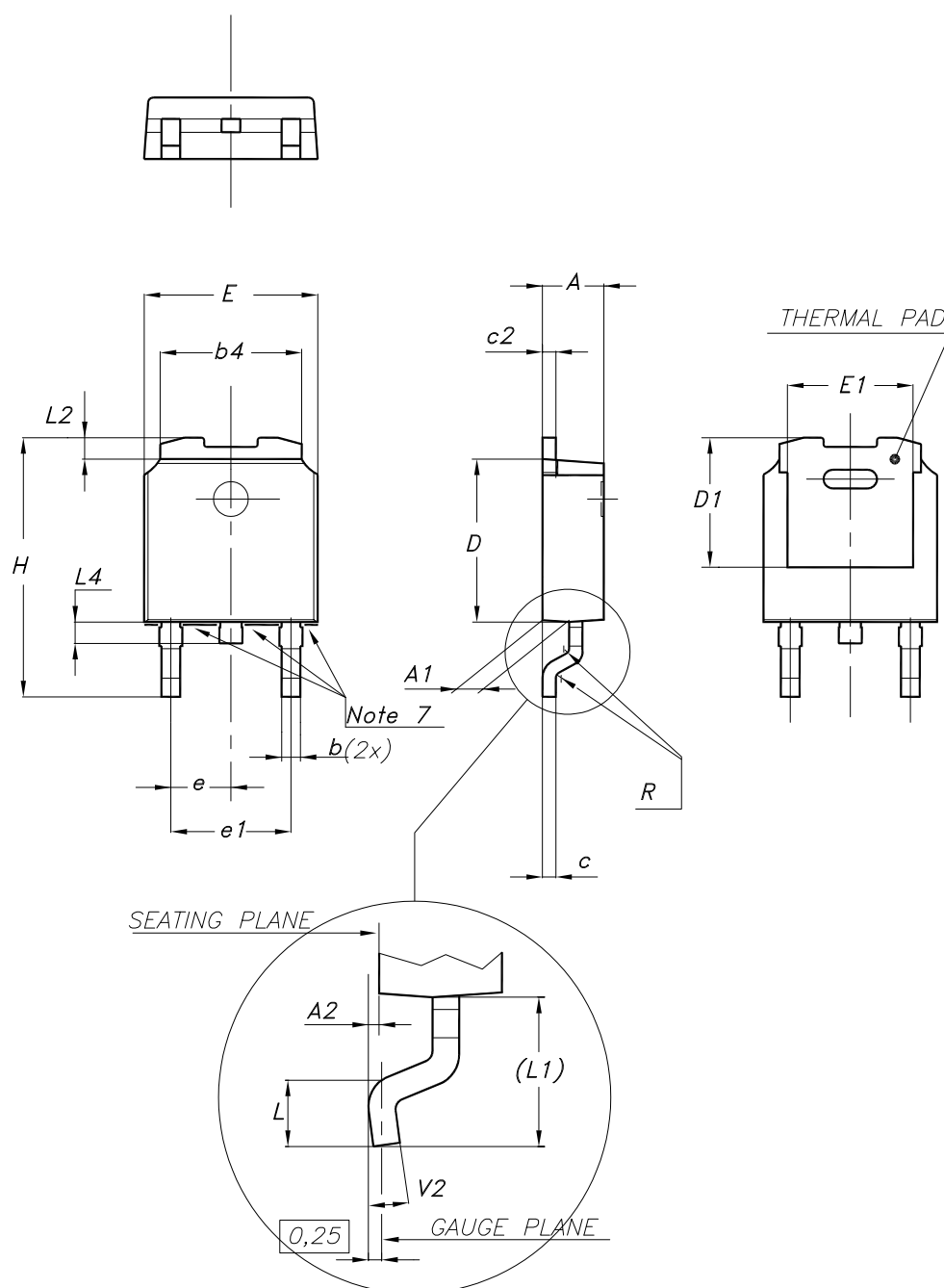
AM01473v1

## 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 DPAK (TO-252) type A package information

**Figure 19. DPAK (TO-252) type A package outline**



0068772\_A\_34

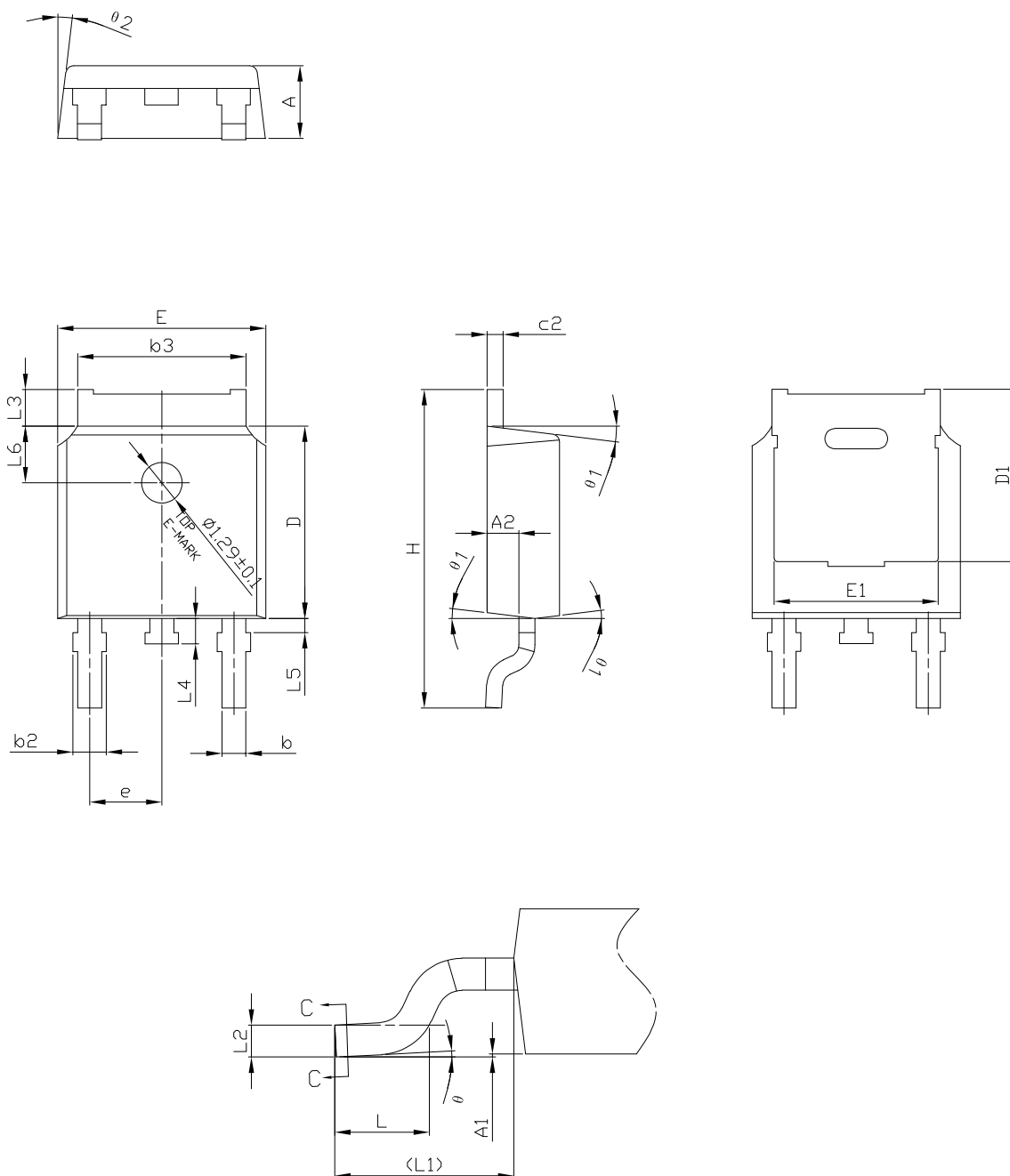


**Table 8. DPAK (TO-252) type A mechanical data**

| 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 C3 package information

Figure 20. DPAK (TO-252) type C3 package outline



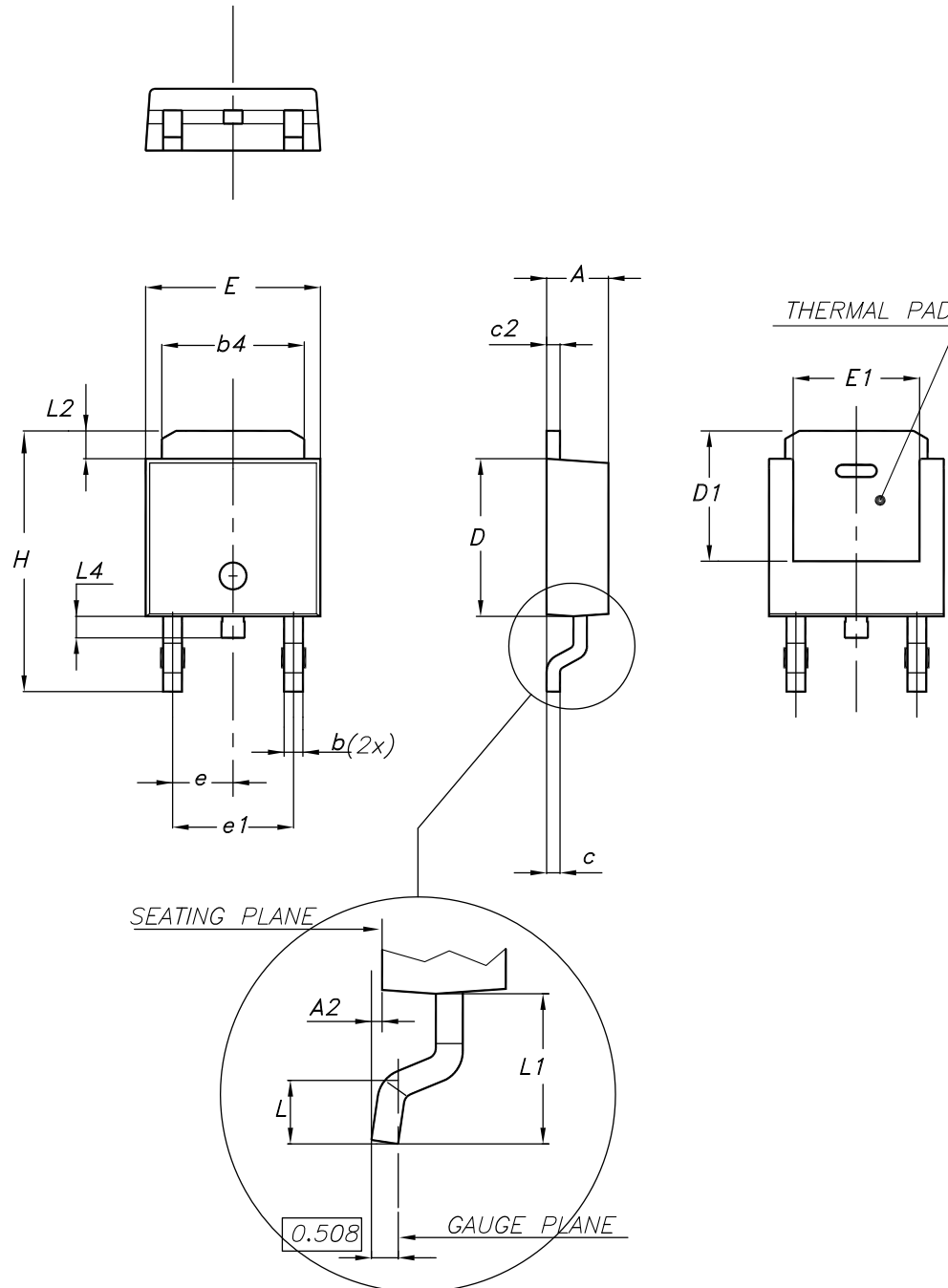
0068772\_type-C3\_rev34

**Table 9. DPAK (TO-252) type C3 mechanical data**

| Dim. | mm       |       |       |
|------|----------|-------|-------|
|      | Min.     | Typ.  | Max.  |
| A    | 2.20     | 2.30  | 2.38  |
| A1   | 0.00     |       | 0.10  |
| A2   | 0.90     | 1.01  | 1.10  |
| b    | 0.72     |       | 0.85  |
| b2   | 0.72     |       | 1.10  |
| b3   | 5.13     | 5.33  | 5.46  |
| c    | 0.47     |       | 0.60  |
| c2   | 0.47     |       | 0.60  |
| D    | 6.00     | 6.10  | 6.20  |
| D1   | 5.20     | 5.45  | 5.70  |
| E    | 6.50     | 6.60  | 6.70  |
| E1   | 5.00     | 5.20  | 5.40  |
| e    | 2.186    | 2.286 | 2.386 |
| H    | 9.80     | 10.10 | 10.40 |
| L    | 1.40     | 1.50  | 1.70  |
| L1   | 2.90 REF |       |       |
| L2   | 0.51 BSC |       |       |
| L3   | 0.90     |       | 1.25  |
| L4   | 0.60     | 0.80  | 1.00  |
| L5   | 0.15     |       | 0.75  |
| L6   | 1.80 REF |       |       |
| θ    | 0°       |       | 8°    |
| θ1   | 5°       | 7°    | 9°    |
| θ2   | 5°       | 7°    | 9°    |

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

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

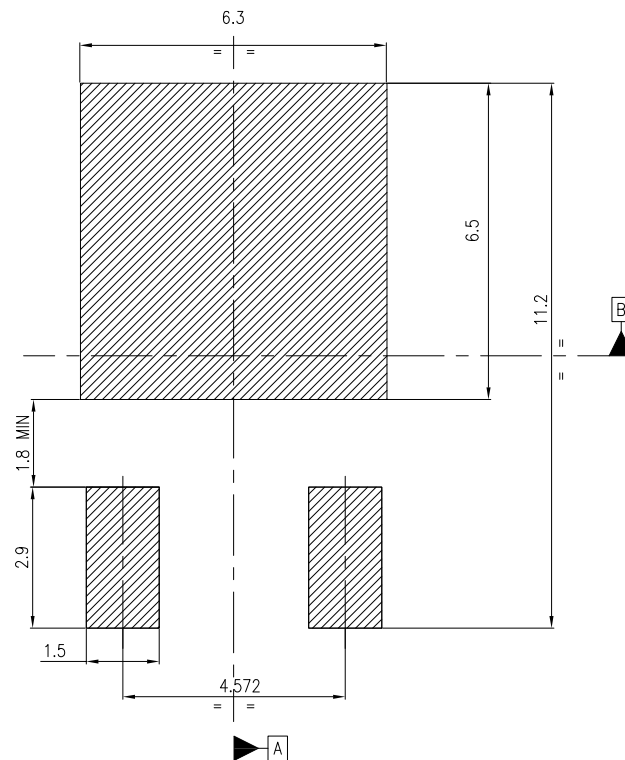


0068772\_typeE\_rev.34

**Table 10. 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)**



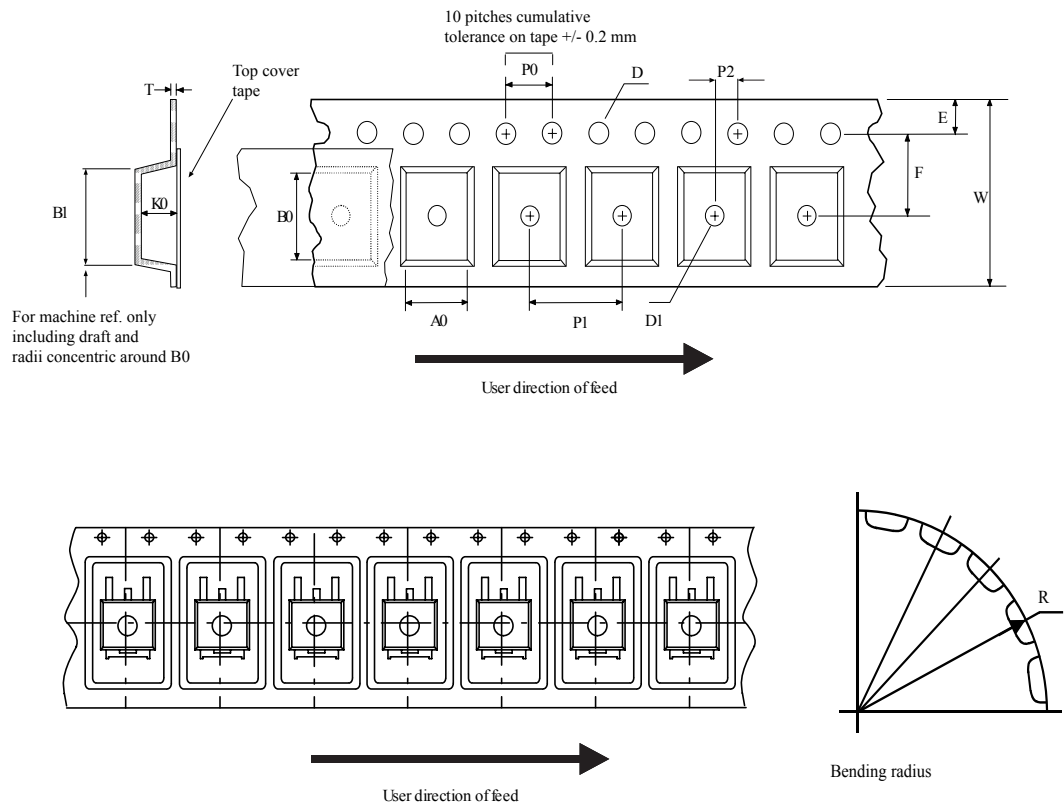
Notes:

- 1) This footprint is able to ensure insulation up to 630 Vrms (according to CEI IEC 664-1)
- 2) The device must be positioned within  $\Phi 0.05$  A B

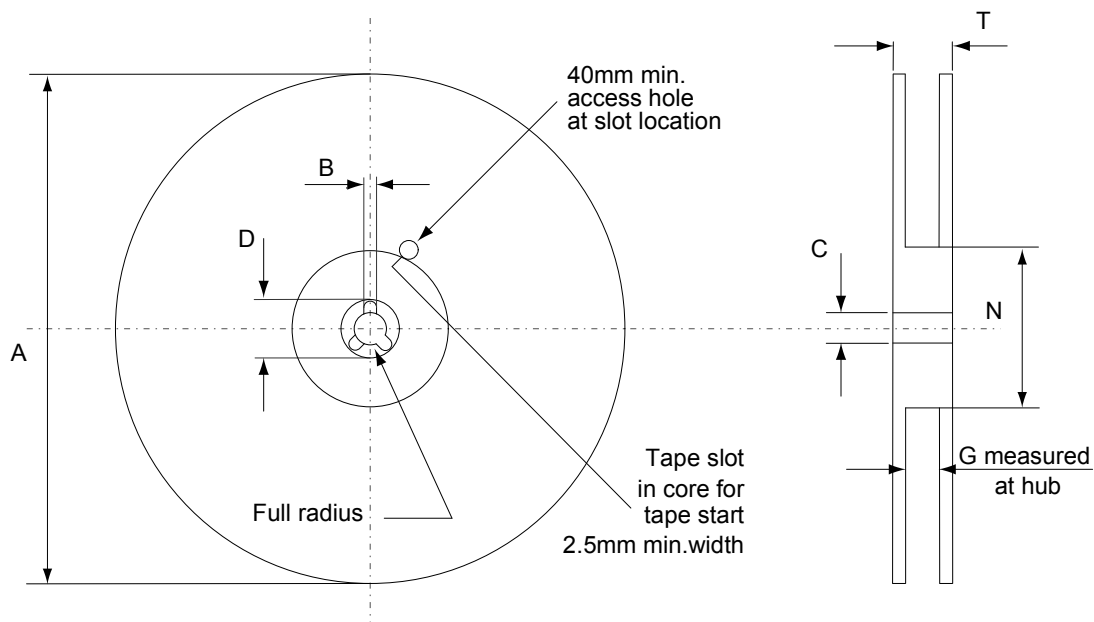
FP\_0068772\_34

## 4.4 DPAK (TO-252) packing information

**Figure 23. DPAK (TO-252) tape outline**



AM08852v1

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


AM06038v1

**Table 11. 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 12. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 02-Sep-2002 | 2        | Document updated.                                                                                                                                                                                                                                                                                                                                                                                                              |
| 11-Jul-2018 | 3        | Part number STD7NK40Z-1 was moved to a separate datasheet, and the document was updated accordingly.<br>Updated title, features, applications and description on cover page.<br>Updated <i>Section 1 Electrical ratings</i> , <i>Section 2 Electrical characteristics</i> , <i>Section 3 Test circuits</i> and <i>Section 4 Package information</i> .<br>Minor text changes                                                    |
| 23-May-2023 | 4        | The part numbers STP7NK40Z and STP7NK40ZFP have been moved to a separate datasheet and the document has been updated accordingly.<br>Removed " <i>Table 8. Gate-source Zener diode</i> ".<br>Updated <i>Section 4.1 DPAK (TO-252) type A package information</i> , <i>Section 4.3 DPAK (TO-252) type E package information</i> and added <i>Section 4.2 DPAK (TO-252) type C3 package information</i> .<br>Minor text changes. |
| 24-May-2023 | 5        | Updated <b>Features</b> on cover page.                                                                                                                                                                                                                                                                                                                                                                                         |

## Contents

|          |                                           |           |
|----------|-------------------------------------------|-----------|
| <b>1</b> | <b>Electrical ratings</b>                 | <b>2</b>  |
| <b>2</b> | <b>Electrical characteristics</b>         | <b>3</b>  |
| 2.1      | Electrical characteristics (curves)       | 5         |
| <b>3</b> | <b>Test circuits</b>                      | <b>7</b>  |
| <b>4</b> | <b>Package information</b>                | <b>8</b>  |
| 4.1      | DPAK (TO-252) type A package information  | 8         |
| 4.2      | DPAK (TO-252) type C3 package information | 10        |
| 4.3      | DPAK (TO-252) type E package information  | 12        |
| 4.4      | DPAK (TO-252) packing information         | 15        |
|          | <b>Revision history</b>                   | <b>17</b> |

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