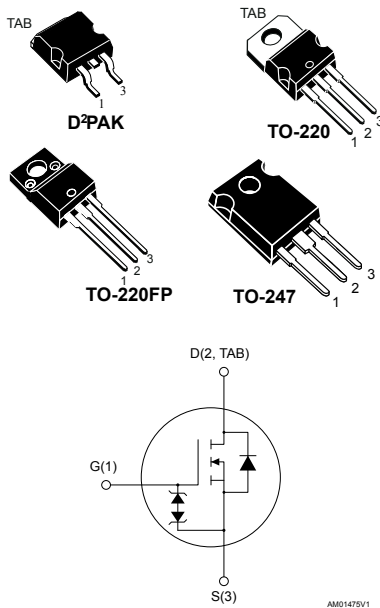


## N-channel 900 V, 1.56 $\Omega$ typ., 5.8 A SuperMESH™ Power MOSFET in D<sup>2</sup>PAK, TO-220, TO-220FP and TO-247 packages



### Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|-------------|-----------------|--------------------------|----------------|
| STB6NK90ZT4 | 900 V           | 2 $\Omega$               | 5.8 A          |
| STP6NK90Z   |                 |                          |                |
| STP6NK90ZFP |                 |                          |                |
| STW7NK90Z   |                 |                          |                |

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- 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 |
|----------------|
| STB6NK90ZT4    |
| STP6NK90Z      |
| STP6NK90ZFP    |
| STW7NK90Z      |

# 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                                                            | 5.8                                | 5.8 <sup>(1)</sup>  | A    |
| I <sub>D</sub>                 | Drain current (continuous) at T <sub>C</sub> = 100 °C                                                           | 3.65                               | 3.65 <sup>(1)</sup> | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)                                                                                          | 23.2                               | 23.2                | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C                                                                     | 140                                | 30                  | W    |
| 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) | -                                  | 2500                | V    |
| T <sub>J</sub>                 | Operating junction temperature range                                                                            | -55 to 150                         |                     | °C   |
| T <sub>stg</sub>               | Storage temperature range                                                                                       |                                    |                     | °C   |

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3.  $I_{SD} \leq 5.8 \text{ A}$ ,  $di/dt \leq 200 \text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ .

**Table 2. Thermal data**

| Symbol                | Parameter                           | Value              |        |          |        | Unit |
|-----------------------|-------------------------------------|--------------------|--------|----------|--------|------|
|                       |                                     | D <sup>2</sup> PAK | TO-220 | TO-220FP | TO-247 |      |
| R <sub>thj-case</sub> | Thermal resistance junction-case    | 0.89               |        | 4.2      | 0.89   | °C/W |
| R <sub>thj-pcb</sub>  | Thermal resistance junction-pcb     | 60                 |        |          |        | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient | 62.5               |        |          | 50     | °C/W |

**Table 3. Avalanche characteristics**

| Symbol          | Parameter                                                                                                                  | Value | Unit |
|-----------------|----------------------------------------------------------------------------------------------------------------------------|-------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> Max)                                | 5.8   | 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

( $T_{CASE} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified)

**Table 4. On/off states**

| Symbol        | Parameter                         | Test conditions                                                                                      | Min. | Typ. | Max.     | Unit          |
|---------------|-----------------------------------|------------------------------------------------------------------------------------------------------|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source                      | $I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$                                                          | 900  |      |          | V             |
|               | Breakdown voltage                 |                                                                                                      |      |      |          |               |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 900\text{ V}$                                                      |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 900\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 50       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$                                                   |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$                                                   | 3    | 3.75 | 4.5      | V             |
| $R_{DS(on)}$  | Static drain-source on resistance | $V_{GS} = 10\text{ V}$ , $I_D = 2.9\text{ A}$                                                        |      | 1.56 | 2        | $\Omega$      |

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

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                                                                                              | Min. | Typ. | Max. | Unit          |
|----------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$                                                                                                                                          |      | 1350 |      | $\mu\text{F}$ |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                                                                                              |      | 130  |      |               |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                                                                                              |      | 26   |      |               |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ V to } 720\text{ V}$                                                                                                                                               |      | 70   |      | $\mu\text{F}$ |
| $t_{d(on)}$                | Turn-on delay time            | $V_{DD} = 450\text{ V}$ , $I_D = 3\text{ A}$ , $R_G = 4.7\text{ }\Omega$ ,<br>$V_{GS} = 10\text{ V}$ (see Figure 17. Test circuit for resistive load switching times and Figure 22. Switching time waveform) |      | 17   |      | ns            |
| $t_r$                      | Rise time                     |                                                                                                                                                                                                              |      | 20   |      |               |
| $t_{r(off)}$               | Turn-off delay time           |                                                                                                                                                                                                              |      | 45   |      |               |
| $t_f$                      | Fall time                     |                                                                                                                                                                                                              |      | 20   |      |               |
| $Q_g$                      | Total gate charge             | $V_{DD} = 720\text{ V}$ , $I_D = 5.8\text{ A}$ , $V_{GS} = 0\text{ to } 10\text{ V}$<br>(see Figure 18. Test circuit for gate charge behavior)                                                               |      | 46.5 | 60.5 | nC            |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                                                                                              |      | 8.5  |      |               |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                                                                                              |      | 25   |      |               |
| $t_{r(voff)}$              | Off-voltage rise time         | $V_{DD} = 720\text{ V}$ , $I_D = 5.8\text{ A}$ , $R_G = 4.7\text{ }\Omega$ ,<br>$V_{GS} = 10\text{ V}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times)                   |      | 11   |      | ns            |
| $t_f$                      | Fall time                     |                                                                                                                                                                                                              |      | 12   |      |               |
| $t_c$                      | Cross-over time               |                                                                                                                                                                                                              |      | 20   |      |               |

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

**Table 6. Source drain diode**

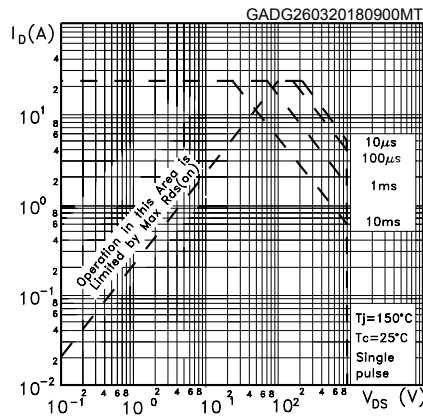
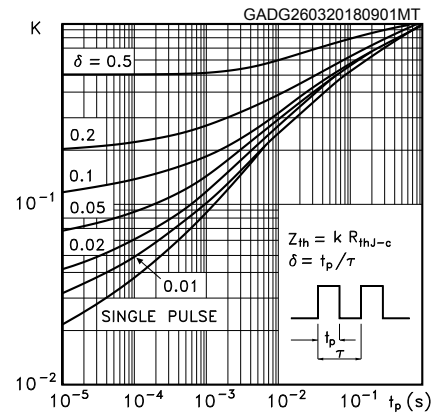
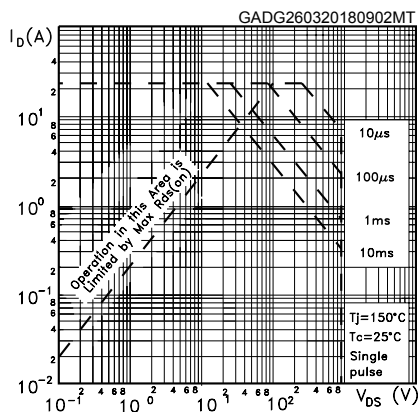
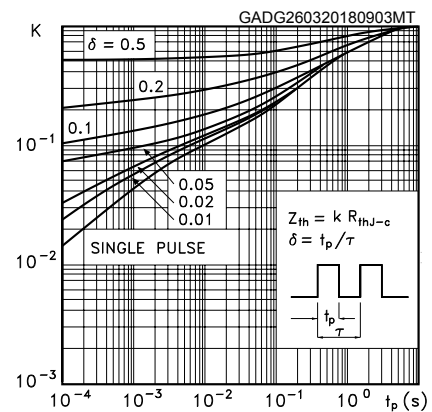
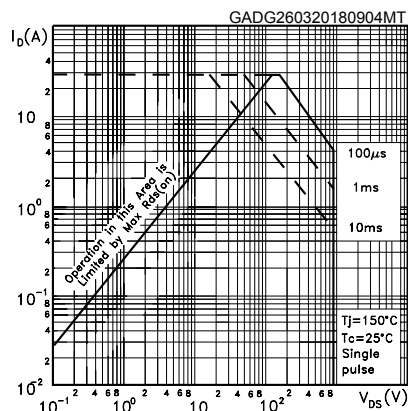
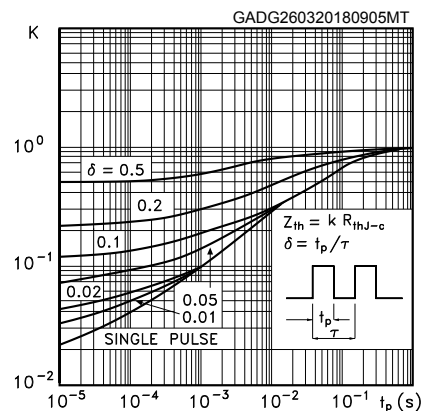
| Symbol    | Parameter                     | Test conditions                                                                                                                         | Min. | Typ. | Max. | Unit |
|-----------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$  | Source-drain current          |                                                                                                                                         |      |      | 5.8  | A    |
| $I_{SDM}$ | Source-drain current (pulsed) |                                                                                                                                         |      |      | 23.2 |      |
| $V_{SD}$  | Forward on voltage            | $I_{SD} = 5.8 \text{ A}$ , $V_{GS} = 0 \text{ V}$                                                                                       |      |      | 1.6  | V    |
| $t_{rr}$  | Reverse recovery time         | $I_{SD} = 5.8 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$                                                                          |      | 840  |      | ns   |
| $Q_{rr}$  | Reverse recovery charge       | $V_{DD} = 36 \text{ V}$ , $T_j = 150^\circ\text{C}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times) |      | 5880 |      | nC   |
| $I_{RRM}$ | Reverse recovery current      |                                                                                                                                         |      | 14   |      | A    |

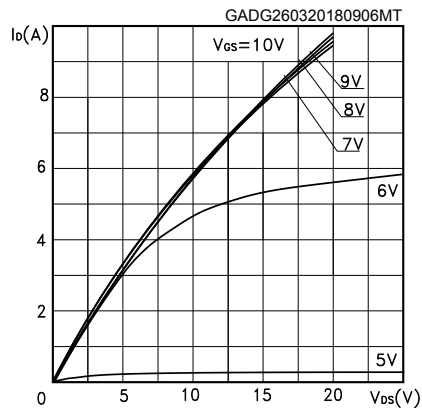
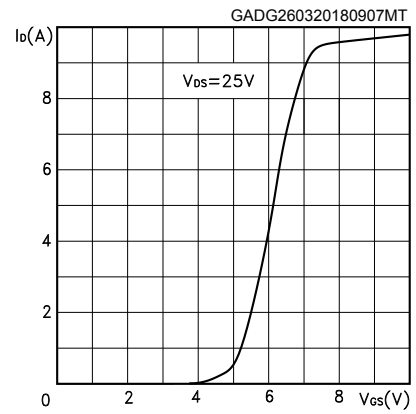
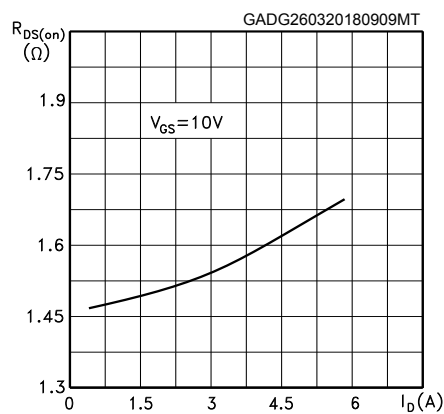
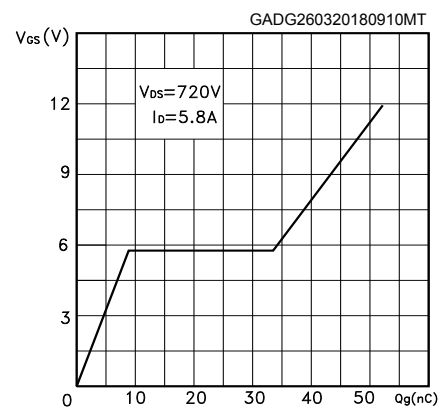
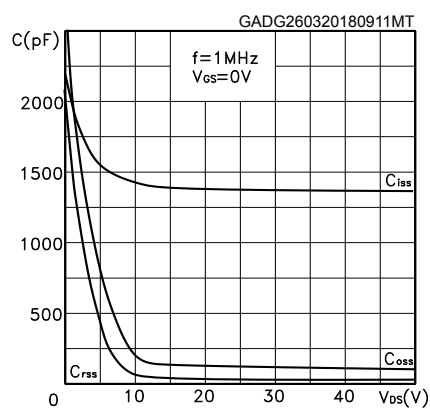
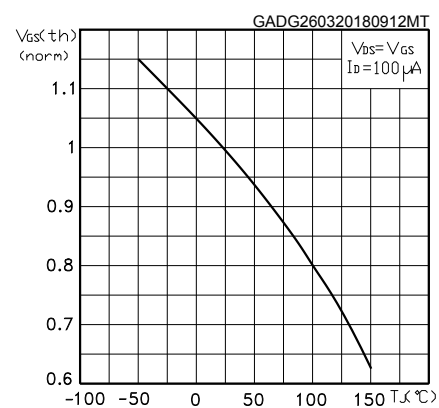
**Table 7. Gate-source zener diode**

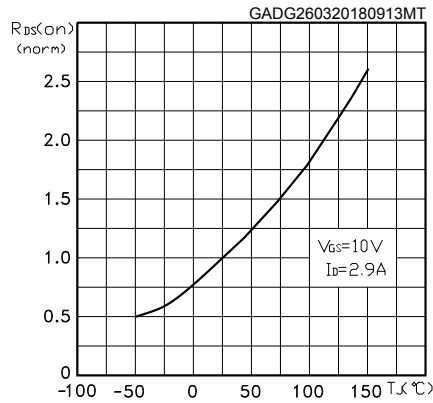
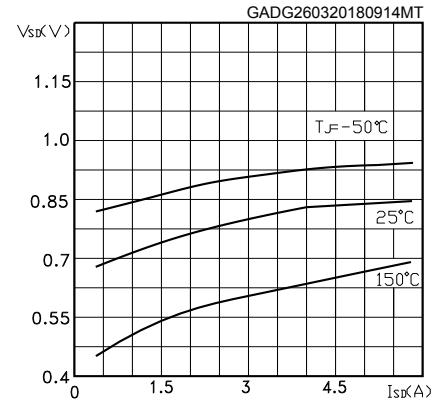
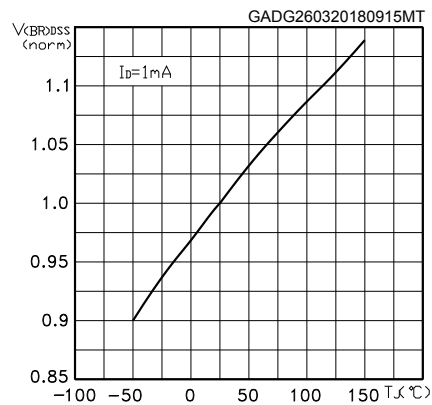
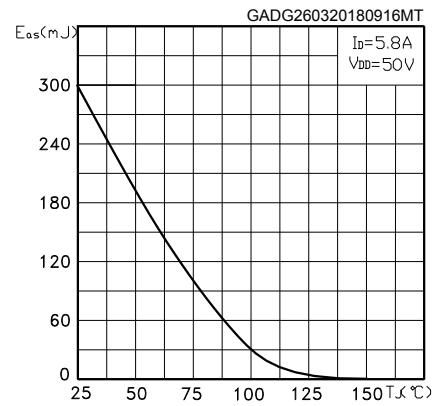
| Symbol        | Parameter                     | Test conditions                                   | Min.     | Typ. | Max. | Unit |
|---------------|-------------------------------|---------------------------------------------------|----------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown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

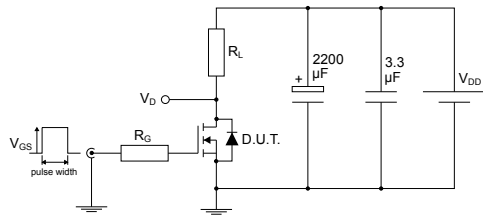
## 2.1 Electrical characteristics curves

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

**Figure 2. Thermal impedance for TO-220/D<sup>2</sup>PAK**

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

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

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

**Figure 6. Thermal impedance for TO-247**


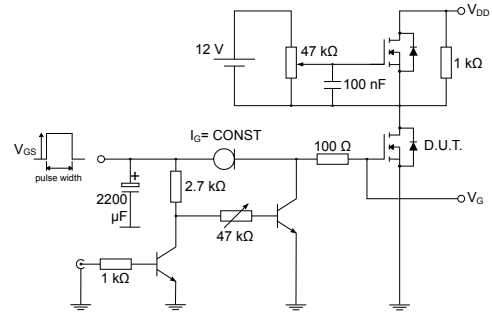
**Figure 7. Output characteristics**

**Figure 8. Transfer characteristics**

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

**Figure 10. Gate charge vs gate-source voltage**

**Figure 11. Capacitance variations**

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


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

**Figure 14. Source-drain diode forward characteristic**

**Figure 15. Normalized  $V_{(BR)DSS}$  vs temperature**

**Figure 16. Maximum avalanche energy vs temperature**


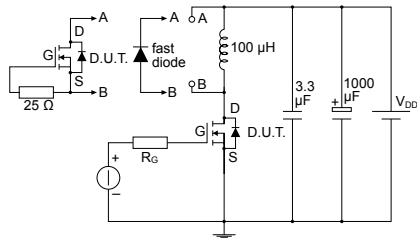
### 3 Test circuits

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


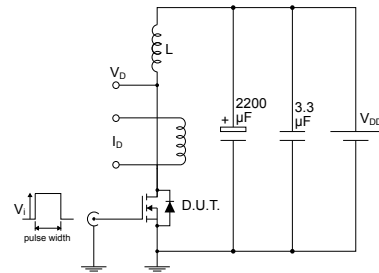
AM01468v1

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


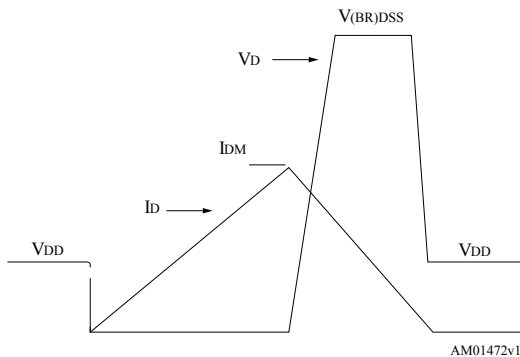
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**Figure 19. Test circuit for inductive load switching and diode recovery times**


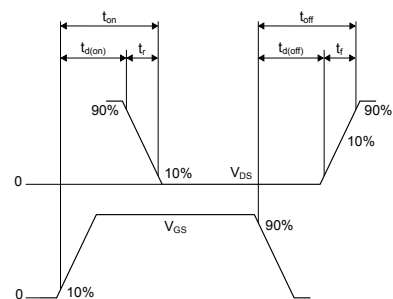
AM01470v1

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


AM01471v1

**Figure 21. Unclamped inductive waveform**


AM01472v1

**Figure 22. Switching time waveform**


AM01473v1



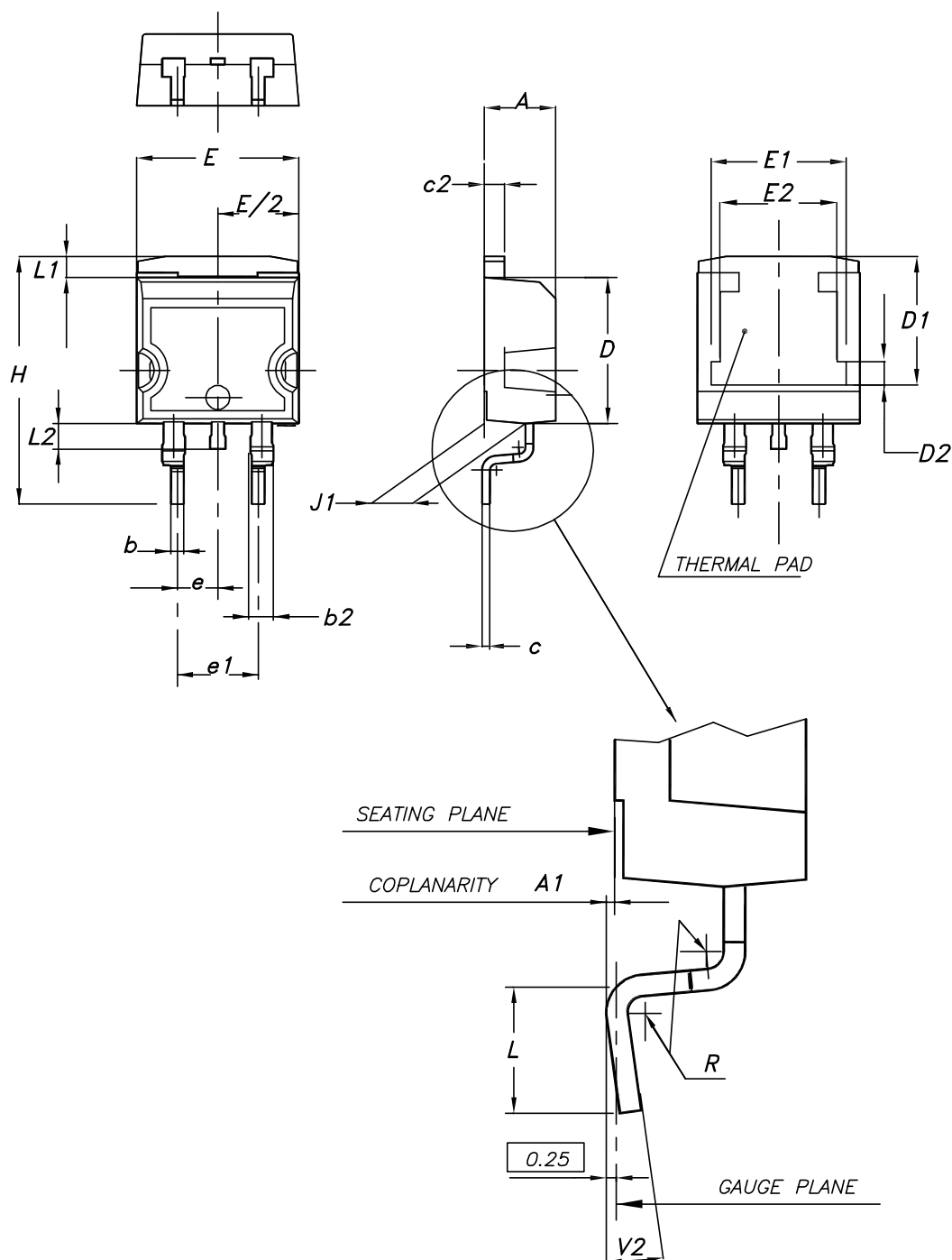
## 4 Package information

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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 D<sup>2</sup>PAK (TO-263) package information

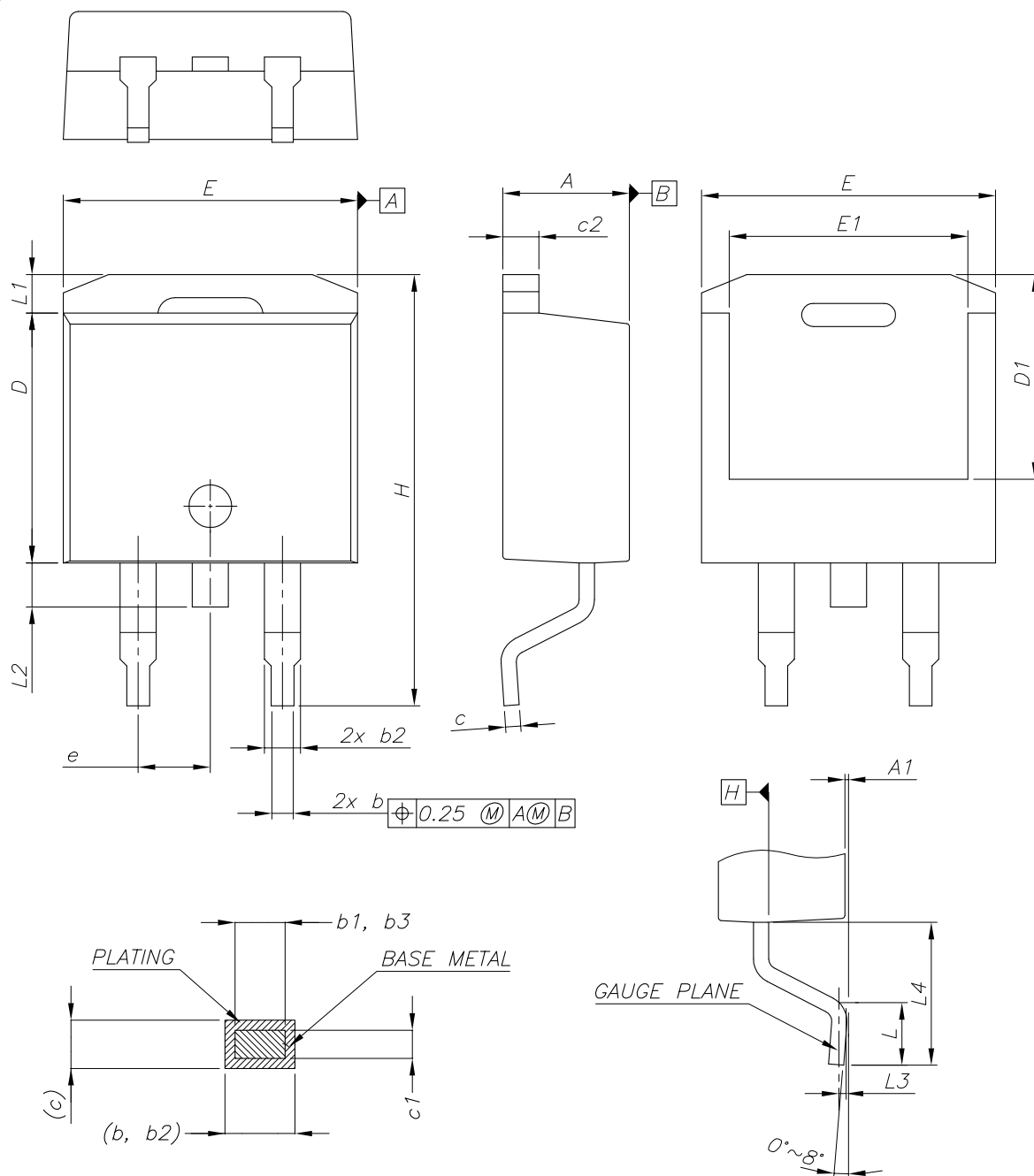
Figure 23. D<sup>2</sup>PAK (TO-263) type A package outline



0079457\_24

**Table 8. D<sup>2</sup>PAK (TO-263) type A 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   | 8.50  | 8.70 | 8.90  |
| E2   | 6.85  | 7.05 | 7.25  |
| 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°    |

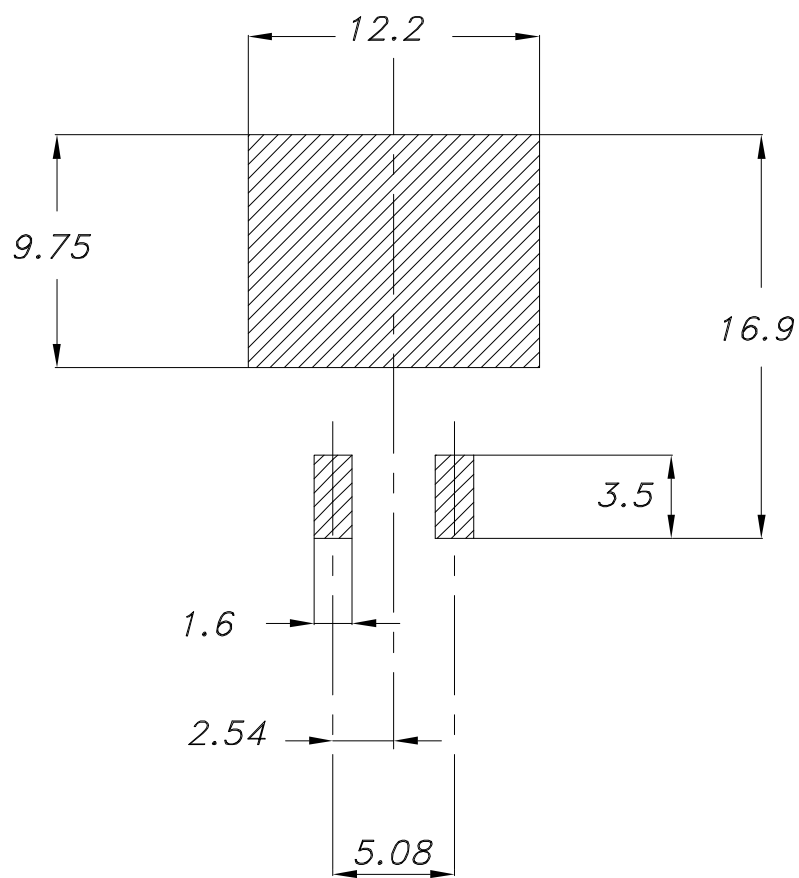
**Figure 24. D<sup>2</sup>PAK (TO-263) type B package outline**


0079457\_24\_B

**Table 9. D<sup>2</sup>PAK (TO-263) type B mechanical data**

| Dim. | mm       |      |       |
|------|----------|------|-------|
|      | Min.     | Typ. | Max.  |
| A    | 4.36     |      | 4.56  |
| A1   | 0        |      | 0.25  |
| b    | 0.70     |      | 0.90  |
| b1   | 0.51     |      | 0.89  |
| b2   | 1.17     |      | 1.37  |
| b3   | 1.36     |      | 1.46  |
| c    | 0.38     |      | 0.694 |
| c1   | 0.38     |      | 0.534 |
| c2   | 1.19     |      | 1.34  |
| D    | 8.60     |      | 9.00  |
| D1   | 6.90     |      | 7.50  |
| E    | 10.15    |      | 10.55 |
| E1   | 8.10     |      | 8.70  |
| e    | 2.54 BSC |      |       |
| H    | 15.00    |      | 15.60 |
| L    | 1.90     |      | 2.50  |
| L1   |          |      | 1.65  |
| L2   |          |      | 1.78  |
| L3   |          | 0.25 |       |
| L4   | 4.78     |      | 5.28  |

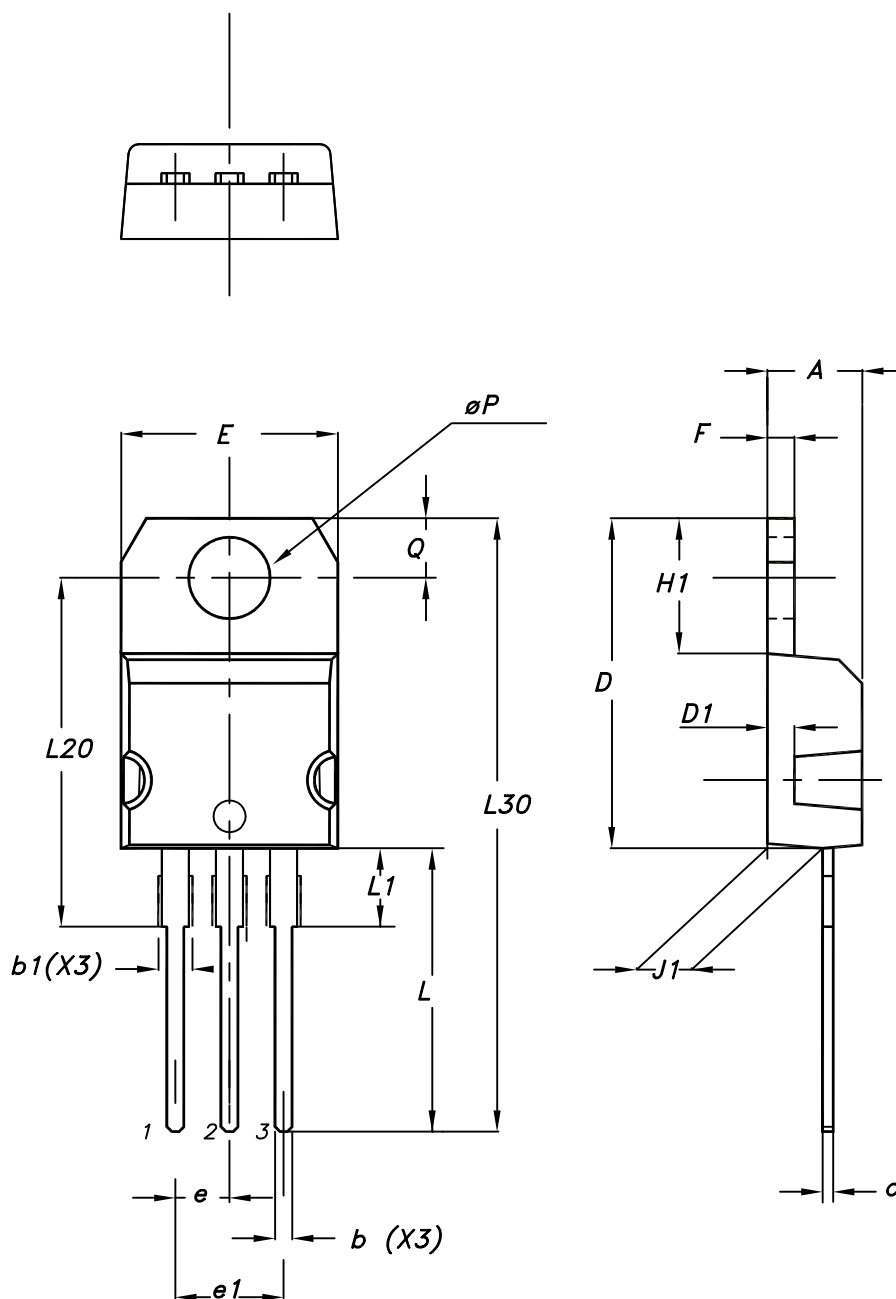
**Figure 25. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)**



Footprint

## 4.2 TO-220 type A package information

Figure 26. TO-220 type A package outline



0015988\_typeA\_Rev\_21

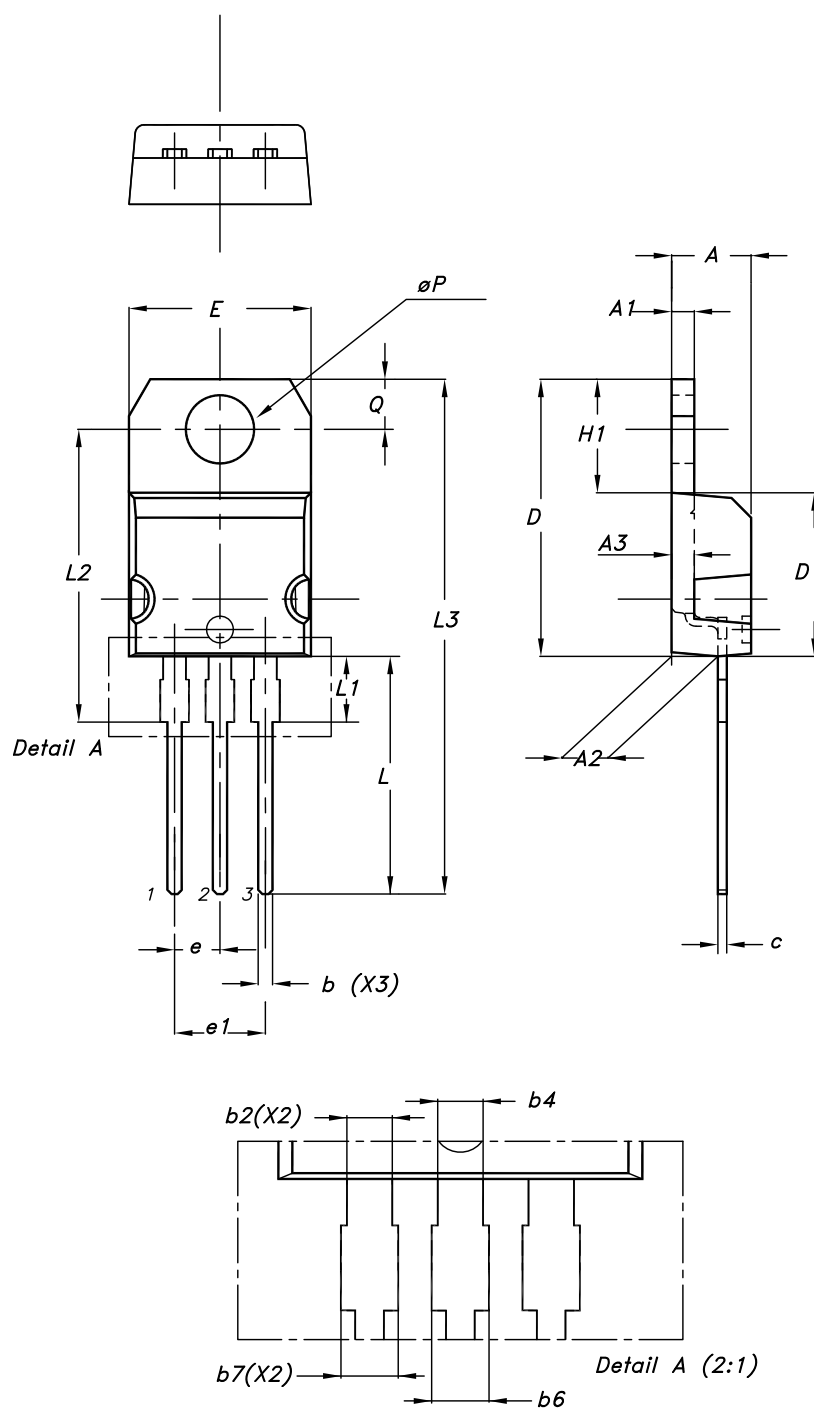
**Table 10. TO-220 type A package mechanical data**

| 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  |



### 4.3 TO-220 type H package information

**Figure 27. TO-220 type H package outline**



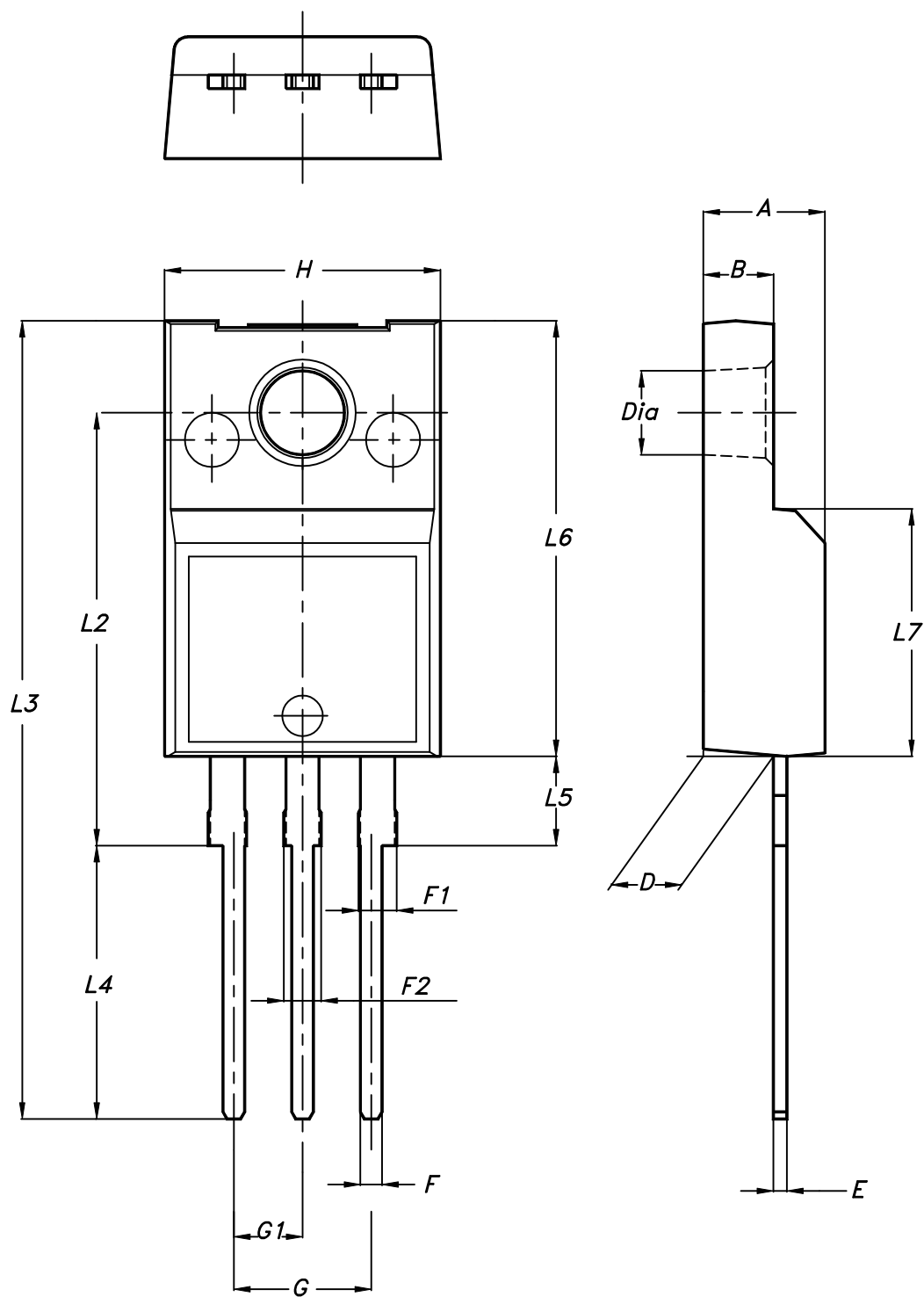
0015988\_H\_21

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

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  | 4.45  | 4.50  |
| A1   | 1.22  |       | 1.32  |
| A2   | 2.49  | 2.59  | 2.69  |
| A3   | 1.17  | 1.27  | 1.37  |
| b    | 0.78  |       | 0.87  |
| b2   | 1.25  |       | 1.34  |
| b4   | 1.20  |       | 1.29  |
| b6   |       |       | 1.50  |
| b7   |       |       | 1.45  |
| c    | 0.49  |       | 0.56  |
| D    | 15.40 | 15.50 | 15.60 |
| D1   | 9.05  | 9.15  | 9.25  |
| E    | 10.08 | 10.18 | 10.28 |
| e    | 2.44  | 2.54  | 2.64  |
| e1   | 4.98  | 5.08  | 5.18  |
| H1   | 6.25  | 6.35  | 6.45  |
| L    | 13.20 | 13.40 | 13.60 |
| L1   | 3.50  | 3.70  | 3.90  |
| L2   | 16.30 | 16.40 | 16.50 |
| L3   | 28.70 | 28.90 | 29.10 |
| ØP   | 3.75  | 3.80  | 3.85  |
| Q    | 2.70  | 2.80  | 2.90  |

#### 4.4 TO-220FP package information

Figure 28. TO-220FP package outline



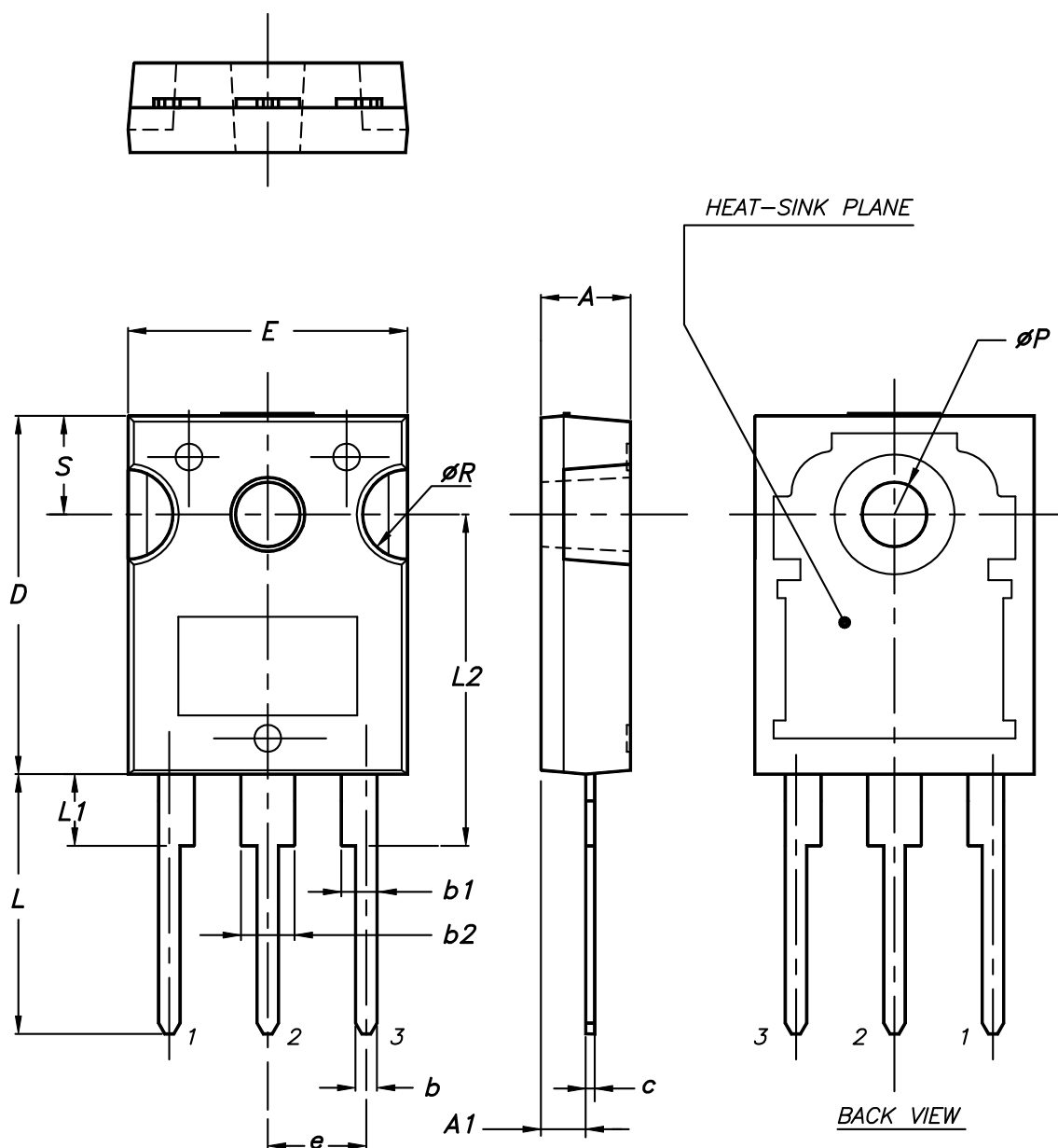
7012510\_Rev\_12\_B

**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 |
| L4   | 9.8  |      | 10.6 |
| L5   | 2.9  |      | 3.6  |
| L6   | 15.9 |      | 16.4 |
| L7   | 9    |      | 9.3  |
| Dia  | 3    |      | 3.2  |

## 4.5 TO-247 package information

Figure 29. TO-247 package outline



0075325\_9

**Table 13. 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  |

## 5 Ordering information

**Table 14. Order codes**

| Order code  | Marking   | Package            | Packing     |
|-------------|-----------|--------------------|-------------|
| STB6NK90ZT4 | B6NK90Z   | D <sup>2</sup> PAK | Tape e reel |
| STP6NK90Z   | P6NK90Z   | TO-220             | Tube        |
| STP6NK90ZFP | P6NK90ZFP | TO-220FP           | Tube        |
| STW7NK90Z   | W7NK90Z   | TO-247             | Tube        |

## Revision history

**Table 15. Document revision history**

| Date        | Version | Changes                                                                                                                                                                                                          |
|-------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29-Nov-2005 | 3       | Complete version                                                                                                                                                                                                 |
| 16-Aug-2006 | 4       | New template, no content change                                                                                                                                                                                  |
| 10-Apr-2007 | 5       | Typo mistake on Table 2                                                                                                                                                                                          |
| 04-Apr-2018 | 6       | Removed maturity status indication from cover page. The document status is production data.<br>Updated <a href="#">Table 5. Dynamic</a> and <a href="#">Table 6. Source drain diode</a> .<br>Minor text changes. |



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