

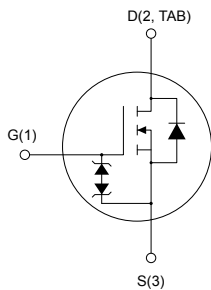
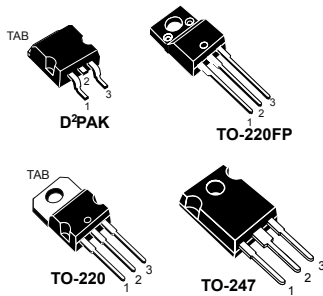


# STB9NK90Z, STF9NK90Z STP9NK90Z, STW9NK90Z

Datasheet

N-channel 900 V, 1.1  $\Omega$  typ., 8 A SuperMESH Power MOSFETs  
in D<sup>2</sup>PAK, TO-220FP, TO-220 and TO-247 packages

## Features



AM01476v1\_tab

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|------------|----------|-------------------|-------|
| STB9NK90Z  | 900 V    | 1.3 $\Omega$      | 8 A   |
| STF9NK90Z  |          |                   |       |
| STP9NK90Z  |          |                   |       |
| STW9NK90Z  |          |                   |       |

- 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

[STB9NK90Z](#)

[STF9NK90Z](#)

[STP9NK90Z](#)

[STW9NK90Z](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                         | Parameter                                                                                                       | Value                              |                   | Unit |
|--------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------|------|
|                                |                                                                                                                 | D <sup>2</sup> PAK, TO-220, TO-247 | TO-220FP          |      |
| V <sub>DS</sub>                | Drain-source voltage                                                                                            | 900                                |                   | V    |
| V <sub>GS</sub>                | Gate-source voltage                                                                                             | ±30                                |                   | V    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 25 °C                                                            | 8                                  | 8 <sup>(1)</sup>  | A    |
|                                | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                           | 5                                  | 5 <sup>(1)</sup>  |      |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                          | 32                                 | 32 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>               | Total power dissipation at T <sub>C</sub> = 25 °C                                                               | 160                                | 40                | W    |
| ESD                            | Gate-source human body model (C = 100 pF, R = 1.5 kΩ)                                                           | 4                                  |                   | 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>stg</sub>               | Storage temperature range                                                                                       | -55 to 150                         |                   | °C   |
| T <sub>J</sub>                 | Operating junction temperature range                                                                            |                                    |                   |      |

1. Limited by maximum junction temperature.
2. Pulse width is limited by safe operating area.
3. I<sub>SD</sub> ≤ 10 A, di/dt ≤ 200 A/μs, V<sub>DS</sub> (peak) < V<sub>(BR)DSS</sub>.

**Table 2. Thermal data**

| Symbol            | Parameter                               | Value                      |        |          | Unit |
|-------------------|-----------------------------------------|----------------------------|--------|----------|------|
|                   |                                         | D <sup>2</sup> PAK, TO-220 | TO-247 | TO-220FP |      |
| R <sub>thJC</sub> | Thermal resistance, junction-to-case    | 0.78                       |        | 3.1      | °C/W |
| R <sub>thJA</sub> | Thermal resistance, junction-to-ambient | 62.5                       | 50     | 62.5     | °C/W |

**Table 3. Avalanche characteristics**

| Symbol          | Parameter                                                                                                                  | Value | Unit |
|-----------------|----------------------------------------------------------------------------------------------------------------------------|-------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not repetitive (pulse width is limited by T <sub>J</sub> max.)                            | 8     | 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) | 300   | 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    | $I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$                                                 | 900  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 900\text{ V}$                                             |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 900\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}^{(1)}$ |      |      | 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            | $V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$                                          | 3.00 | 3.75 | 4.50     | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 3.6\text{ A}$                                               |      | 1.1  | 1.3      | $\Omega$      |

1. Specified by design, not tested in production.

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                             | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$                                                                         | -    | 2115 | -    | pF   |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                             | -    | 190  | -    | pF   |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                             | -    | 40   | -    | pF   |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }720\text{ V}$                                                                                 | -    | 115  | -    | pF   |
| $Q_g$                      | Total gate charge             | $V_{DD} = 720\text{ V}$ , $I_D = 8\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 18. Test circuit for gate charge behavior) | -    | 72   | -    | nC   |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                             | -    | 14   | -    | nC   |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                             | -    | 38   | -    | 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  | $V_{DD} = 450\text{ V}$ , $I_D = 4\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$    | -    | 22   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                         | -    | 13   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time | (see Figure 17. Test circuit for resistive load switching times and Figure 22. Switching time waveform) | -    | 55   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                         | -    | 28   | -    | ns   |

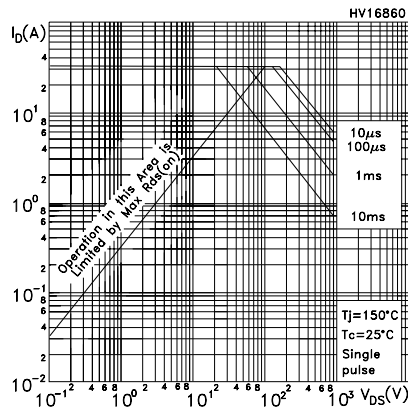
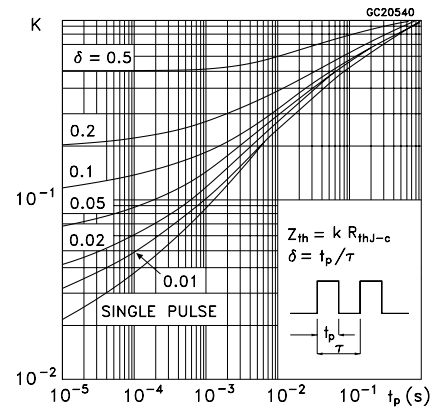
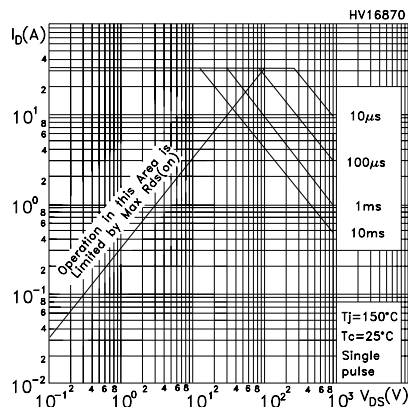
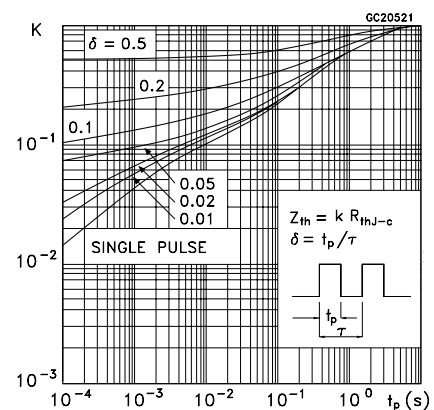
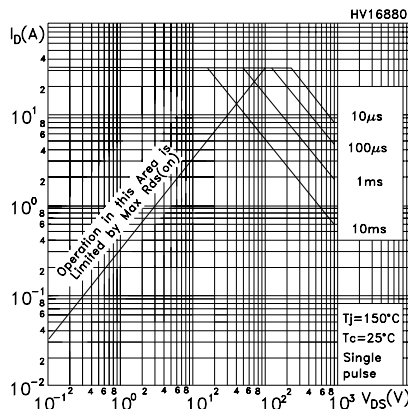
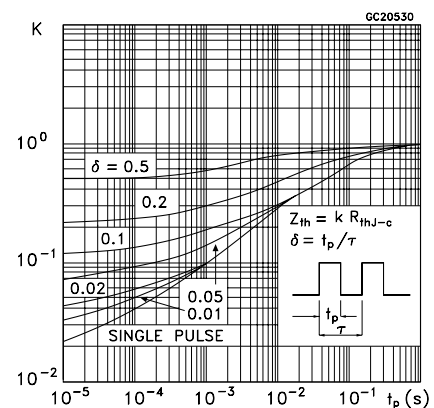
**Table 7. Source-drain diode**

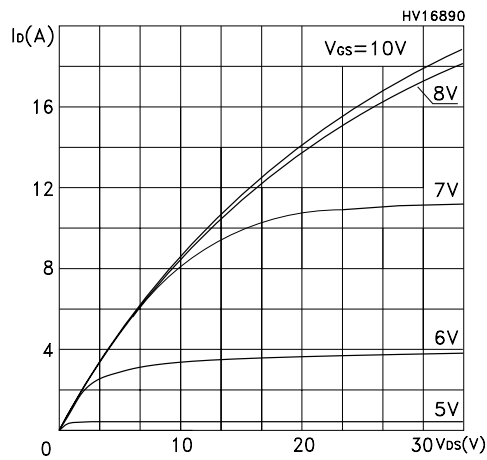
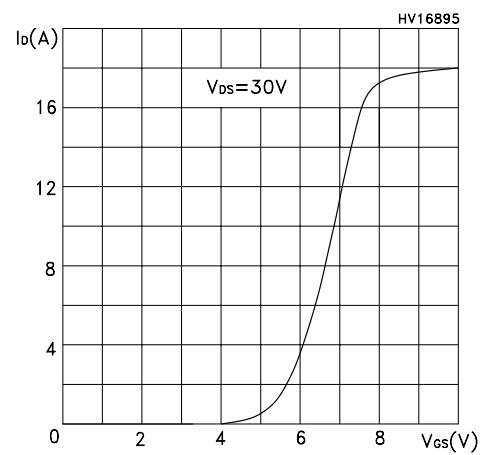
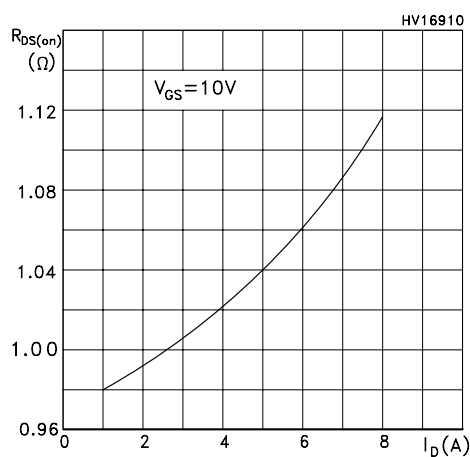
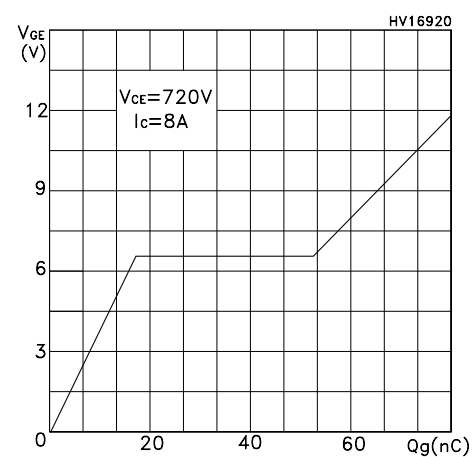
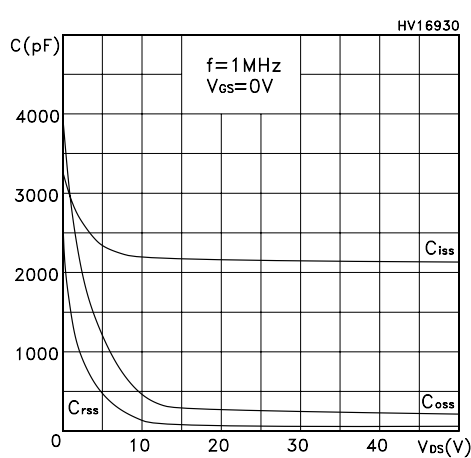
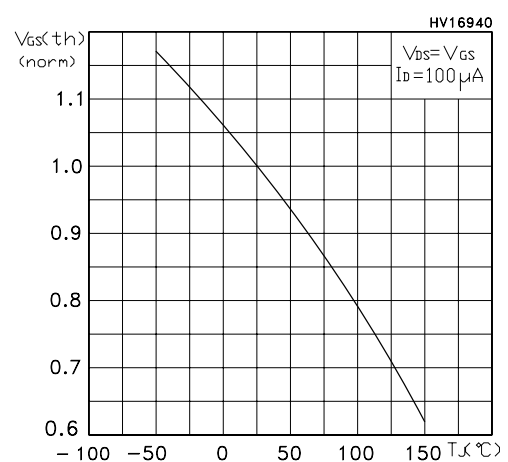
| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                   | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                   | -    |      | 8    | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                   | -    |      | 32   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 8\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                                                                                                                     | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 8\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 50\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$<br>(see Figure 19. Test circuit for inductive load switching and diode recovery times) | -    | 950  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                   | -    | 10   |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                   | -    | 21   |      | A             |

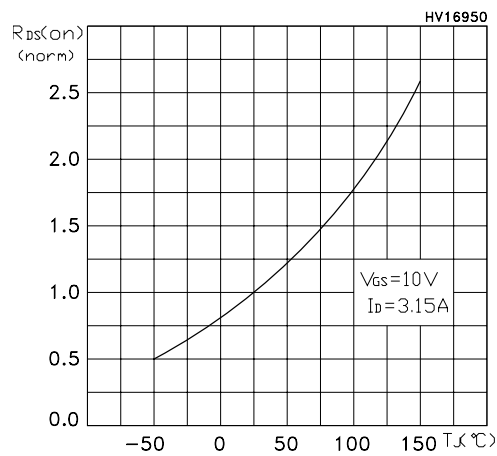
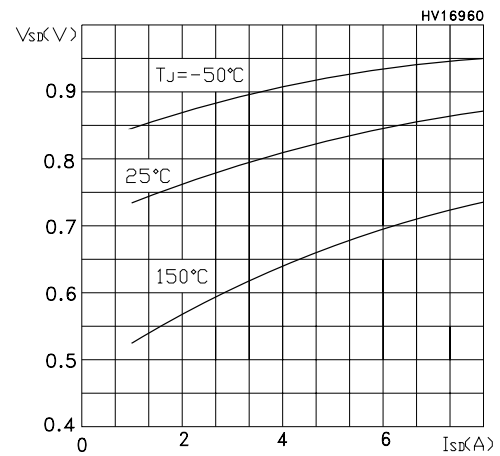
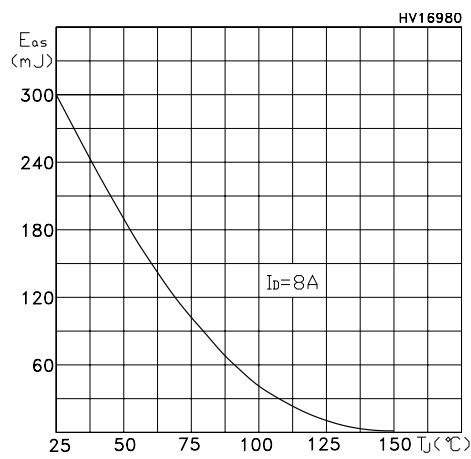
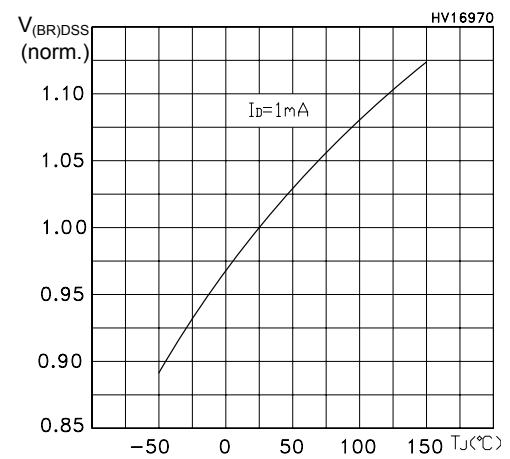
1. Pulse width is limited by safe operating area.

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

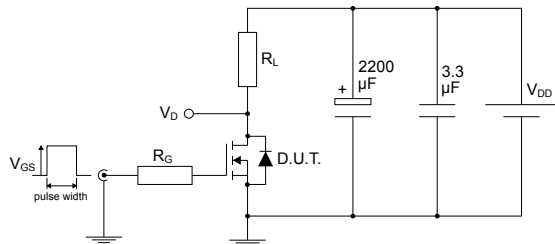
## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area for D<sup>2</sup>PAK and TO-220**

**Figure 2. Normalized transient thermal impedance for D<sup>2</sup>PAK 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**


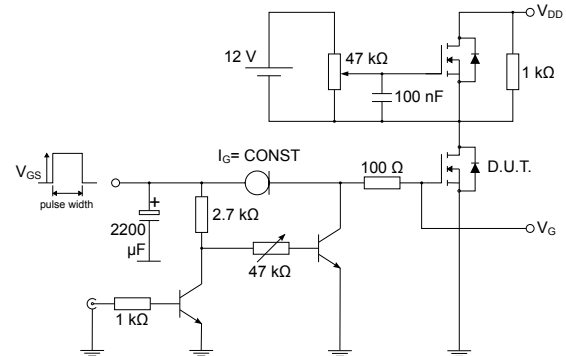
**Figure 7. Typical output characteristics**

**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**


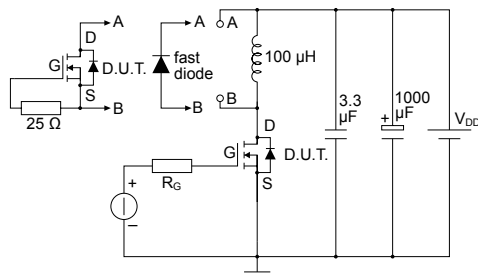
### 3 Test circuits

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


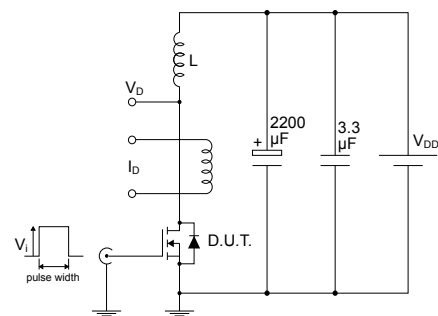
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**Figure 18. Test circuit for gate charge behavior**


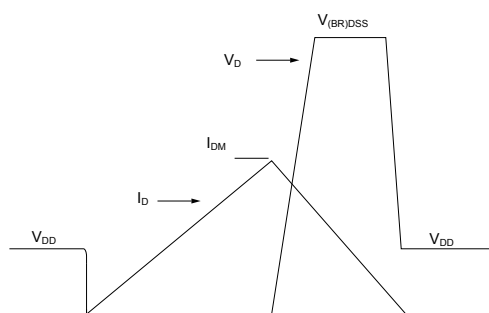
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**Figure 19. Test circuit for inductive load switching and diode recovery times**


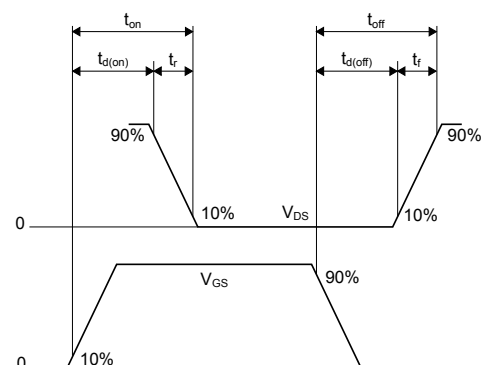
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**Figure 20. Unclamped inductive load test circuit**


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**Figure 21. Unclamped inductive waveform**


AM01472v1

**Figure 22. Switching time waveform**


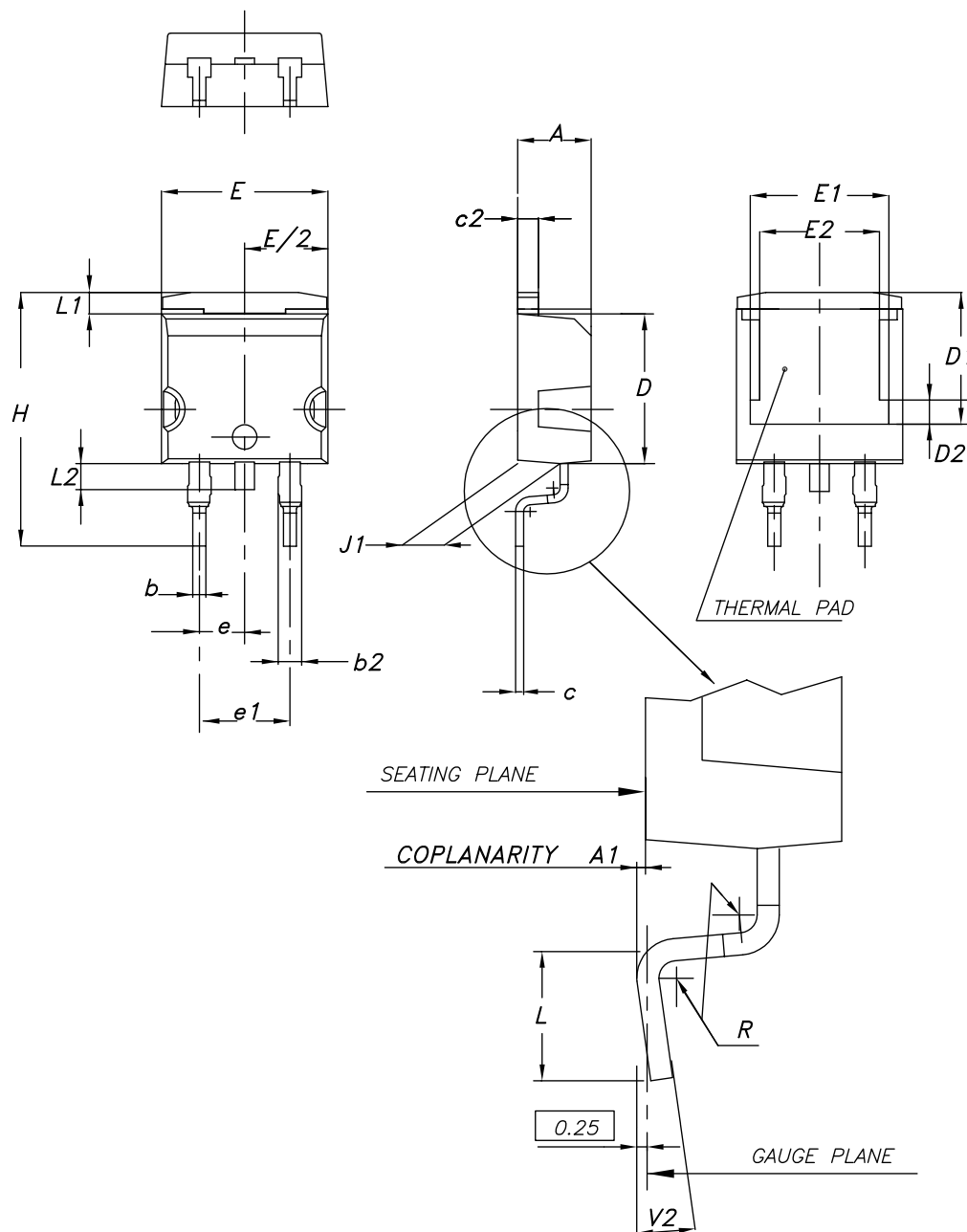
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## 4 Package information

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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 D<sup>2</sup>PAK (TO-263) type A2 package information

**Figure 23. D<sup>2</sup>PAK (TO-263) type A2 package outline**

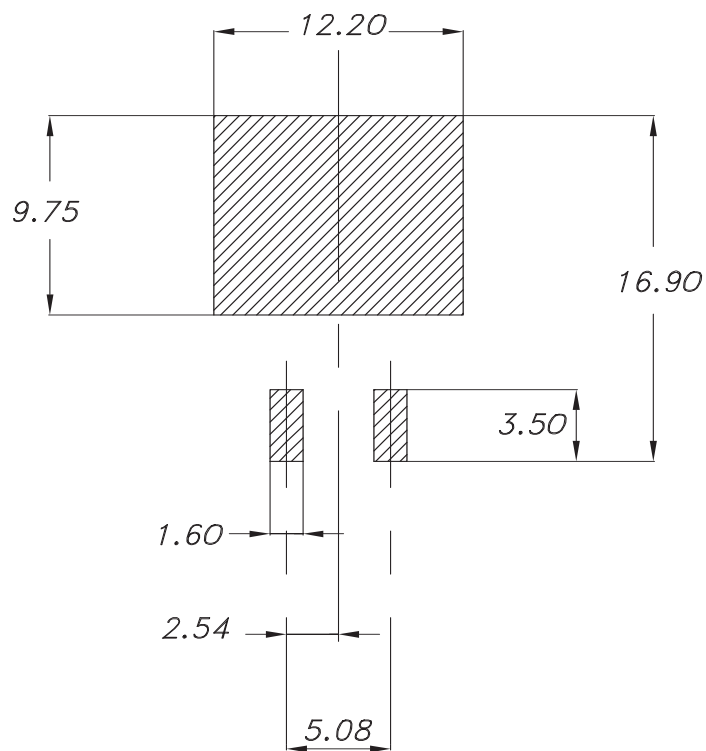


0079457\_A2\_27

**Table 8. D<sup>2</sup>PAK (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°    |

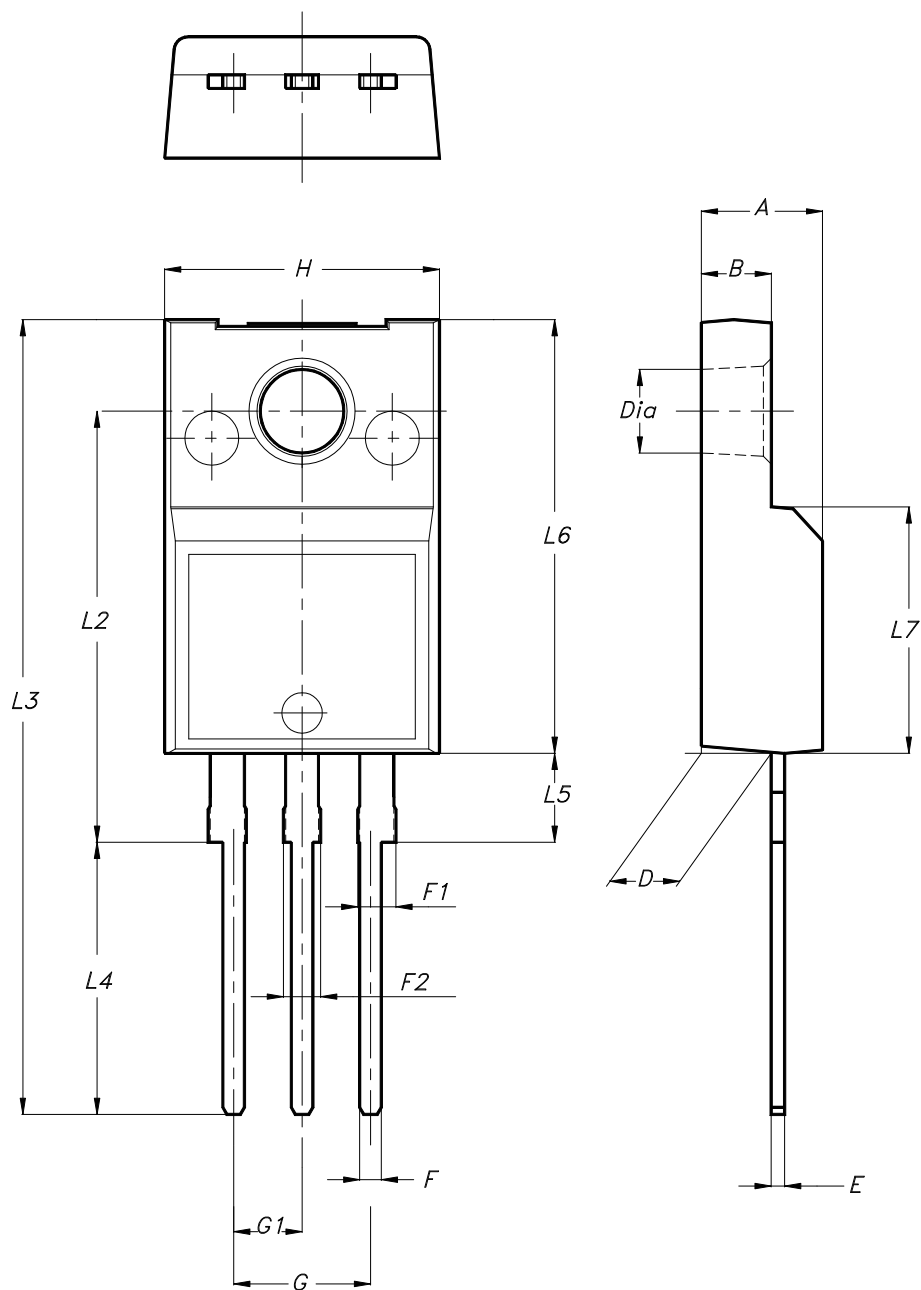
**Figure 24. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)**



0079457\_Rev27\_footprint

## 4.2 TO-220FP type B package information

Figure 25. TO-220FP type B package outline



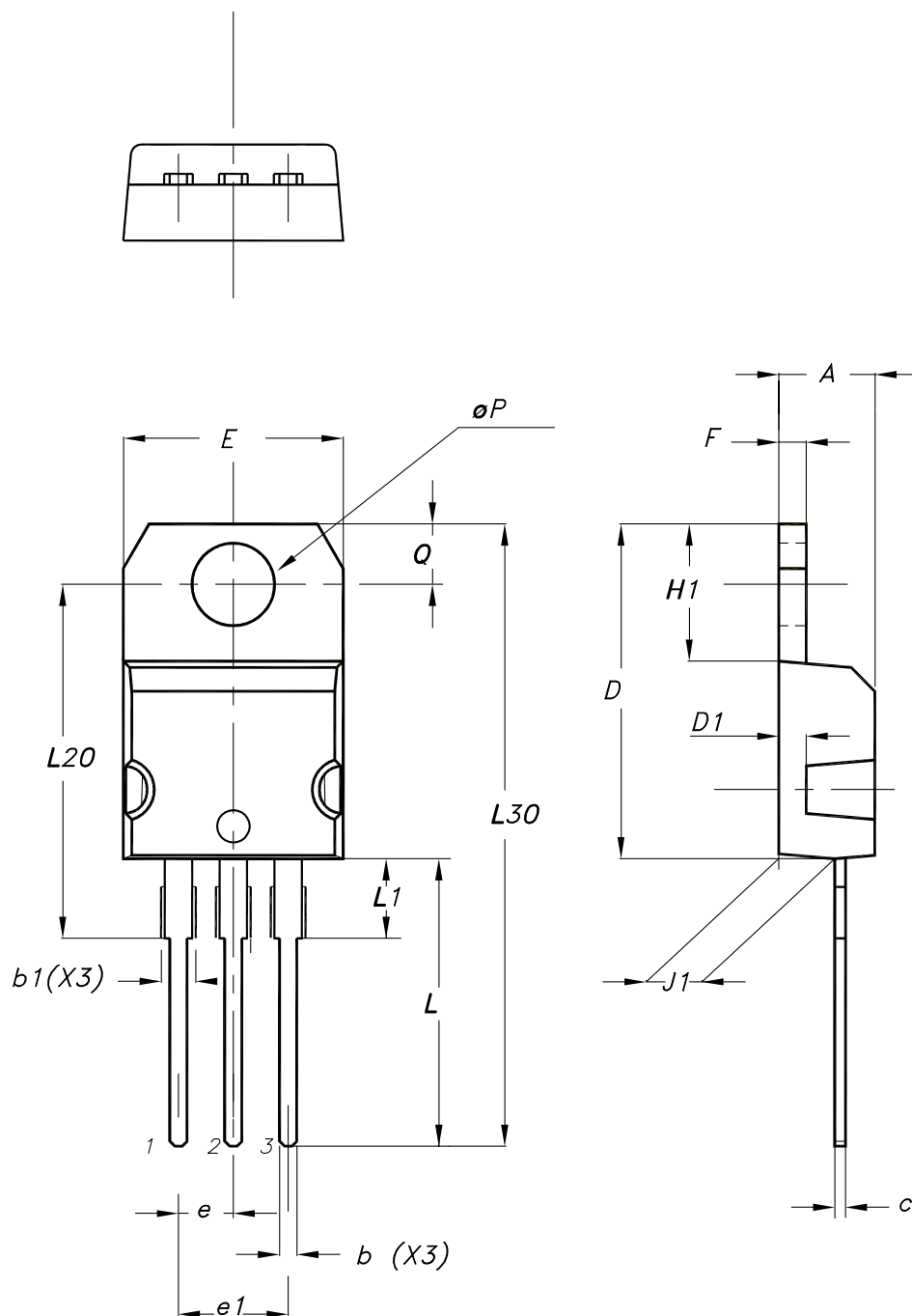
7012510\_B\_rev.14

**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



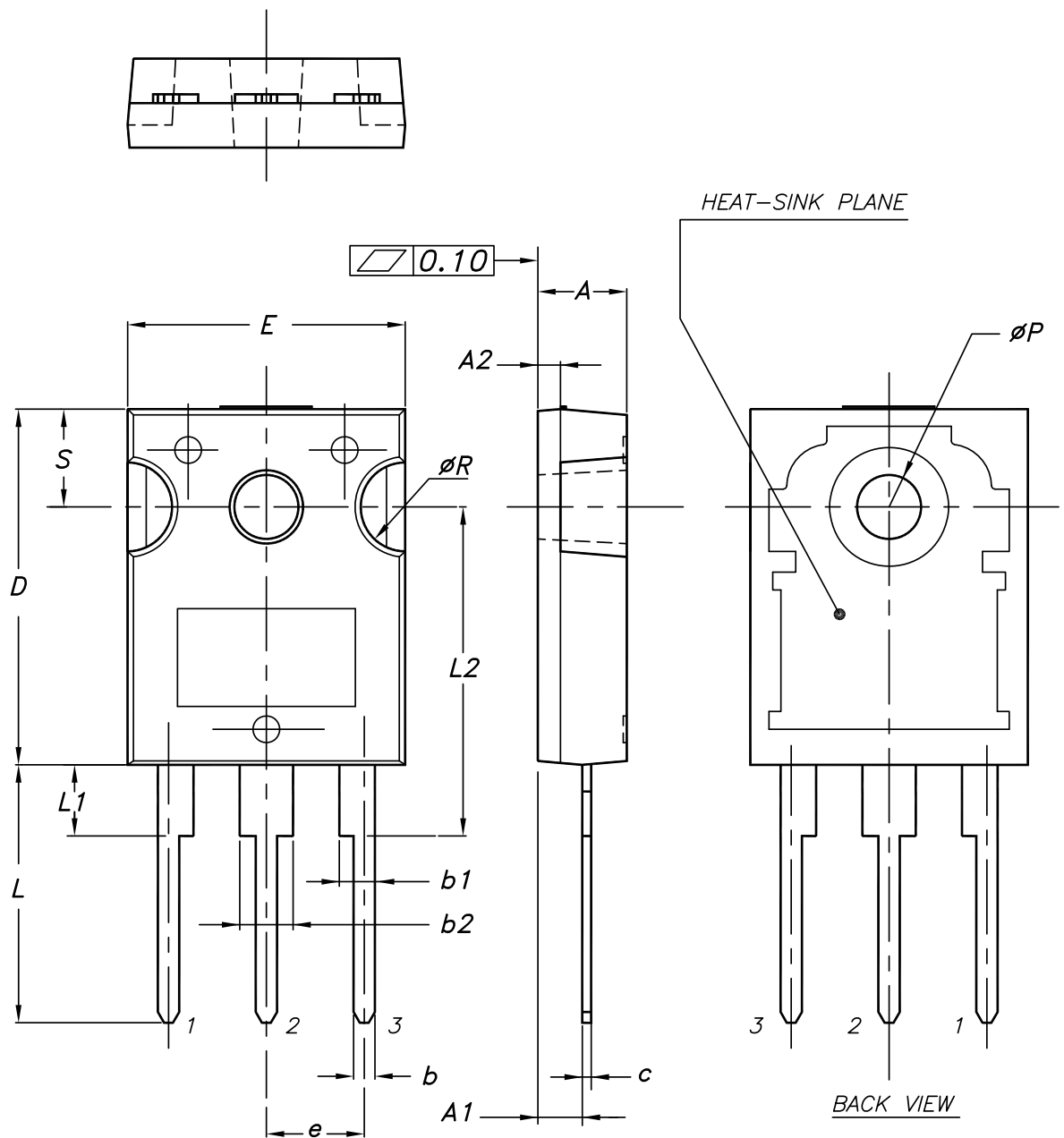
0015988\_typeA\_Rev\_24

**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



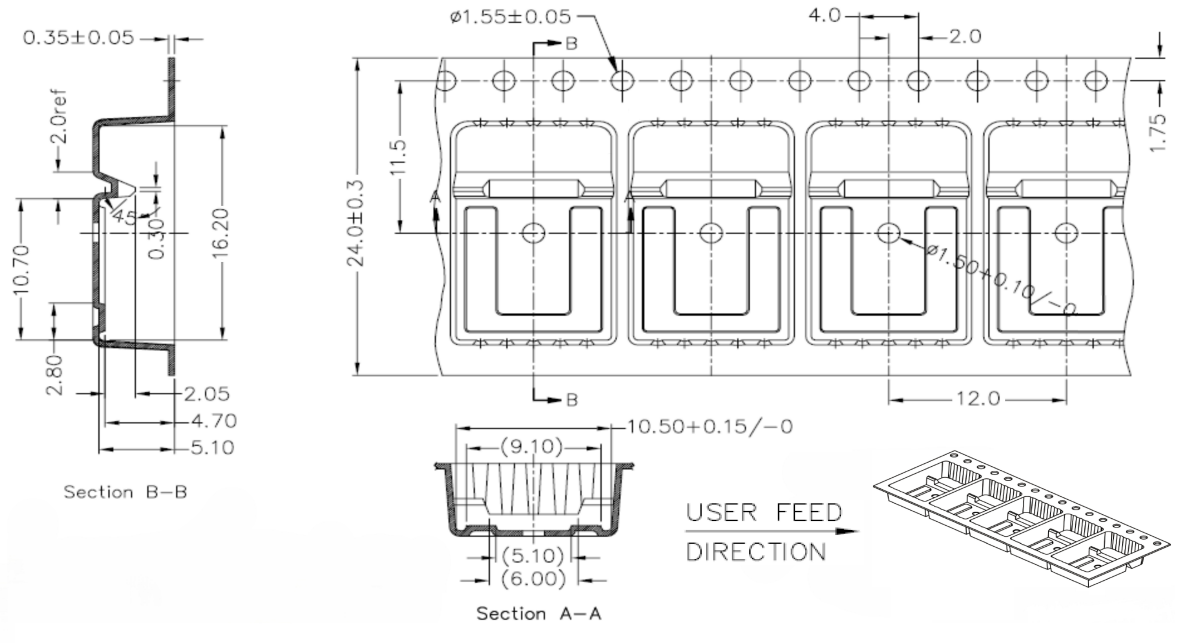
0075325\_11

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

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.85  |       | 5.15  |
| A1   | 2.20  |       | 2.60  |
| A2   |       | 1.27  |       |
| 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  |

## 4.5 D<sup>2</sup>PAK packing information

**Figure 28. D<sup>2</sup>PAK tape drawing (dimensions are in mm)**



DM01095771\_2



## 5 Ordering information

Table 12. Order codes

| Order codes | Marking | Package            | Packing       |
|-------------|---------|--------------------|---------------|
| STB9NK90Z   | B9NK90Z | D <sup>2</sup> PAK | Tape and reel |
| STF9NK90Z   | F9NK90Z | TO-220FP           | Tube          |
| STP9NK90Z   | P9NK90Z | TO-220             |               |
| STW9NK90Z   | W9NK90Z | TO-247             |               |

## Revision history

**Table 13. Document revision history**

| Date        | Revision | Changes                                                                         |
|-------------|----------|---------------------------------------------------------------------------------|
| 08-Sep-2005 | 2        | Complete version                                                                |
| 27-Oct-2005 | 3        | Inserted ecopack indication                                                     |
| 20-Jul-2006 | 4        | New template, no content change                                                 |
| 20-Mar-2007 | 5        | Typo mistake on cover page                                                      |
| 13-Jul-2007 | 6        | Corrected unit on <i>Table 5.: On/off states</i>                                |
| 19-May-2010 | 7        | Corrected <i>Figure 18: Maximum avalanche energy vs temperature</i>             |
| 10-Dec-2025 | 8        | Updated <a href="#">Section 4: Package information</a> .<br>Minor text changes. |



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