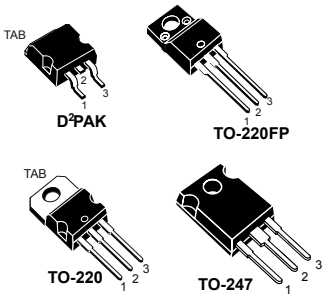
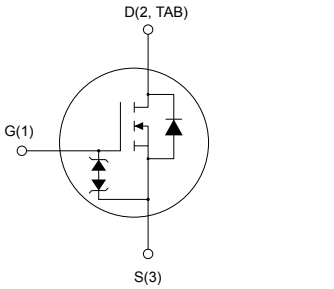
# STB12NK80ZT4, STF12NK80Z
# STP12NK80Z, STW12NK80Z

Datasheet

## N-channel 800 V, 585 mΩ typ., 10.5 A SuperMESH Power MOSFETs in D²PAK, TO-220FP, TO-220 and TO-247 packages




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STB12NK80ZT4 | 800 V | 750 mΩ | 10.5 A |
| STF12NK80Z | | | |
| STP12NK80Z | | | |
| STW12NK80Z | | | |

- Extremely high dv/dt capability
- Improved ESD 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 |
|---|
| STB12NK80ZT4 |
| STF12NK80Z |
| STP12NK80Z |
| STW12NK80Z |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | $D^2PAK$, TO-220, TO-247 | TO-220FP | |
| $V_{DS}$ | Drain-source voltage | 800 | | V |
| $V_{GS}$ | Gate-source voltage | ±30 | | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 10.5 | 10.5(1) | A |
| | Drain current (continuous) at $T_C$ = 100 °C | 6.6 | 6.6(1) | |
| $I_{DM}$(2) | Drain current (pulsed) | 42 | 42(1) | A |
| $P_{TOT}$ | Total power dissipation at $T_C$ = 25 °C | 190 | 40 | W |
| ESD | Gate-source human body model (C = 100 pF, R = 1.5 kΩ) | 4 | | kV |
| dv/dt(3) | Peak diode recovery voltage slope | 4.5 | | V/ns |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, $T_C$ = 25 °C) | | 2.5 | kV |
| $T_{stg}$ | Storage temperature range | -55 to 150 | | °C |
| $T_J$ | Operating junction temperature range | | | |

1. *Limited by maximum junction temperature.*
2. *Pulse width is limited by safe operating area.*
3. *$I_{SD}$ ≤ 10.5 A, di/dt ≤ 200 A/µs, $V_{DS}$ (peak) < $V_{(BR)DSS}$.*

**Table 2. Thermal data**

| Symbol | Parameter | Value | | | Unit |
|---|---|---|---|---|---|
| | | $D^2PAK$, TO-220 | TO-247 | TO-220FP | |
| $R_{thJC}$ | Thermal resistance, junction-to-case | 0.66 | | 3.1 | °C/W |
| $R_{thJA}$ | Thermal resistance, junction-to-ambient | 62.5 | 50 | 62.5 | °C/W |

**Table 3. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width is limited by $T_J$ max.) | 10.5 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 400 | mJ |

# 2 Electrical characteristics

$T_C$ = 25 °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 mA, $V_{GS}$ = 0 V | 800 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 800 V | | | 1 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 800 V, $T_C$ = 125 °C(1) | | | 50 | |
| $I_{GSS}$ | Gate body leakage current | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | | | ±10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 100 µA | 3.00 | 3.75 | 4.50 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 5.25 A | | 585 | 750 | mΩ |

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 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 2620 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 250 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 53 | - | pF |
| $C_{oss\ eq.}$(1) | Equivalent output capacitance | $V_{GS}$ = 0 V, $V_{DS}$ = 0 to 640 V | - | 100 | - | pF |
| $Q_g$ | Total gate charge | $V_{DD}$ = 640 V, $I_D$ = 10.5 A, $V_{GS}$ = 0 to 10 V (see Figure 18. Test circuit for gate charge behavior) | - | 87 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 14 | - | nC |
| $Q_{gd}$ | Gate-drain charge | | - | 44 | - | nC |

1. *$C_{oss\ eq.}$ 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 | $V_{DD}$ = 400 V, $I_D$ = 5.25 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see Figure 17. Test circuit for resistive load switching times and Figure 22. Switching time waveform) | - | 30 | - | ns |
| $t_r$ | Rise time | | - | 18 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 70 | - | ns |
| $t_f$ | Fall time | | - | 20 | - | ns |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{DD}$ = 640 V, $I_D$= 10.5 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see Figure 19. Test circuit for inductive load switching and diode recovery times) | - | 16 | - | ns |
| $t_f$ | Fall time | | - | 15 | - | ns |
| $t_c$ | Cross-over time | | - | 28 | - | ns |

**Table 7. Source-drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 10.5 | A |
| $I_{SDM}$(1) | Source-drain current (pulsed) | | - | | 42 | A |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$ = 10.5 A, $V_{GS}$ = 0 V | - | | 1.6 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 10.5 A, di/dt = 100 A/µs, | - | 635 | | ns |
| $Q_{rr}$ | Reverse recovery charge | $V_{DD}$ = 100 V, $T_J$ = 150 °C | - | 5.9 | | µC |
| $I_{RRM}$ | Reverse recovery current | (see Figure 19. Test circuit for inductive load switching and diode recovery times) | - | 18.5 | | A |

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

## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area for D²PAK and TO-220**

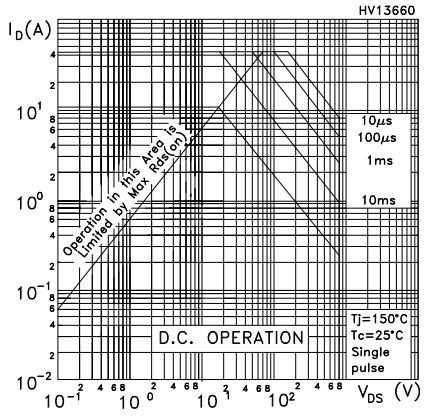



**Figure 2. Normalized transient thermal impedance for D²PAK and TO-220**

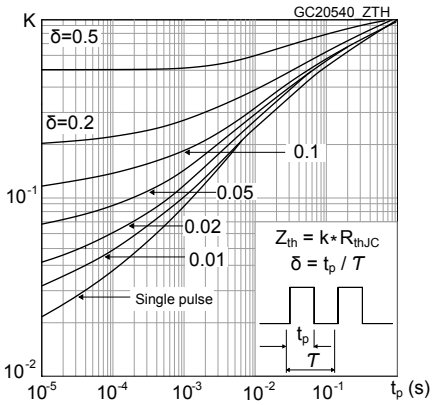



**Figure 3. Safe operating area for TO-220FP**

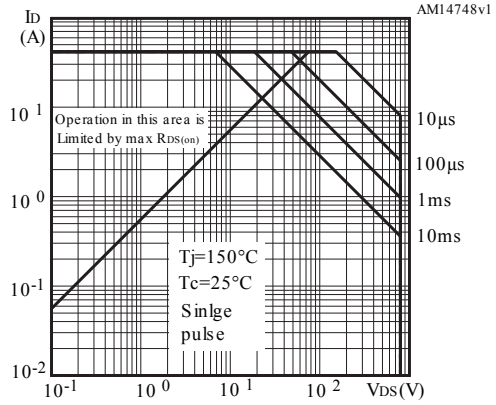



**Figure 4. Normalized transient thermal impedance for TO-220FP**

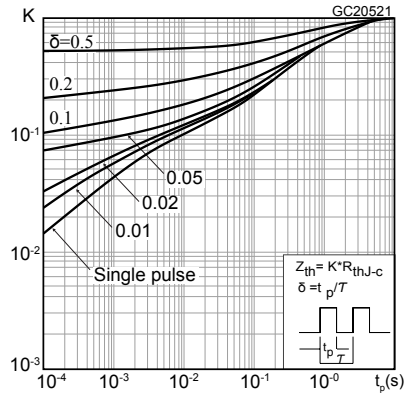



**Figure 5. Safe operating area for TO-247**

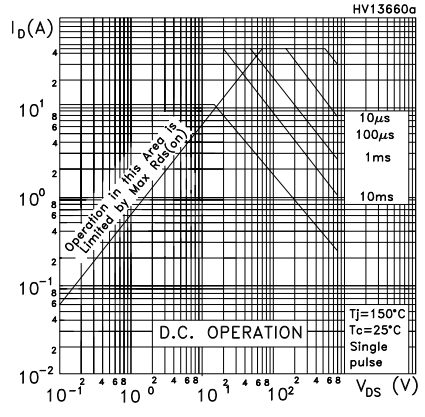



**Figure 6. Normalized transient thermal impedance for TO-247**

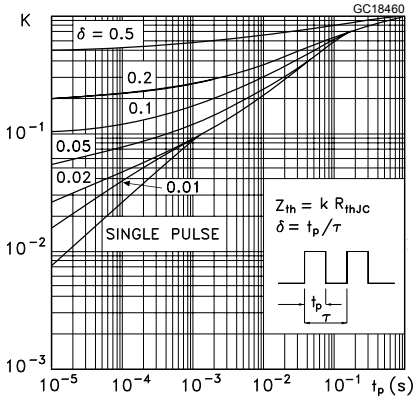


**Figure 7. Typical output characteristics**

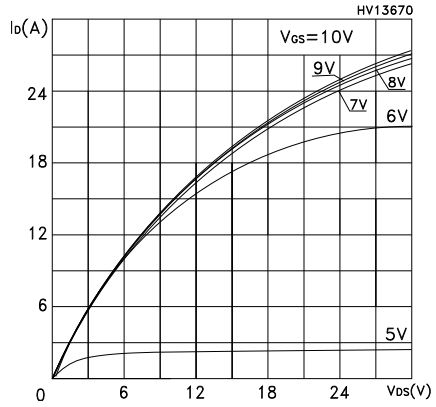



**Figure 8. Typical transfer characteristics**

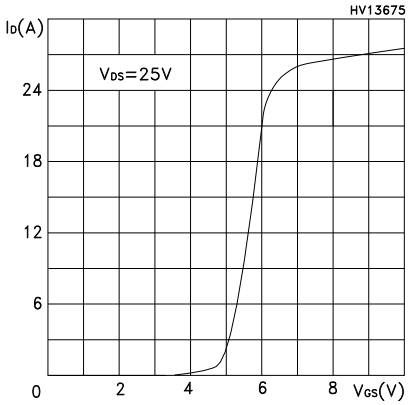



**Figure 9. Typical drain-source on-resistance**

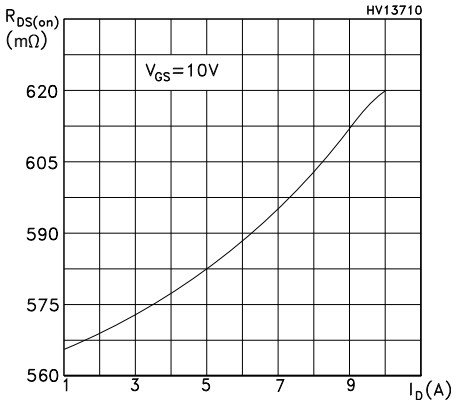



**Figure 10. Typical gate charge characteristics**

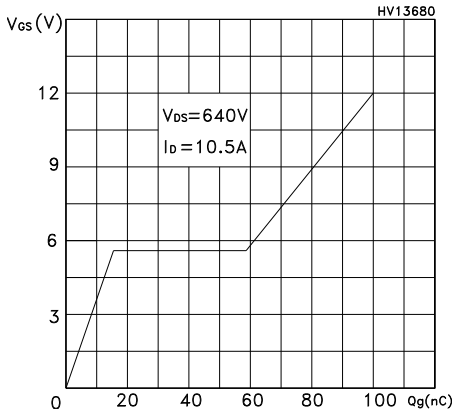



**Figure 11. Typical capacitance characteristics**

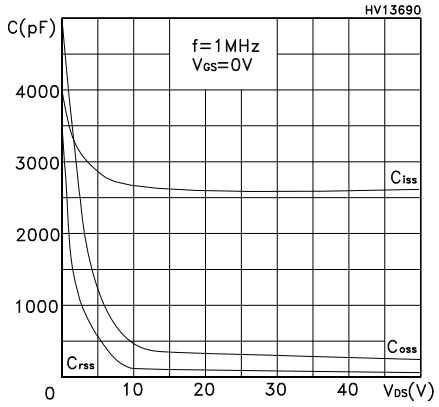



**Figure 12. Normalized gate threshold vs temperature**

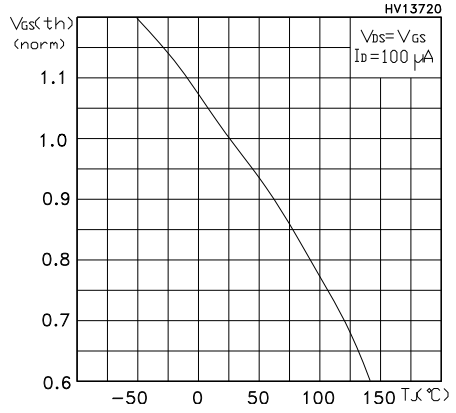


**Figure 13. Normalized on-resistance vs temperature**

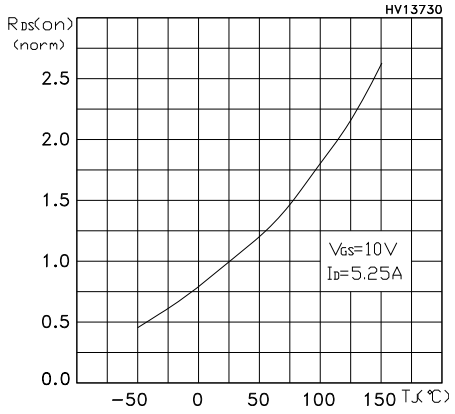



**Figure 14. Typical reverse diode forward characteristics**

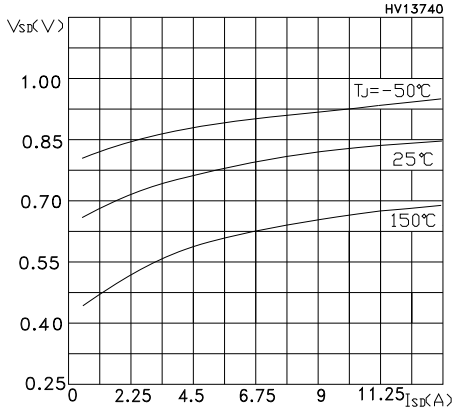



**Figure 15. Maximum avalanche energy vs temperature**

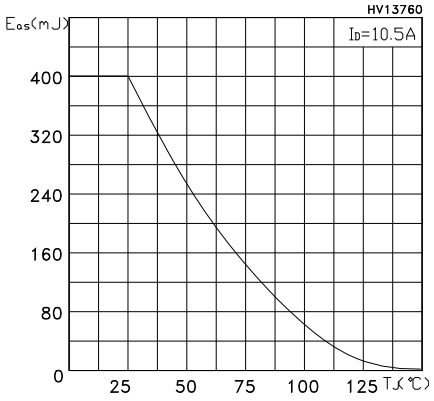
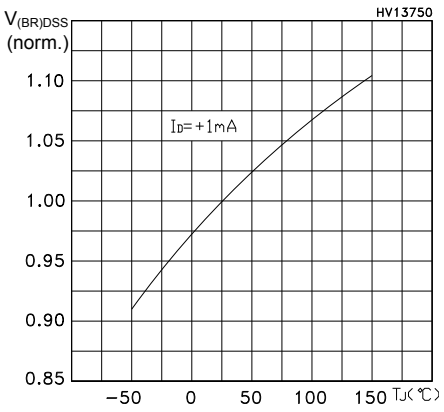
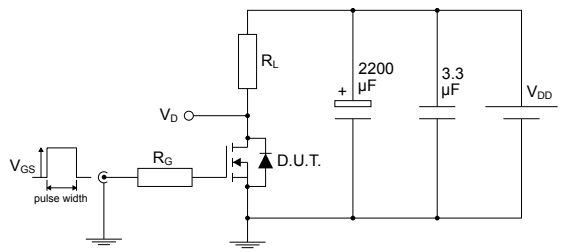



**Figure 16. Normalized breakdown voltage vs temperature**



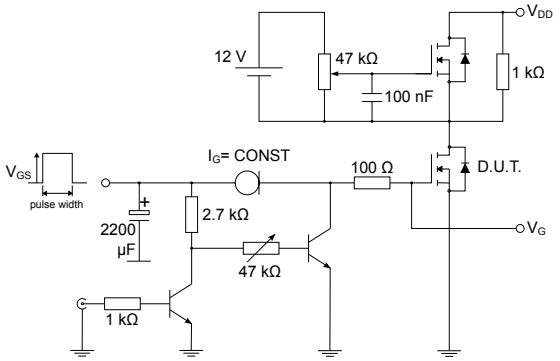
# 3 Test circuits

**Figure 17. Test circuit for resistive load switching times**



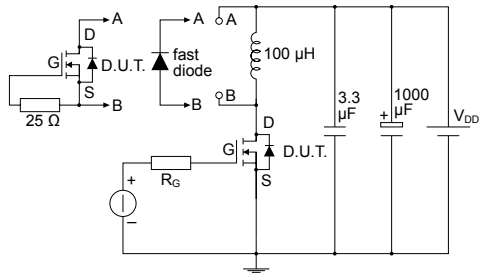

AM01468v1

**Figure 18. Test circuit for gate charge behavior**



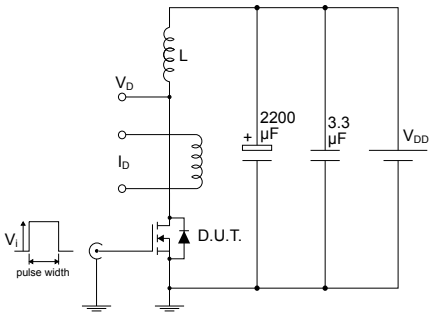

AM01469v1

**Figure 19. Test circuit for inductive load switching and diode recovery times**



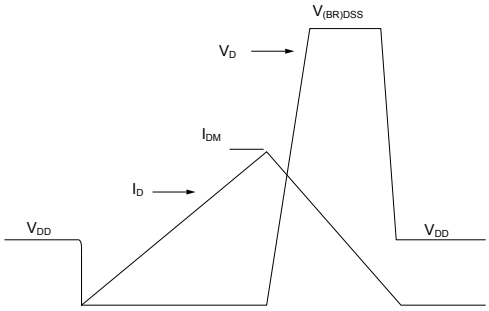

AM01470v1

**Figure 20. Unclamped inductive load test circuit**



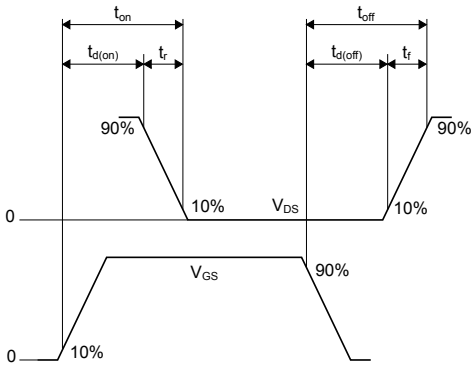

AM01471v1

**Figure 21. Unclamped inductive waveform**




AM01472v1

**Figure 22. Switching time waveform**



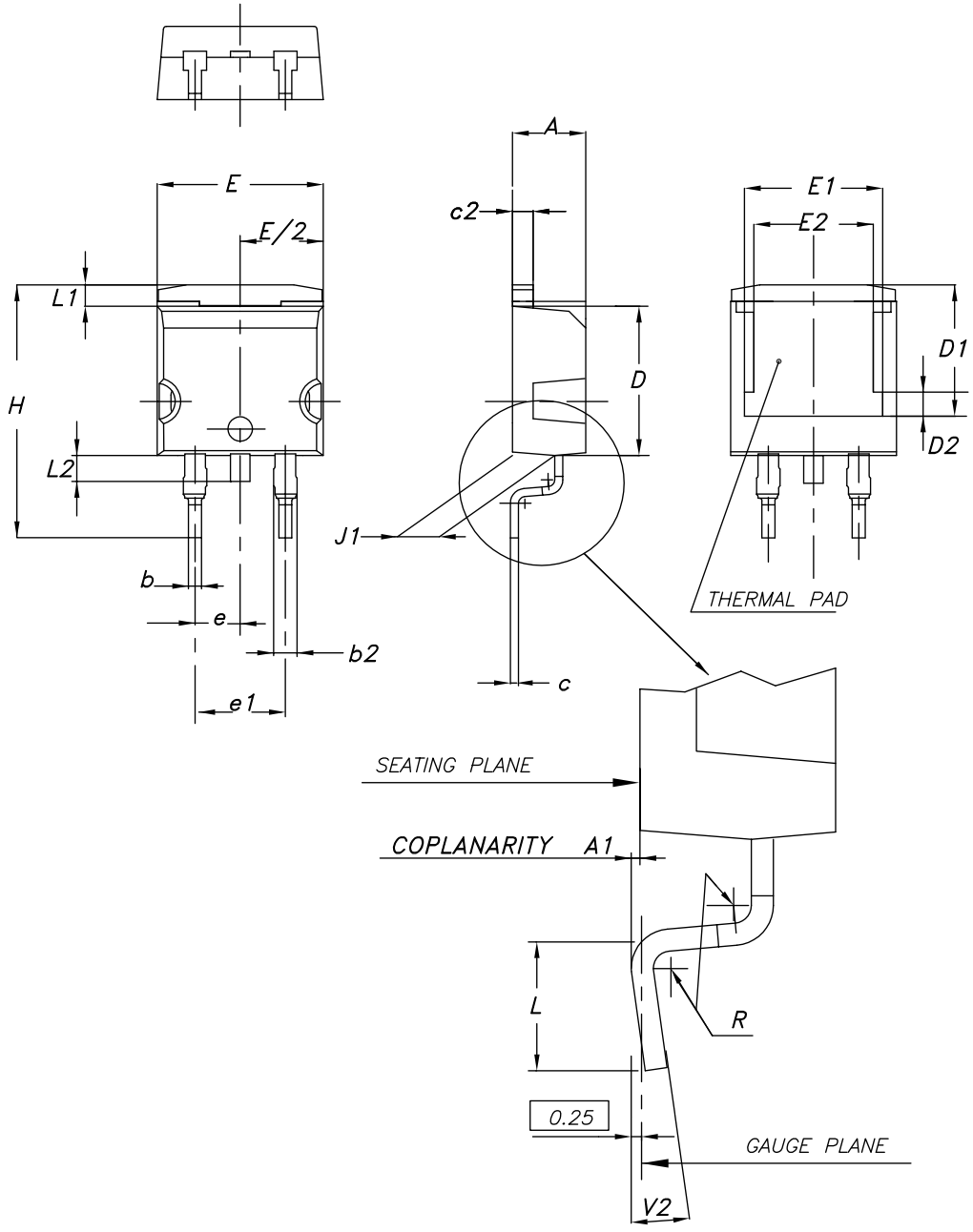

AM01473v1

# 4 Package information

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. ECOPACK is an ST trademark.

## 4.1 D²PAK (TO-263) type A2 package information

**Figure 23. D²PAK (TO-263) type A2 package outline**

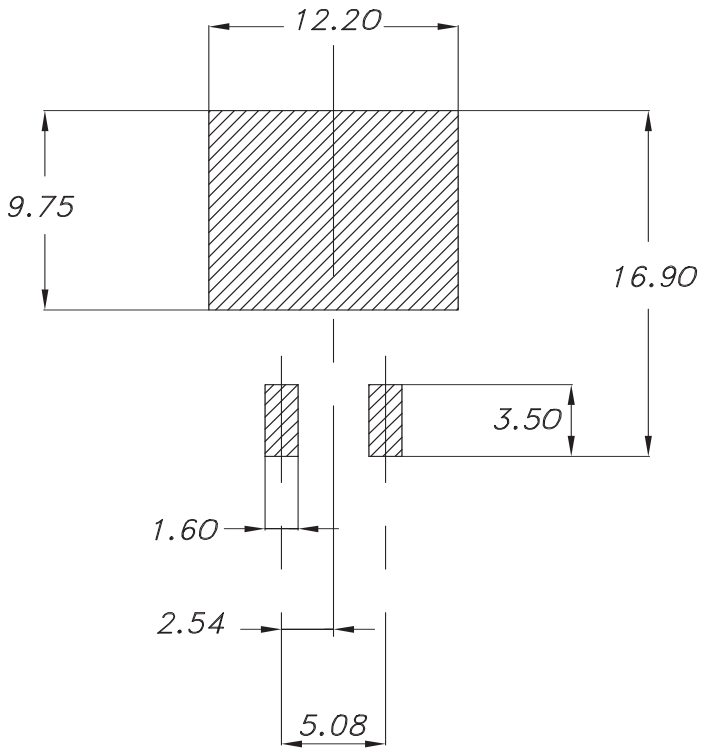



0079457_A2_27

Table 8. **D²PAK (TO-263) type A2 package mechanical data**

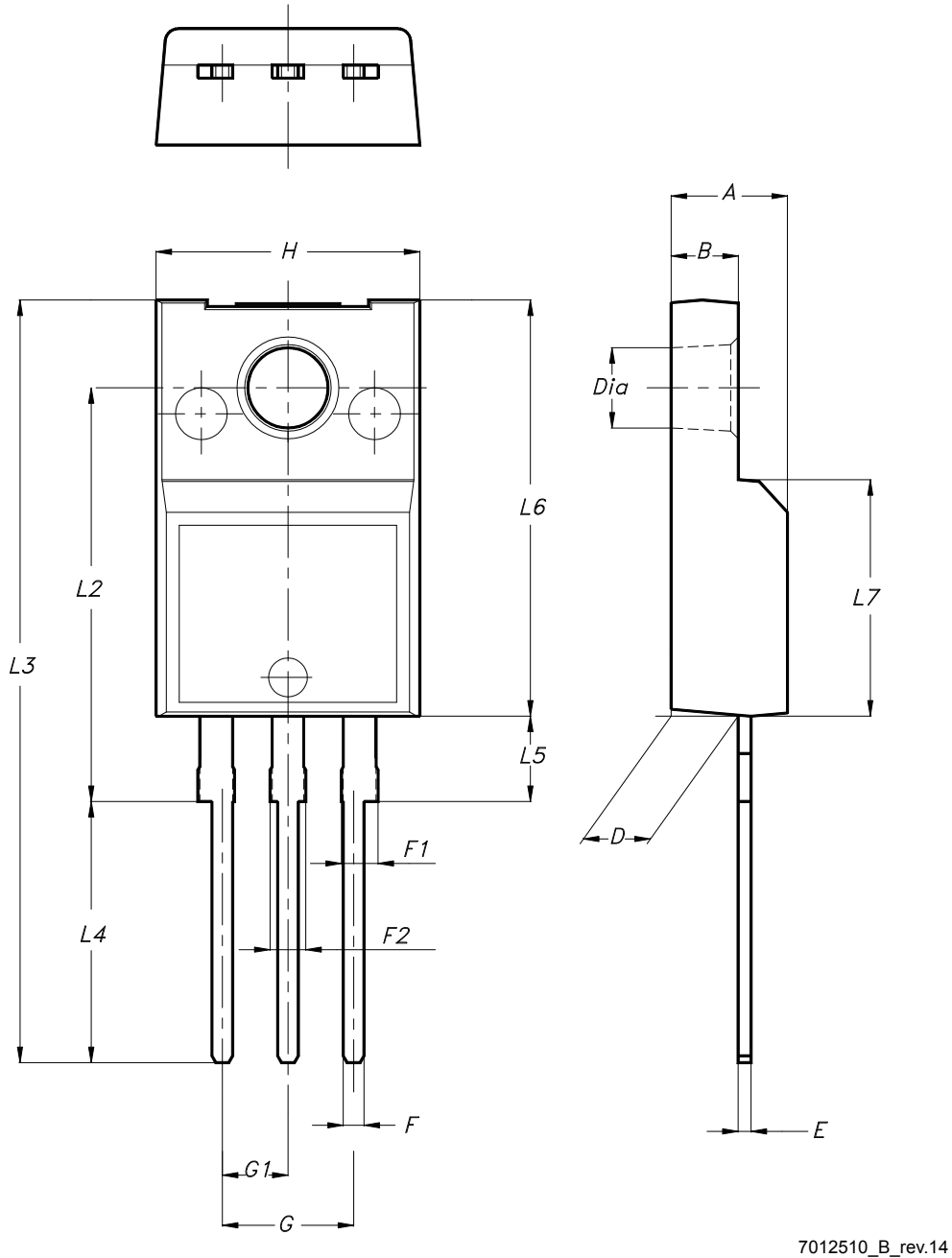
| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| A1 | 0.03 | | 0.23 |
| b | 0.70 | | 0.93 |
| b2 | 1.14 | | 1.70 |
| c | 0.45 | | 0.60 |
| c2 | 1.23 | | 1.36 |
| D | 8.95 | | 9.35 |
| D1 | 7.50 | 7.75 | 8.00 |
| D2 | 1.10 | 1.30 | 1.50 |
| E | 10.00 | | 10.40 |
| E1 | 8.70 | 8.90 | 9.10 |
| E2 | 7.30 | 7.50 | 7.70 |
| e | | 2.54 | |
| e1 | 4.88 | | 5.28 |
| H | 15.00 | | 15.85 |
| J1 | 2.49 | | 2.69 |
| L | 2.29 | | 2.79 |
| L1 | 1.27 | | 1.40 |
| L2 | 1.30 | | 1.75 |
| R | | 0.40 | |
| V2 | 0° | | 8° |

Figure 24. D²PAK (TO-263) recommended footprint (dimensions are in mm)



## 4.2 TO-220FP type B package information

Figure 25. **TO-220FP type B package outline**




7012510_B_rev.14

Table 9. **TO-220FP type B package mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| B | 2.50 | | 2.70 |
| D | 2.50 | | 2.75 |
| E | 0.45 | | 0.70 |
| F | 0.75 | | 1.00 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.70 |
| G | 4.95 | | 5.20 |
| G1 | 2.40 | | 2.70 |
| H | 10.00 | | 10.40 |
| L2 | | 16.00 | |
| L3 | 28.60 | | 30.60 |
| L4 | 9.80 | | 10.60 |
| L5 | 2.90 | | 3.60 |
| L6 | 15.90 | | 16.40 |
| L7 | 9.00 | | 9.30 |
| Dia | 3.00 | | 3.20 |

## 4.3 TO-220 type A package information

Figure 26. **TO-220 type A package outline**

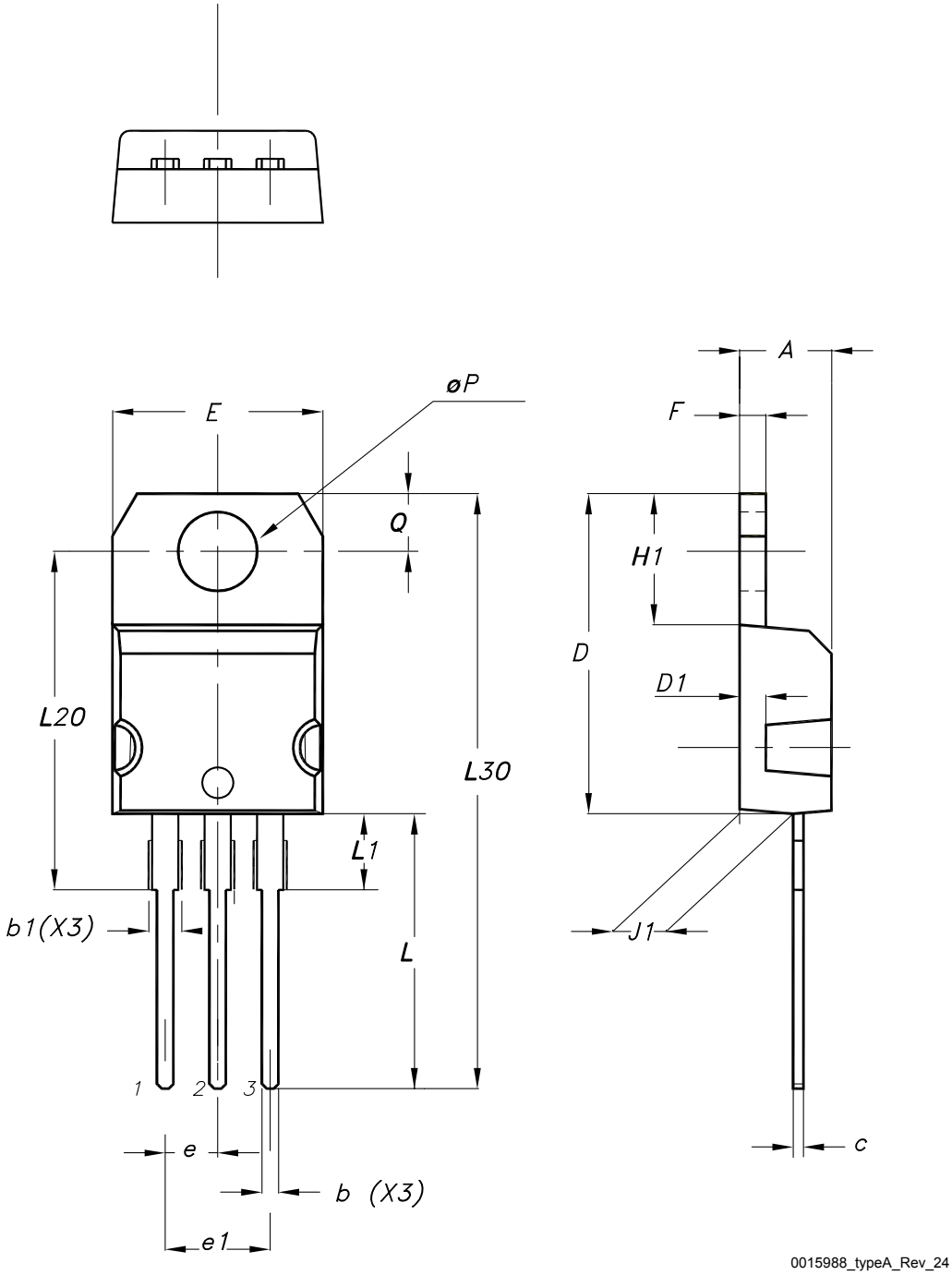
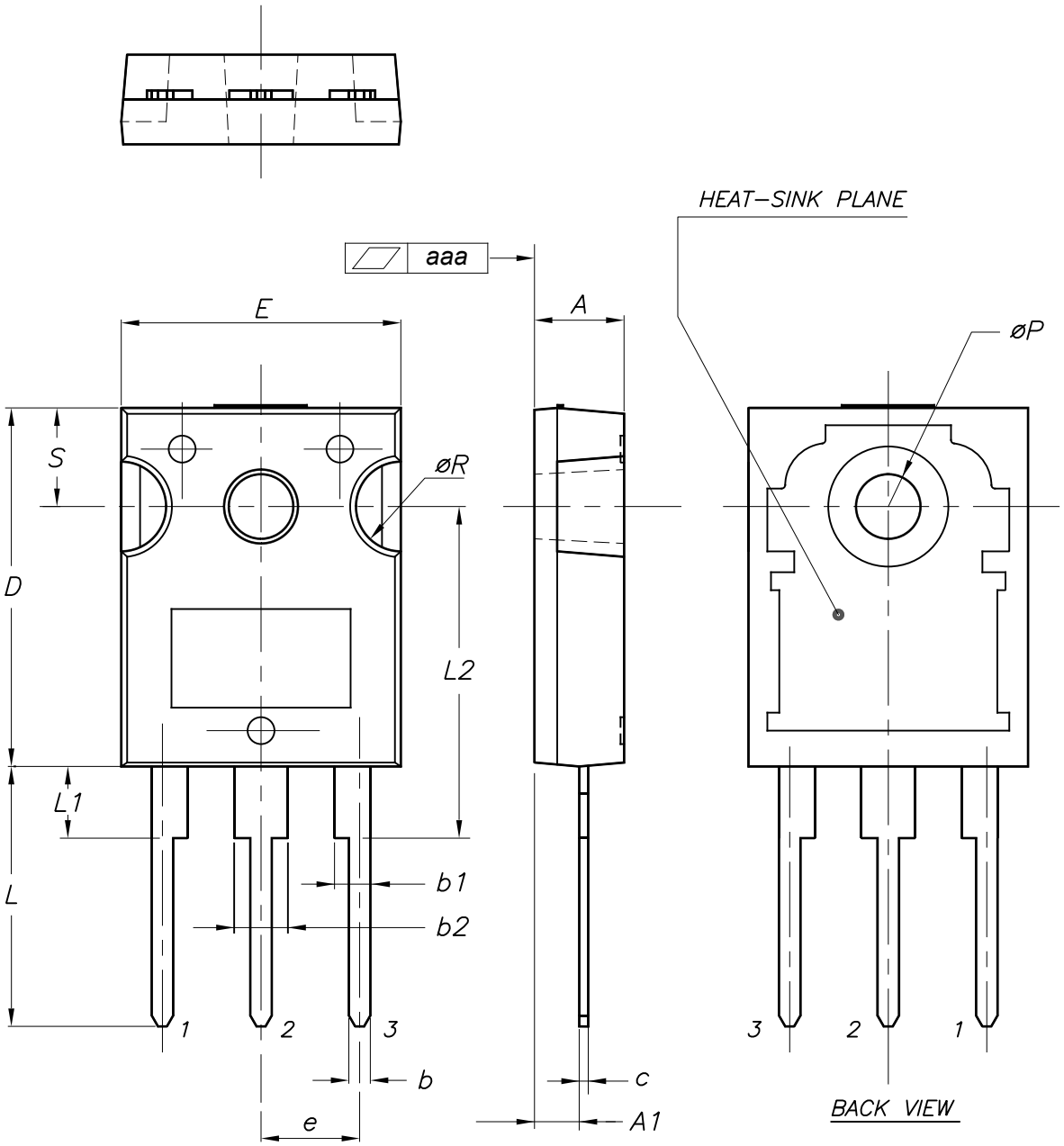


Table 10. **TO-220 type A package mechanical data**

| 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 |
| Slug flatness | | 0.03 | 0.10 |

## 4.4 TO-247 package information

Figure 27. **TO-247 package outline**



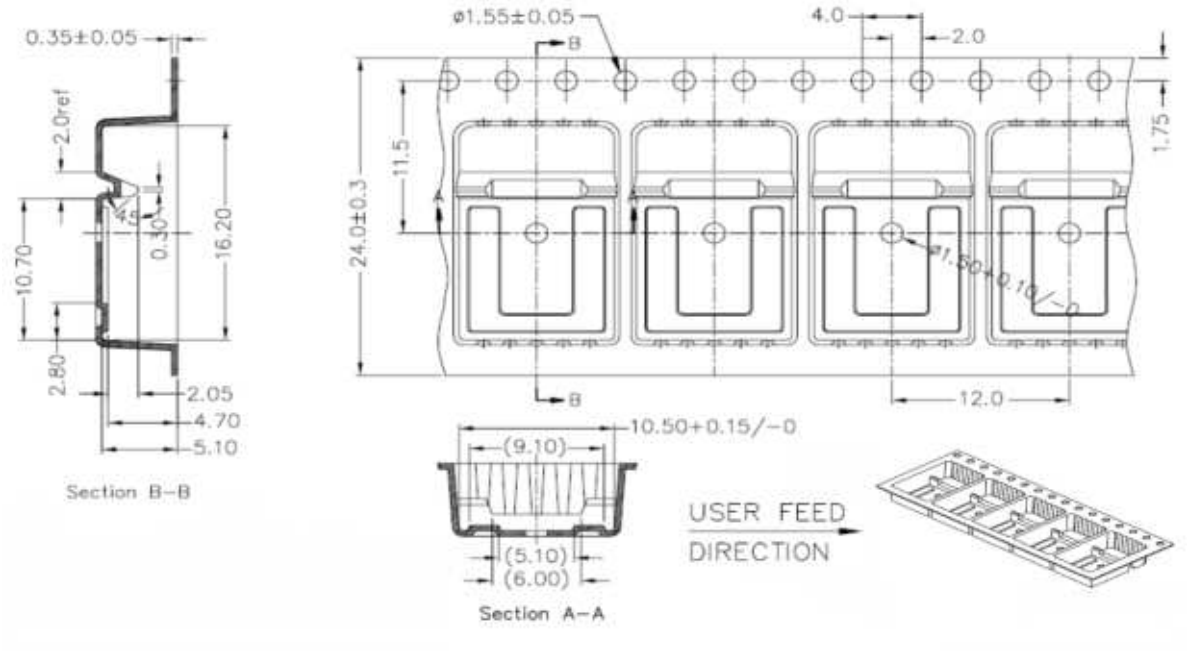

0075325_10

Table 11. **TO-247 package mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.85 | | 5.15 |
| A1 | 2.20 | | 2.60 |
| b | 1.0 | | 1.40 |
| b1 | 2.0 | | 2.40 |
| b2 | 3.0 | | 3.40 |
| c | 0.40 | | 0.80 |
| D | 19.85 | | 20.15 |
| E | 15.45 | | 15.75 |
| e | 5.30 | 5.45 | 5.60 |
| L | 14.20 | | 14.80 |
| L1 | 3.70 | | 4.30 |
| L2 | | 18.50 | |
| ØP | 3.55 | | 3.65 |
| ØR | 4.50 | | 5.50 |
| S | 5.30 | 5.50 | 5.70 |
| aaa | | 0.04 | 0.10 |

## 4.5 D²PAK packing information

Figure 28. **D²PAK tape drawing (dimensions are in mm)**




DM01095771_2

# 5 Ordering information

Table 12. **Order codes**

| Order codes | Marking | Package | Packing |
|---|---|---|---|
| STB12NK80ZT4 | B12NK80Z | D²PAK | Tape and reel |
| STF12NK80Z | F12NK80Z | TO-220FP | Tube |
| STP12NK80Z | P12NK80Z | TO-220 | |
| STW12NK80Z | W12NK80Z | TO-247 | |

## Revision history

Table 13. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 22-Jun-2004 | 2 | Preliminary version. |
| 28-Jan-2005 | 3 | Complete version. |
| 08-Sep-2005 | 4 | *Figure 2* and *Figure 6* changed. |
| 31-Jul-2006 | 5 | The document has been reformatted. |
| 27-Apr-2007 | 6 | Modified $R_{DS(on)}$ value on *Table 5*. |
| 28-Aug-2012 | 7 | Inserted new device in TO-220FP.<br>Updated *Table 1: Device summary*, *Table 2: Absolute maximum ratings* and *Table 3: Thermal data*.<br>Updated *Section 4: Package mechanical data* and *Section 5: Packaging mechanical data*.<br>Minor text changes in the cover page. |
| 28-Oct-2025 | 8 | Updated Section 4: Package information.<br>Minor text changes. |

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