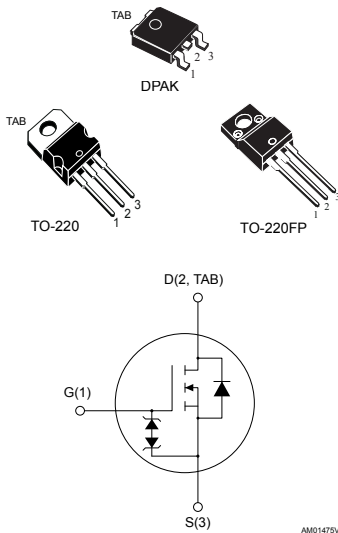


## N-channel 400 V, 0.85 $\Omega$ typ., 5.4 A, SuperMESH™ Power MOSFETs in DPAK, TO-220 and TO-220FP packages



### Features

| Order code  | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ | $P_{TOT}$ |
|-------------|----------|-------------------|-------|-----------|
| STD7NK40ZT4 | 400 V    | 1 $\Omega$        | 5.4 A | 70 W      |
| STP7NK40Z   |          |                   |       | 70 W      |
| STP7NK40ZFP |          |                   |       | 25 W      |

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance
- Zener-protected

### Applications

- Switching applications

### Description

These high-voltage devices are Zener-protected N-channel Power MOSFETs developed using the SuperMESH™ technology by STMicroelectronics, an optimization of the well-established PowerMESH™. In addition to a significant reduction in on-resistance, these devices are designed to ensure a high level of dv/dt capability for the most demanding applications.

#### Product status links

[STD7NK40ZT4](#)
[STP7NK40Z](#)
[STP7NK40ZFP](#)

#### Product summary

##### STD7NK40ZT4

|         |               |
|---------|---------------|
| Marking | D7NK40Z       |
| Package | DPAK          |
| Packing | Tape and reel |

##### STP7NK40Z

|         |         |
|---------|---------|
| Marking | P7NK40Z |
| Package | TO-220  |
| Packing | Tube    |

##### STP7NK40ZFP

|         |           |
|---------|-----------|
| Marking | P7NK40ZFP |
| Package | TO-220FP  |
| Packing | Tube      |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                         | Parameter  | Value       |           |                     | Unit |
|--------------------------------|--|-------------|-----------|---------------------|------|
|                                |  | STD7NK40ZT4 | STP7NK40Z | STP7NK40ZFP         |      |
| V <sub>DS</sub>                | Drain-source voltage   | 400         |           |                     | V    |
| V <sub>DGR</sub>               | Drain-gate voltage (R <sub>GS</sub> = 20 kΩ)   | 400         |           |                     | V    |
| V <sub>GS</sub>                | Gate-source voltage  | ±30         |           |                     | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C   | 5.4         | 5.4       | 5.4 <sup>(1)</sup>  | A    |
|                                | Drain current (continuous) at T <sub>C</sub> = 100 °C  | 3.4         | 3.4       | 3.4 <sup>(1)</sup>  | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)   | 21.6        | 21.6      | 21.6 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C  | 70          | 70        | 25                  | W    |
| I <sub>AR</sub>                | Avalanche current, repetitive or non-repetitive (pulse width is limited by T <sub>J</sub> max.)                            | 5.4         |           |                     | 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> = 50 V) | 130         |           |                     | mJ   |
| ESD                            | Gate-source, human body model, R = 1.5 kΩ, C = 100 pF  | 3           |           |                     | kV   |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope  | 4.5         |           |                     | 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)            |             |           | 2.5                 | kV   |
| T <sub>J</sub>                 | Operating junction temperature range   | -55 to 150  |           |                     | °C   |
| T <sub>stg</sub>               | Storage temperature range  |             |           |                     |      |

1. This value is limited by maximum junction temperature.
2. Pulse width is limited by safe operating area.
3. I<sub>SD</sub> ≤ 5.4 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> < V<sub>(BR)DSS</sub>

**Table 2. Thermal data**

| Symbol                              | Parameter                           | Value |        |          | Unit |
|-------------------------------------|-------------------------------------|-------|--------|----------|------|
|                                     |                                     | DPAK  | TO-220 | TO-220FP |      |
| R <sub>thj-case</sub>               | Thermal resistance junction-case    | 1.78  | 1.78   | 5        | °C/W |
| R <sub>thj-amb</sub>                | Thermal resistance junction-ambient |       |        | 62.5     | °C/W |
| R <sub>thj-pcb</sub> <sup>(1)</sup> | Thermal resistance junction-pcb     | 50    |        |          | °C/W |

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

## 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    | $I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$                                      | 400  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 400\text{ V}$                                  |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 400\text{ V}$ ,<br>$T_C = 125\text{ °C}^{(1)}$ |      |      | 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 | $V_{GS} = 10\text{ V}$ , $I_D = 2.7\text{ A}$                                    |      | 0.85 | 1        | $\Omega$      |

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

**Table 4. Dynamic**

| Symbol                     | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|----------------------------|-------------------------------|--|------|------|------|---------------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$  | -    | 535  | -    | $\mu\text{F}$ |
| $C_{oss}$                  | Output capacitance            |  |      | 82   |      |               |
| $C_{rss}$                  | Reverse transfer capacitance  |  |      | 18   |      |               |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }320\text{ V}$  | -    | 53   | -    | $\mu\text{F}$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 320\text{ V}$ , $I_D = 5.4\text{ A}$ ,<br>$V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 16. Test circuit for gate charge behavior) | -    | 19   | 26   | nC            |
| $Q_{gs}$                   | Gate-source charge            |  |      | 4    |      |               |
| $Q_{gd}$                   | Gate-drain charge             |  |      | 10   |      |               |

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 5. 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   |      |      |
| $t_{d(off)}$  | Turn-off delay time   | (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform) | -    | 30   | -    | ns   |
| $t_f$         | Fall time             |   |      | 12   |      |      |
| $t_{r(Voff)}$ | 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   |      |      |
| $t_c$         | Crossover time        | (see Figure 17. Test circuit for inductive load switching and diode recovery times)                     | -    | 20   | -    | ns   |

**Table 6. 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 |      |
| $V_{SD}^{(2)}$  | 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 <a href="#">Figure 17. Test circuit for inductive load switching and diode recovery times</a> ) | -    | 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%.

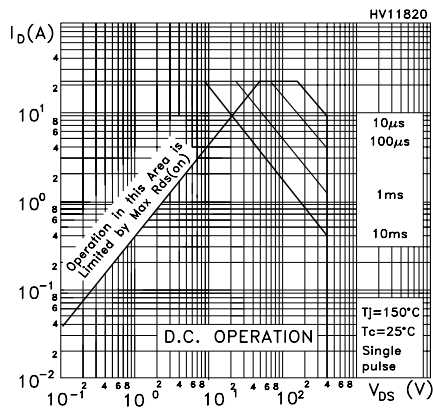
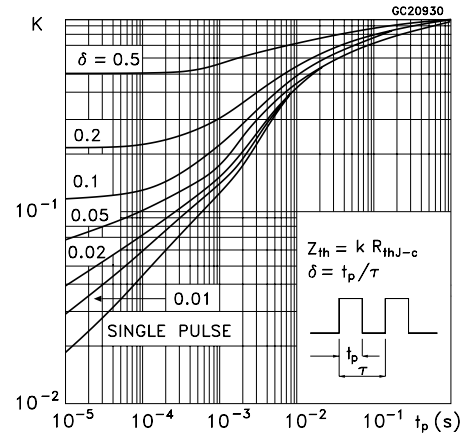
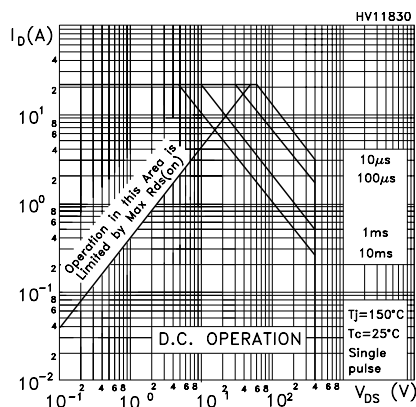
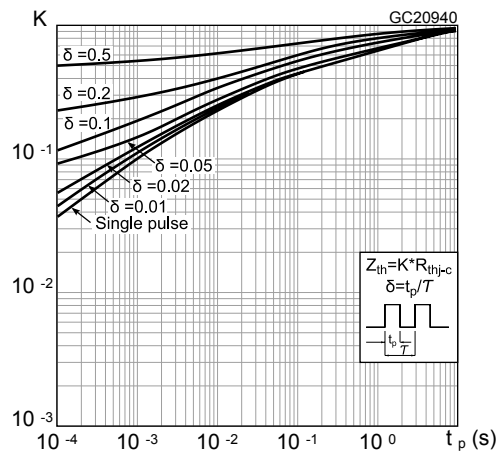
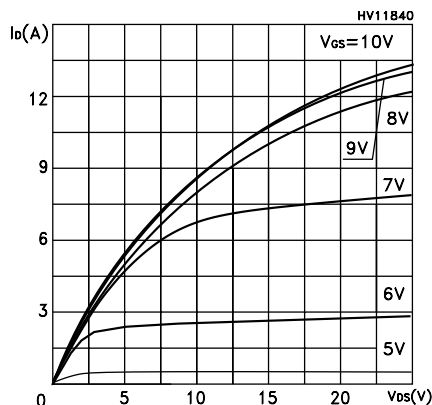
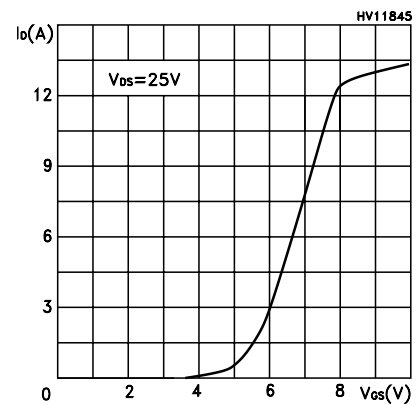
2. Pulse width is limited by safe operating area.

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

| Symbol        | Parameter                     | Test conditions                          | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|--|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1 \text{ mA}$ (open drain) | 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 for TO-220/DPAK**

**Figure 2. Thermal impedance for TO-220/DPAK**

**Figure 3. Safe operating area for TO-220FP**

**Figure 4. Thermal impedance for TO-220FP**

**Figure 5. Output characteristics**

**Figure 6. Transfer characteristics**


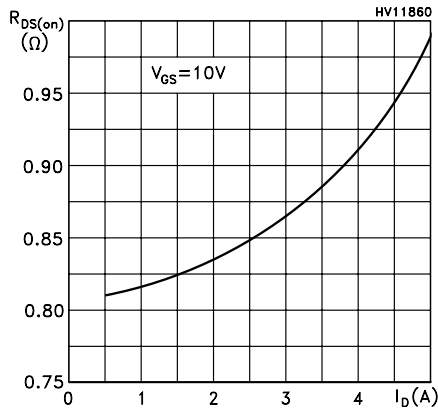
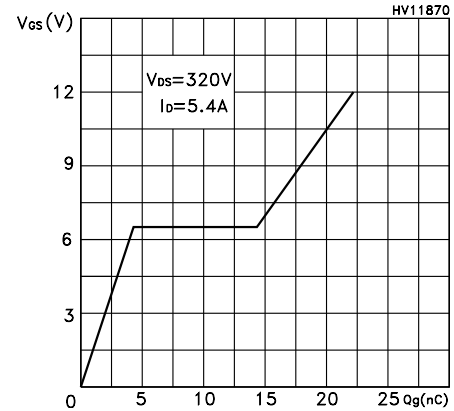
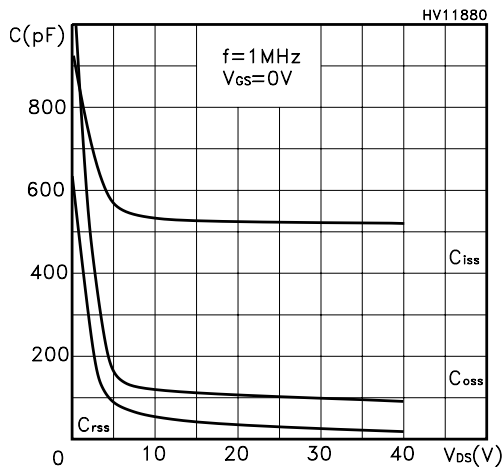
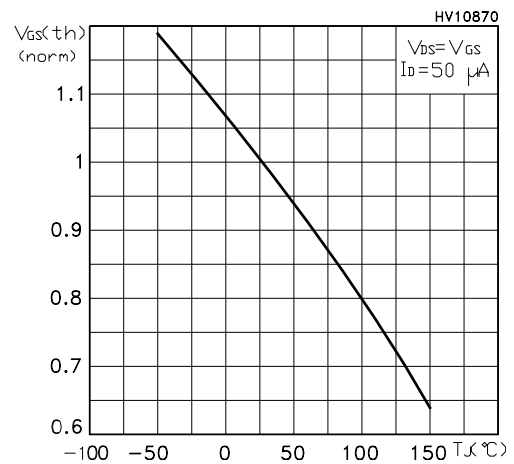
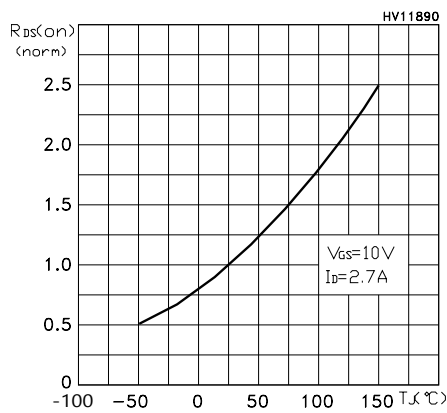
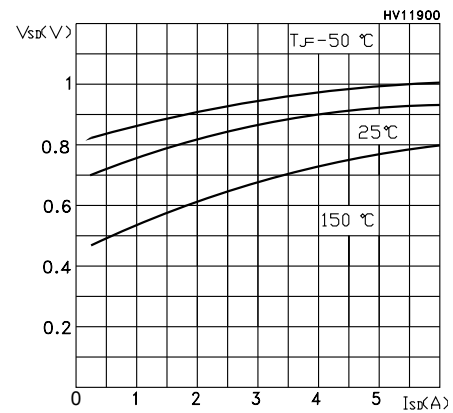
**Figure 7. Static drain-source on-resistance**

**Figure 8. Gate charge vs gate-source voltage**

**Figure 9. Capacitance variations**

**Figure 10. Normalized gate threshold voltage vs temperature**

**Figure 11. Normalized on-resistance vs temperature**

**Figure 12. Source-drain diode forward characteristics**


Figure 13. Normalized  $V_{(BR)DSS}$  vs temperature

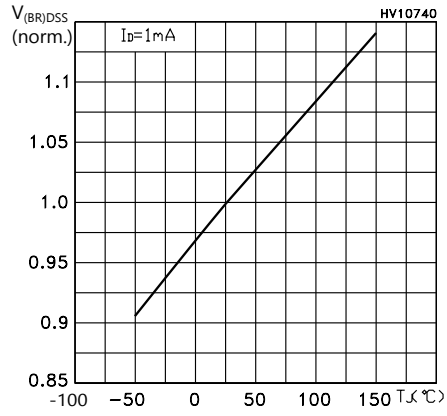
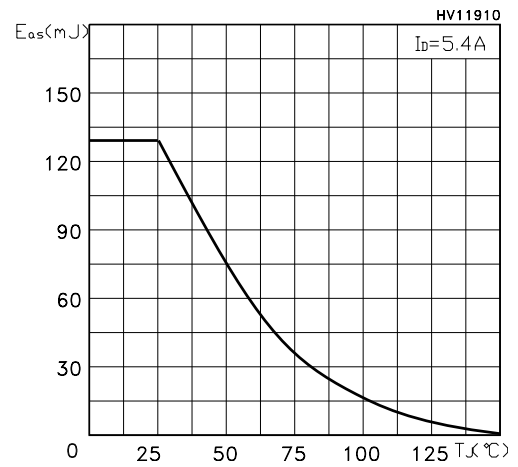
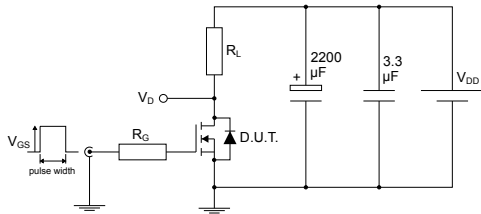


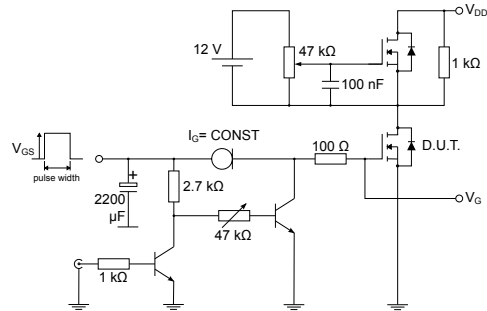
Figure 14. Maximum avalanche energy vs temperature



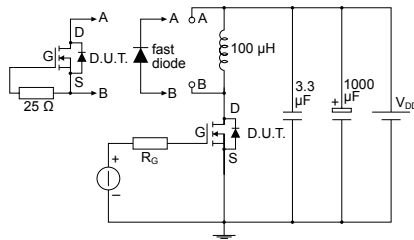
### 3 Test circuits

**Figure 15. Test circuit for resistive load switching times**


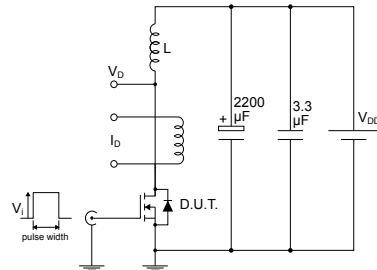
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**Figure 16. Test circuit for gate charge behavior**


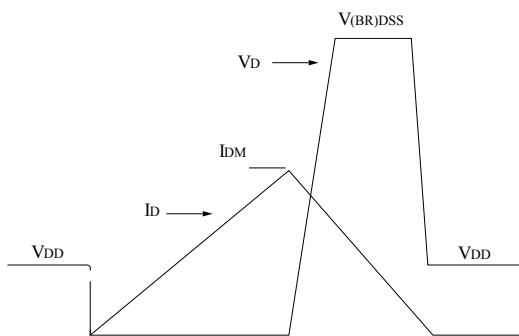
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**Figure 17. Test circuit for inductive load switching and diode recovery times**


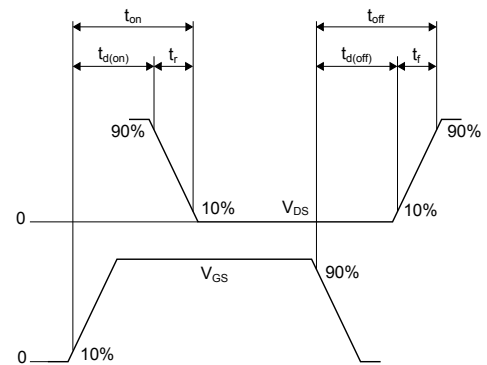
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**Figure 18. Unclamped inductive load test circuit**


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**Figure 19. Unclamped inductive waveform**


AM01472v1

**Figure 20. Switching time waveform**


AM01473v1



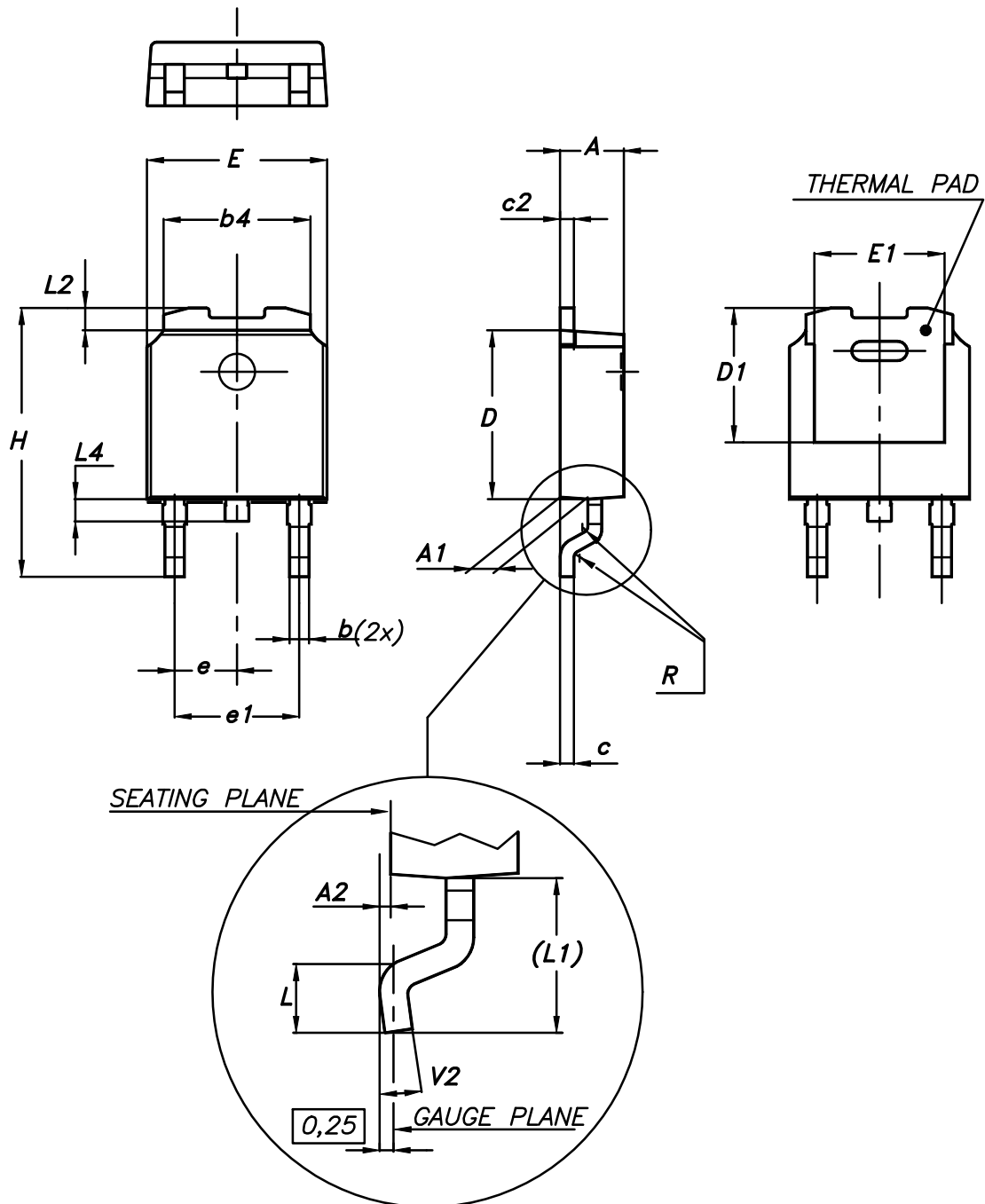
## 4 Package information

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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 21. DPAK (TO-252) type A package outline



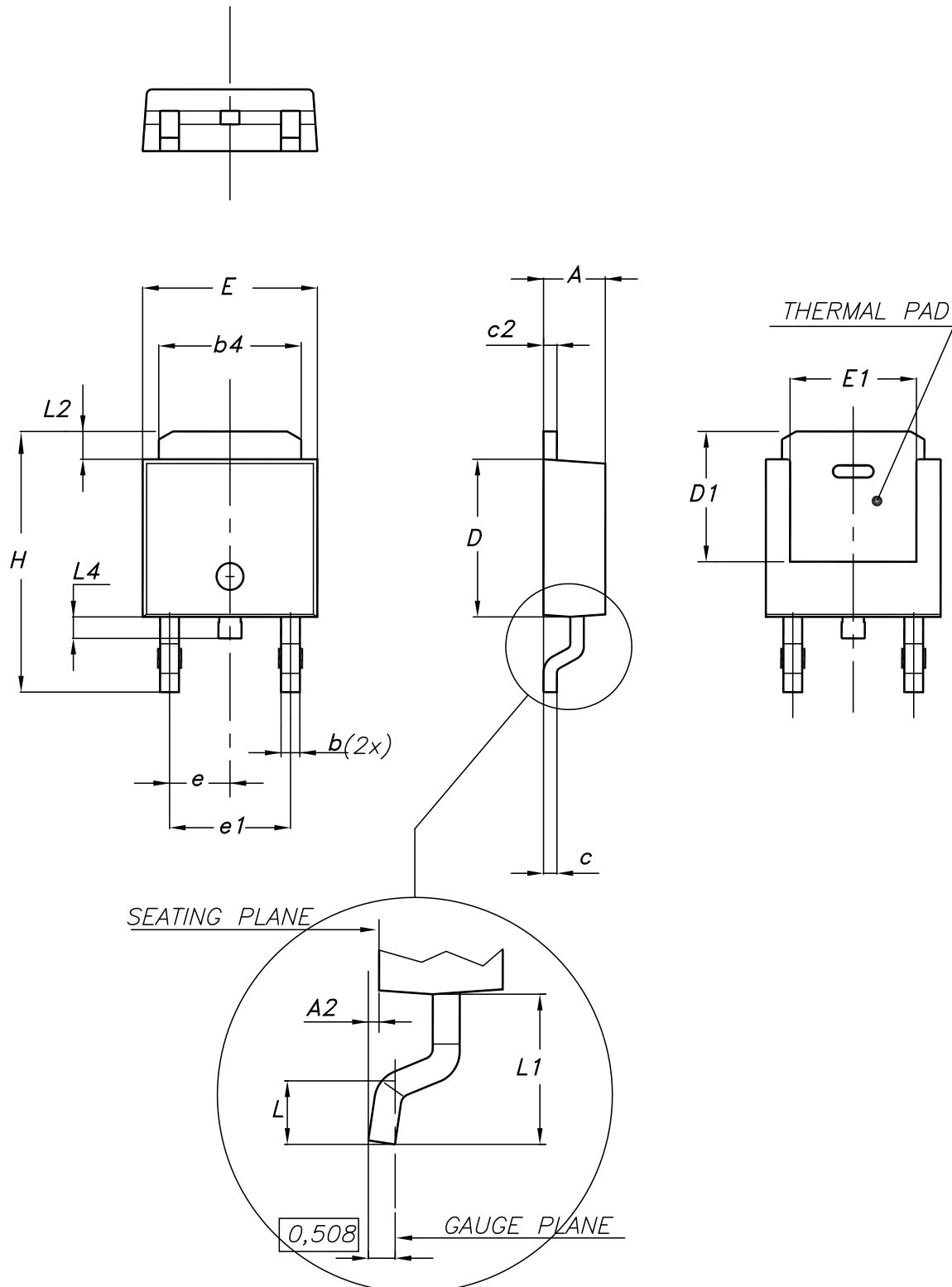
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**Table 8. DPAK (TO-252) type A mechanical data**

| 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°    |

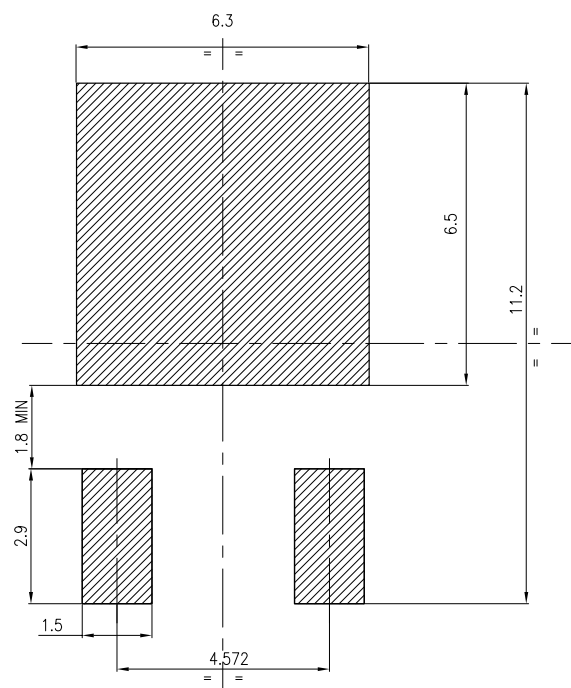
## 4.2 DPAK (TO-252) type E package information

Figure 22. DPAK (TO-252) type E package outline



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

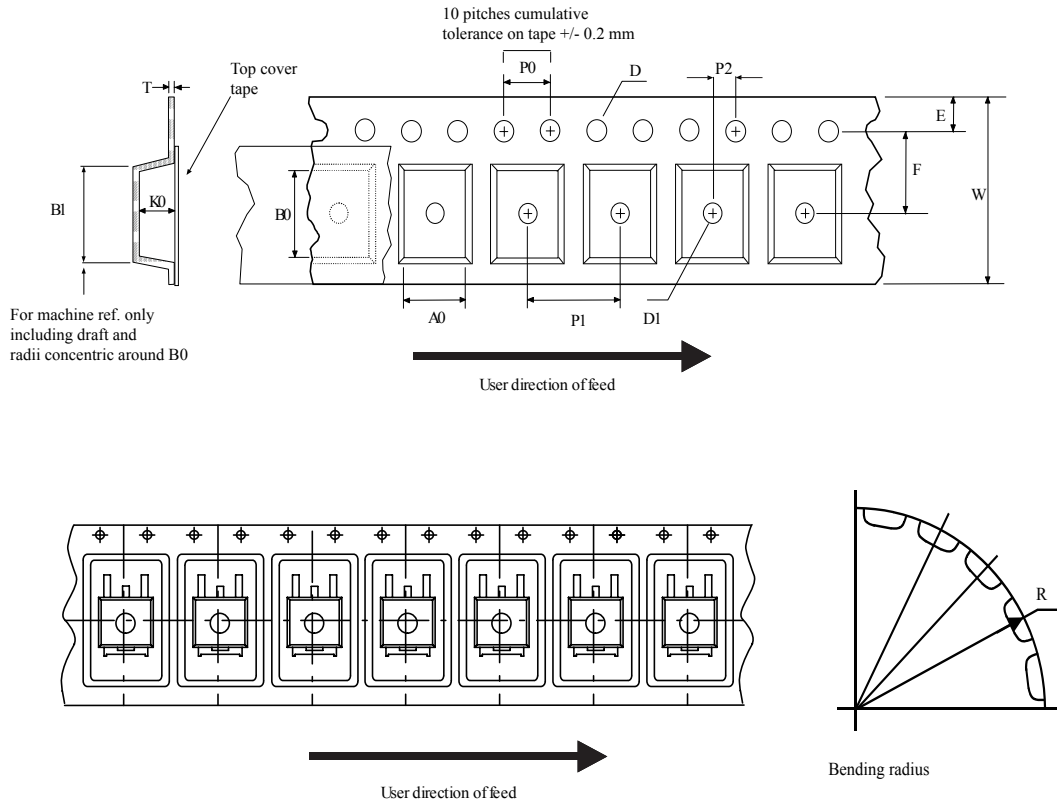
| Dim. | mm   |       |       |
|------|------|-------|-------|
|      | Min. | Typ.  | Max.  |
| A    | 2.18 |       | 2.39  |
| A2   |      |       | 0.13  |
| b    | 0.65 |       | 0.884 |
| b4   | 4.95 |       | 5.46  |
| c    | 0.46 |       | 0.61  |
| c2   | 0.46 |       | 0.60  |
| D    | 5.97 |       | 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 23. DPAK (TO-252) recommended footprint (dimensions are in mm)**


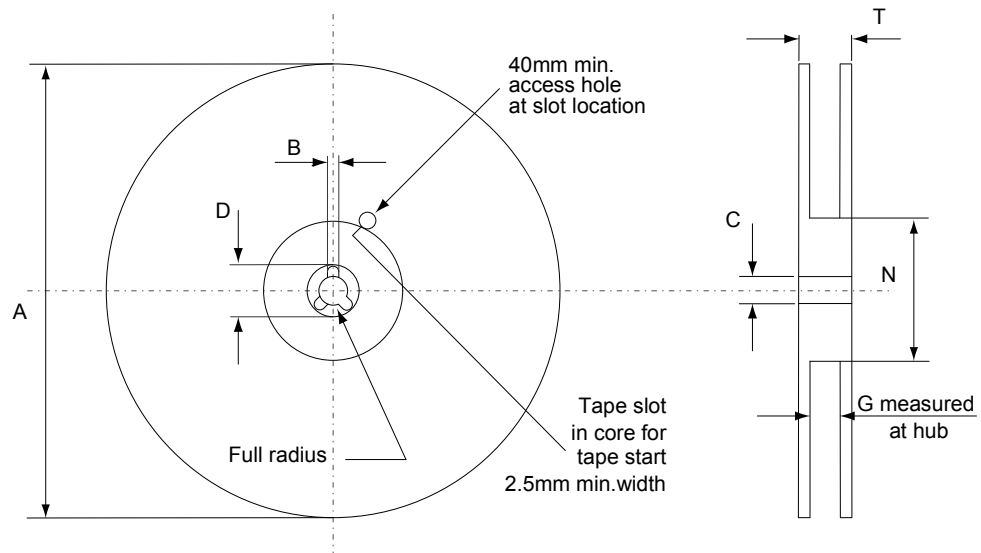
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### 4.3 DPAK (TO-252) packing information

Figure 24. DPAK (TO-252) tape outline



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**Figure 25. DPAK (TO-252) reel outline**


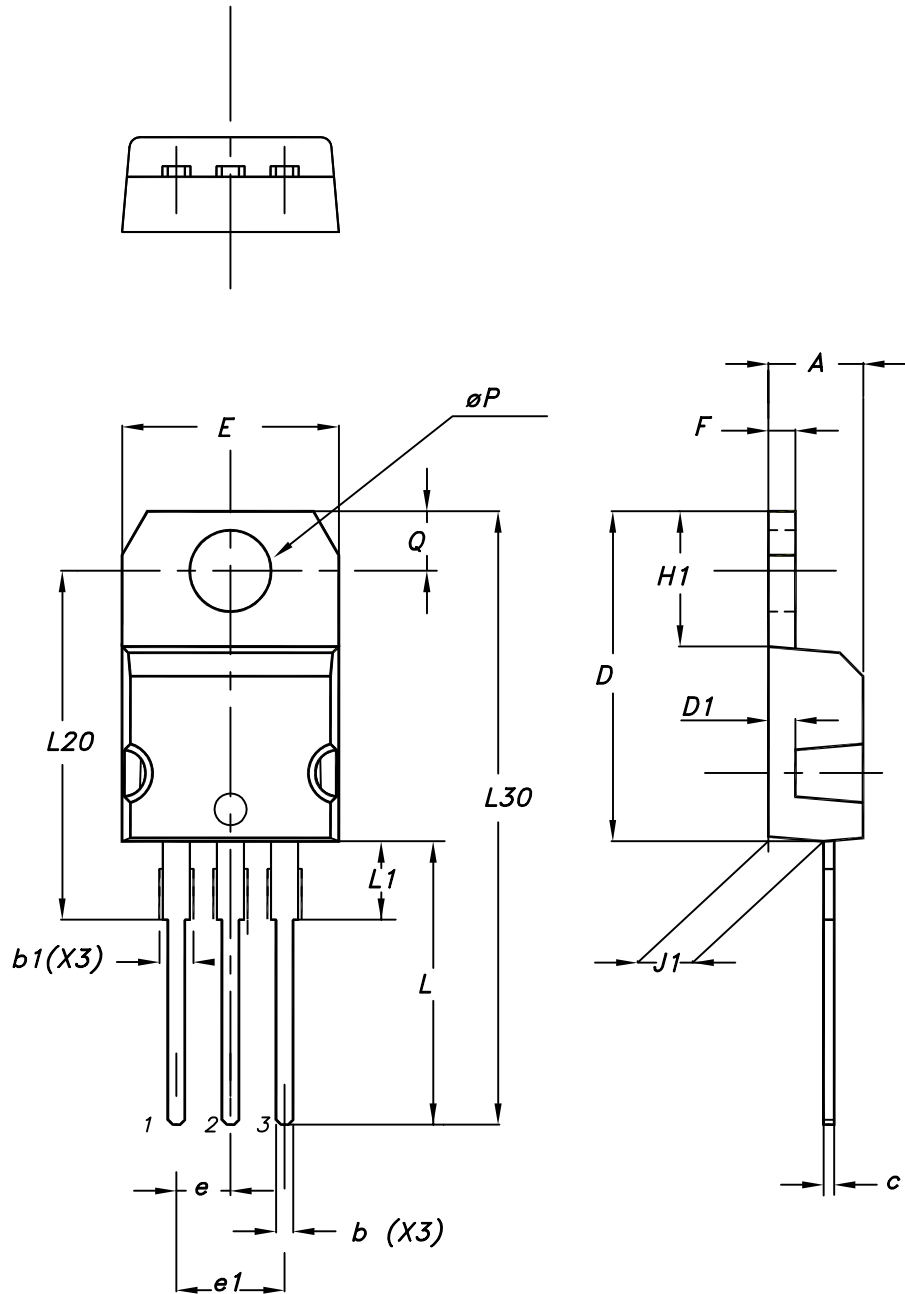
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**Table 10. DPAK (TO-252) tape and reel mechanical data**

| 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 |           |      |      |

#### 4.4 TO-220 type A package information

Figure 26. TO-220 type A package outline



0015988\_typeA\_Rev\_21

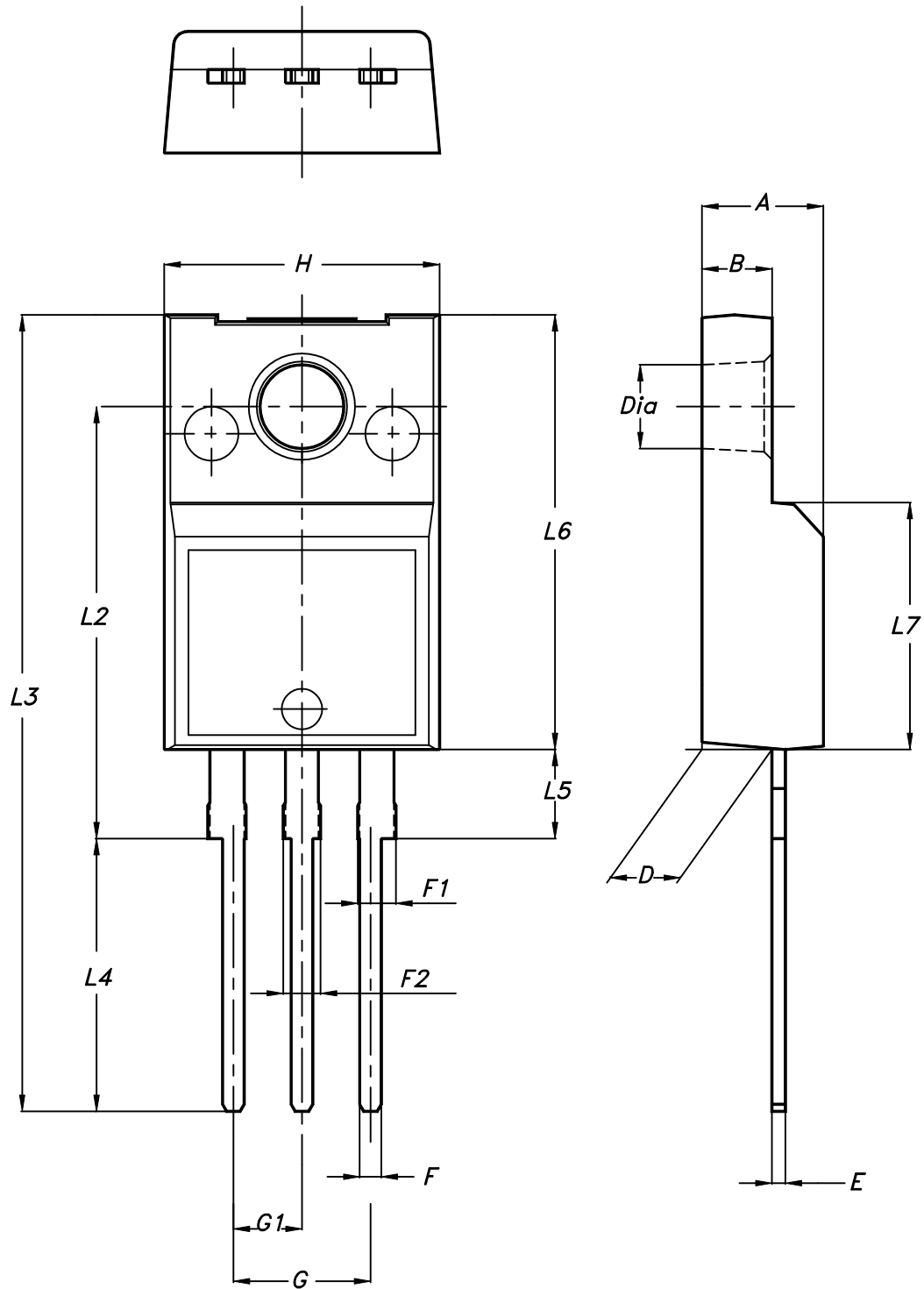


**Table 11. TO-220 type A package mechanical data**

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.55  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10.00 |       | 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    | 13.00 |       | 14.00 |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| øP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

### 4.5 TO-220FP package information

Figure 27. TO-220FP package outline



7012510\_Rev\_12\_B

**Table 12. TO-220FP package 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 |      | 1.70 |
| G    | 4.95 |      | 5.2  |
| G1   | 2.4  |      | 2.7  |
| H    | 10   |      | 10.4 |
| L2   |      | 16   |      |
| L3   | 28.6 |      | 30.6 |
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| L5   | 2.9  |      | 3.6  |
| L6   | 15.9 |      | 16.4 |
| L7   | 9    |      | 9.3  |
| Dia  | 3    |      | 3.2  |

## Revision history

**Table 13. Document revision history**

| Date        | Version | 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 <a href="#">Section 1 Electrical ratings</a> , <a href="#">Section 2 Electrical characteristics</a> , <a href="#">Section 3 Test circuits</a> and <a href="#">Section 4 Package information</a> .<br>Minor text changes |

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