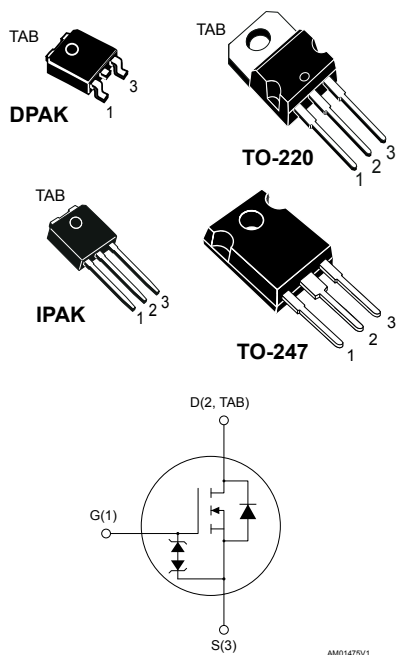


## N-channel 950 V, 1 $\Omega$ typ., 9 A MDmesh™ K5 Power MOSFETs in DPAK, TO-220, IPAK and TO-247 packages



### Features

| Order codes | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ | $P_{TOT}$ |
|-------------|----------|-------------------|-------|-----------|
| STD6N95K5   | 950 V    | 1.25 $\Omega$     | 9 A   | 90 W      |
| STP6N95K5   |          |                   |       |           |
| STU6N95K5   |          |                   |       |           |
| STW6N95K5   |          |                   |       |           |

- DPAK 950 V worldwide best  $R_{DS(on)}$
- Worldwide best FOM (figure of merit)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

#### Product status link

[STD6N95K5](#)  
[STP6N95K5](#)  
[STU6N95K5](#)  
[STW6N95K5](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter                                                                                                                 | Value       | Unit               |
|----------------|---------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|
| $V_{GS}$       | Gate- source voltage                                                                                                      | $\pm 30$    | V                  |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$                                                          | 9           | A                  |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$                                                         | 6           | A                  |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                                                                                    | 24          | A                  |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$                                                                   | 90          | W                  |
| $I_{AR}^{(2)}$ | Max current during repetitive or single pulse avalanche                                                                   | 3           | A                  |
| $E_{AS}$       | Single pulse avalanche energy<br>(starting $T_J = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ ) | 90          | mJ                 |
| $dv/dt^{(3)}$  | Peak diode recovery voltage slope                                                                                         | 4.5         | V/ns               |
| $dv/dt^{(4)}$  | MOSFET $dv/dt$ ruggedness                                                                                                 | 50          | V/ns               |
| $T_J$          | Operating junction temperature range                                                                                      | - 55 to 150 | $^{\circ}\text{C}$ |
| $T_{stg}$      | Storage temperature range                                                                                                 |             |                    |

1. Pulse width limited by safe operating area.
2. Pulse width limited by  $T_{Jmax}$ .
3.  $I_{SD} \leq 9\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DS(peak)} \leq V_{(BR)DSS}$
4.  $V_{DS} \leq 760\text{ V}$

**Table 2. Thermal data**

| Symbol              | Parameter                        | Value           |      |        | Unit                        |
|---------------------|----------------------------------|-----------------|------|--------|-----------------------------|
|                     |                                  | TO-220,<br>IPAK | DPAK | TO-247 |                             |
| $R_{thj-case}$      | Thermal resistance junction-case | 1.39            |      |        | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$       | Thermal resistance junction-amb  | 62.5            |      | 50     | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb  |                 | 50   |        | $^{\circ}\text{C}/\text{W}$ |

1. When mounted on 1 inch<sup>2</sup> FR-4 board, 2 oz Cu

## 2 Electrical characteristics

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

**Table 3. On/off states**

| Symbol        | Parameter                         | Test conditions                                                                             | Min. | Typ. | Max.     | Unit          |
|---------------|-----------------------------------|---------------------------------------------------------------------------------------------|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$                                                 | 950  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 950\text{ V}$                                             |      |      | 1        | $\mu\text{A}$ |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 950\text{ V}$ , $T_c = 125\text{ }^{\circ}\text{C}^{(1)}$ |      |      | 50       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current         | $V_{DS} = 0$ , $V_{GS} = \pm 20\text{ V}$                                                   |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$                                          | 3    | 4    | 5        | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 3\text{ A}$                                                 |      | 1    | 1.25     | $\Omega$      |

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

**Table 4. Dynamic**

| Symbol            | Parameter                             | Test conditions                                                                                                                               | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{GS} = 0\text{ V}$ , $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$                                                                          | -    | 450  | -    | pF       |
| $C_{oss}$         | Output capacitance                    |                                                                                                                                               | -    | 30   | -    | pF       |
| $C_{rss}$         | Reverse transfer capacitance          |                                                                                                                                               | -    | 1.6  | -    | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }760\text{ V}$                                                                                   | -    | 45   | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related |                                                                                                                                               | -    | 19   | -    | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$                                                                                                       | -    | 7    | -    | $\Omega$ |
| $Q_g$             | Total gate charge                     | $V_{DD} = 760\text{ V}$ , $I_D = 6\text{ A}$ ,<br>$V_{GS} = 0\text{ to }10\text{ V}$ , (see Figure 17. Test circuit for gate charge behavior) | -    | 13   | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    |                                                                                                                                               | -    | 3    | -    | nC       |
| $Q_{gd}$          | Gate-drain charge                     |                                                                                                                                               | -    | 7    | -    | nC       |

1.  $C_{o(tr)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

2.  $C_{o(er)}$  is a constant capacitance value that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising 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  | $V_{DD} = 475\text{ V}$ , $I_D = 3\text{ A}$ , $R_G = 4.7\text{ }\Omega$ ,<br>$V_{GS} = 10\text{ V}$    | -    | 12   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                         | -    | 12   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time | (see Figure 16. Test circuit for resistive load switching times and Figure 21. Switching time waveform) | -    | 33   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                         | -    | 21   | -    | ns   |

**Table 6. Source drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                         | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                         | -    |      | 9    | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                         | -    |      | 24   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 6\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                                                                                                           | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 6\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>(see Figure 18. Test circuit for inductive load switching and diode recovery times)                           | -    | 372  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                         | -    | 4    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                         | -    | 22   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 6\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ , $T_j = 150^\circ\text{C}$<br>(see Figure 18. Test circuit for inductive load switching and diode recovery times) | -    | 522  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                         | -    | 5    |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                         | -    | 20   |      | A             |

1. Pulse width limited by safe operating area.

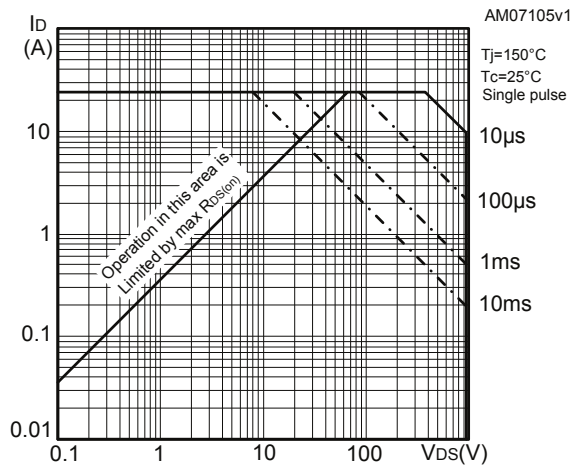
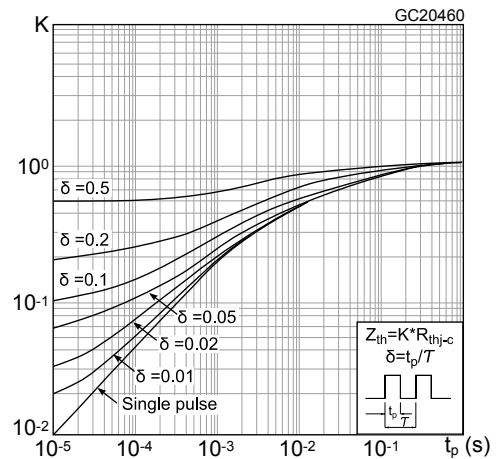
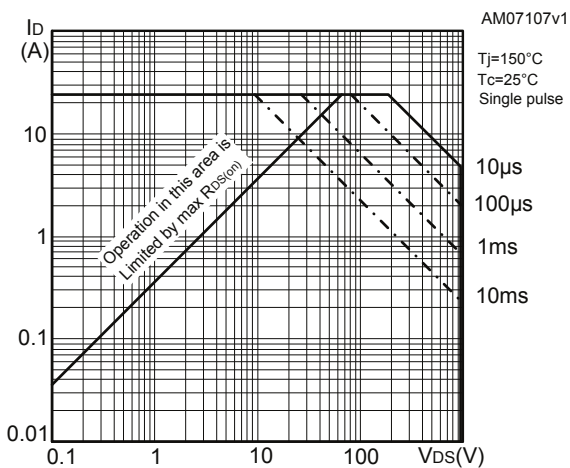
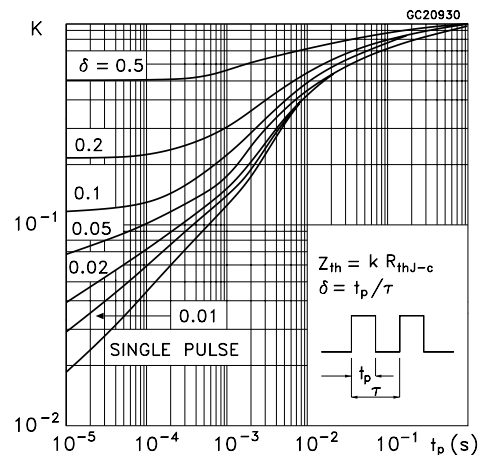
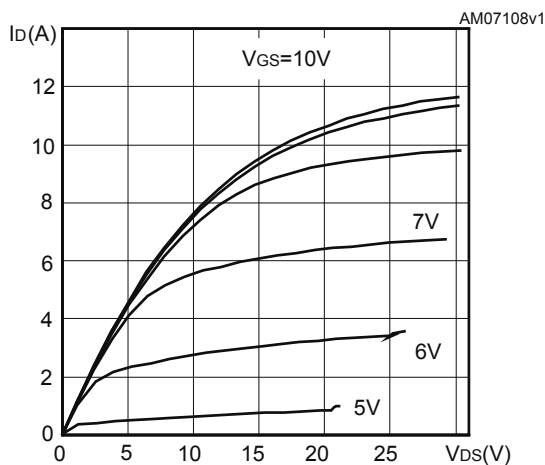
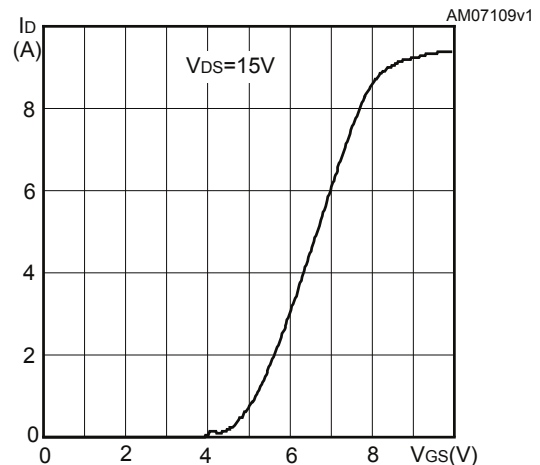
2. Pulsed: pulse duration = 300 $\mu\text{s}$ , duty cycle 1.5%

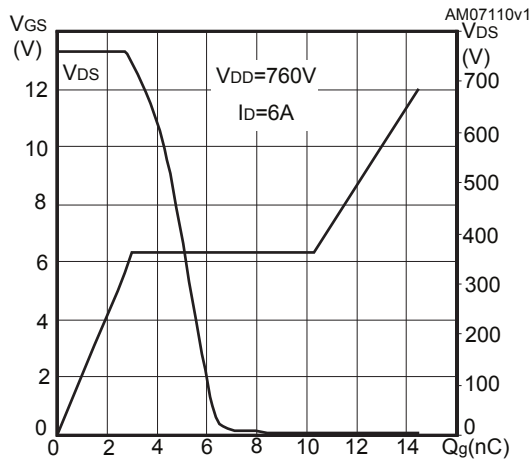
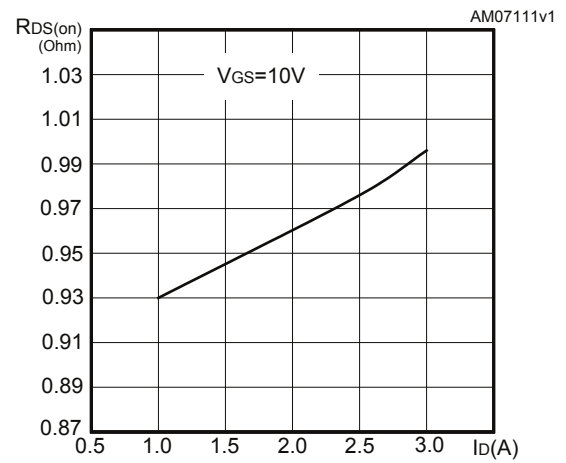
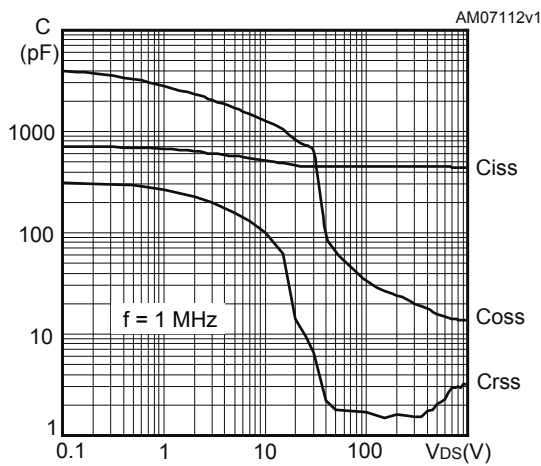
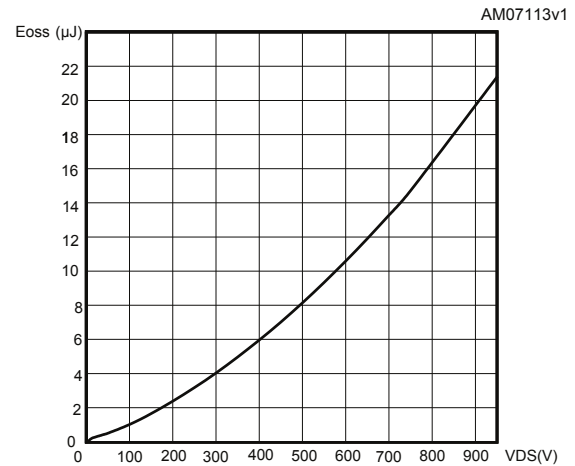
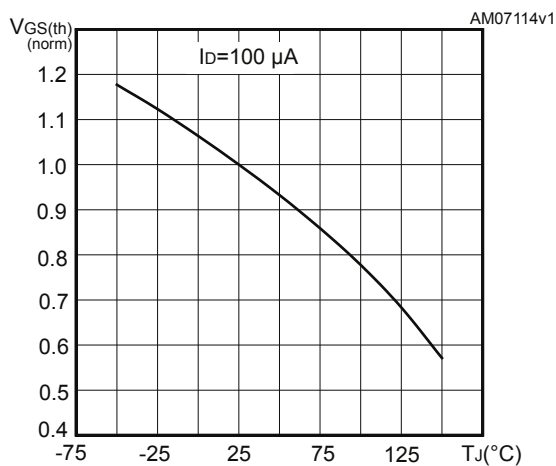
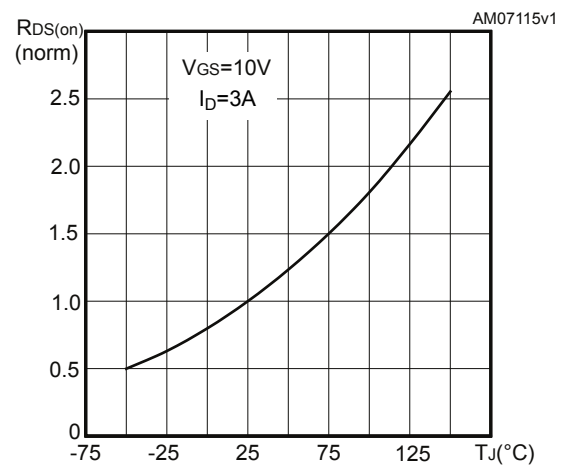
**Table 7. Gate-source Zener diode**

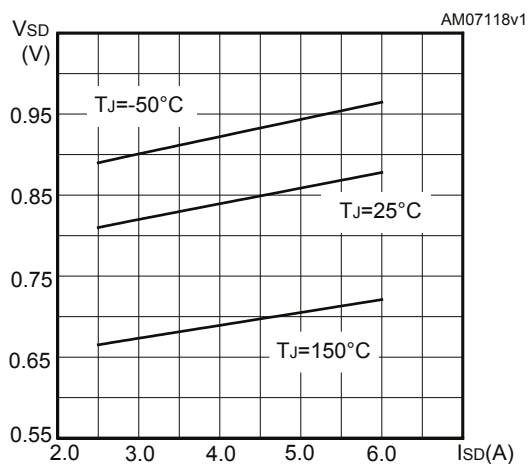
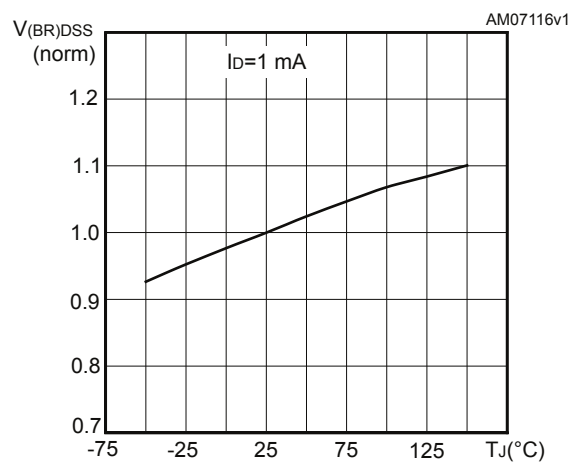
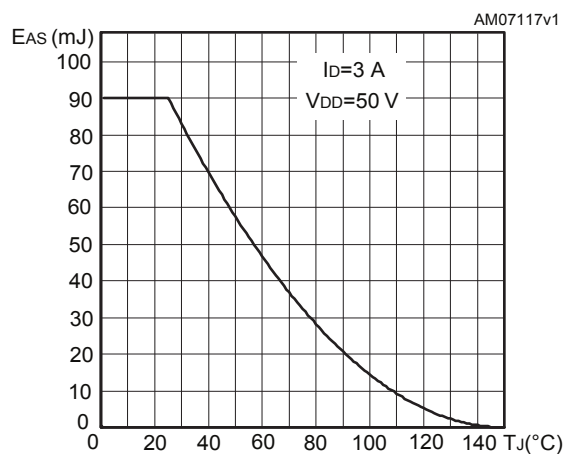
| Symbol        | Parameter                     | Test conditions                                 | Min      | Typ. | Max. | Unit |
|---------------|-------------------------------|-------------------------------------------------|----------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown 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.

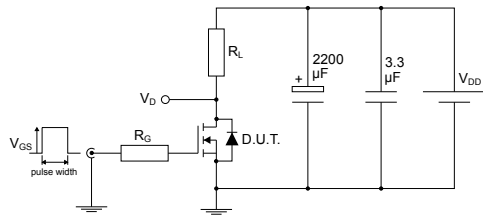
## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area for DPAK and IPAK**

**Figure 2. Thermal impedance for DPAK and IPAK**

**Figure 3. Safe operating area for TO-220 and TO-247**

**Figure 4. Thermal impedance for TO-220 and TO-247**

**Figure 5. Output characteristics**

**Figure 6. Transfer characteristics**


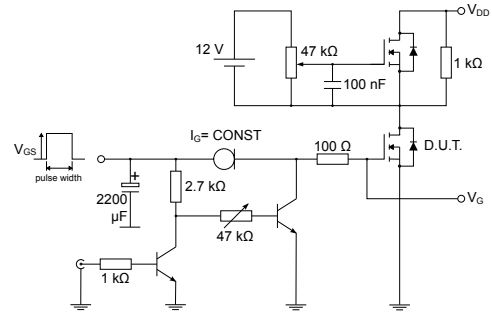
**Figure 7. Gate charge vs gate-source voltage**

**Figure 8. Static drain-source on-resistance**

**Figure 9. Capacitance variations**

**Figure 10. Output capacitance storage energy**

**Figure 11. Normalized gate threshold voltage vs temperature**

**Figure 12. Normalized on-resistance vs temperature**


**Figure 13. Source-drain diode forward characteristics**

**Figure 14. Normalized  $V_{(BR)DSS}$  vs temperature**

**Figure 15. Maximum avalanche energy vs starting  $T_J$** 


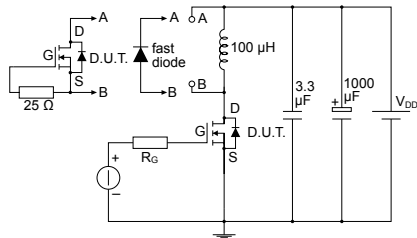
### 3 Test circuits

**Figure 16. Test circuit for resistive load switching times**


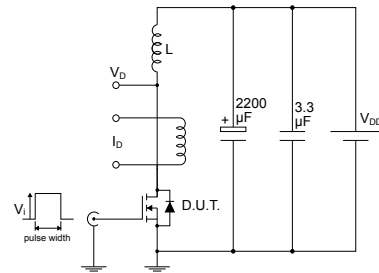
AM01468v1

**Figure 17. Test circuit for gate charge behavior**


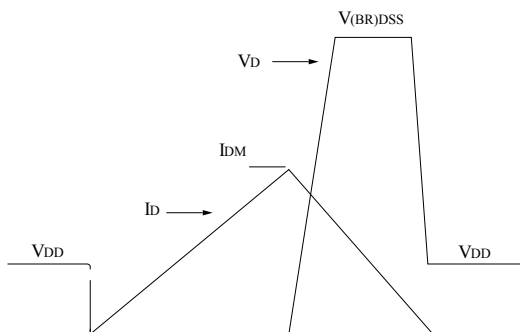
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**Figure 18. Test circuit for inductive load switching and diode recovery times**


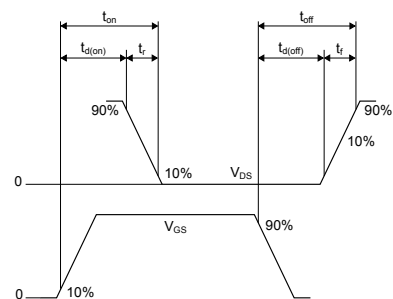
AM01470v1

**Figure 19. Unclamped inductive load test circuit**


AM01471v1

**Figure 20. Unclamped inductive waveform**


AM01472v1

**Figure 21. Switching time waveform**


AM01473v1



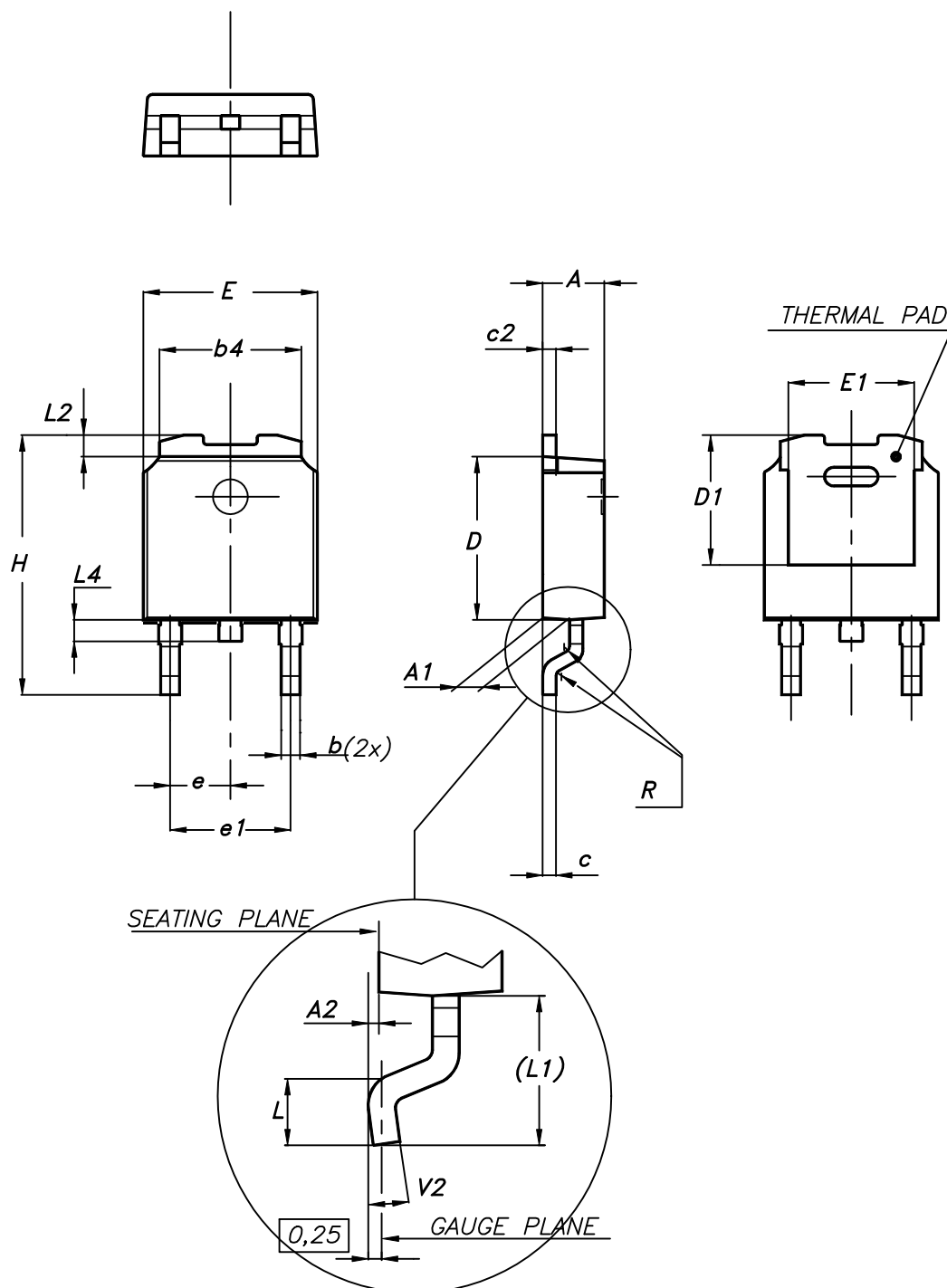
## 4 Package information

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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 A2 package information

Figure 22. DPAK (TO-252) type A2 package outline



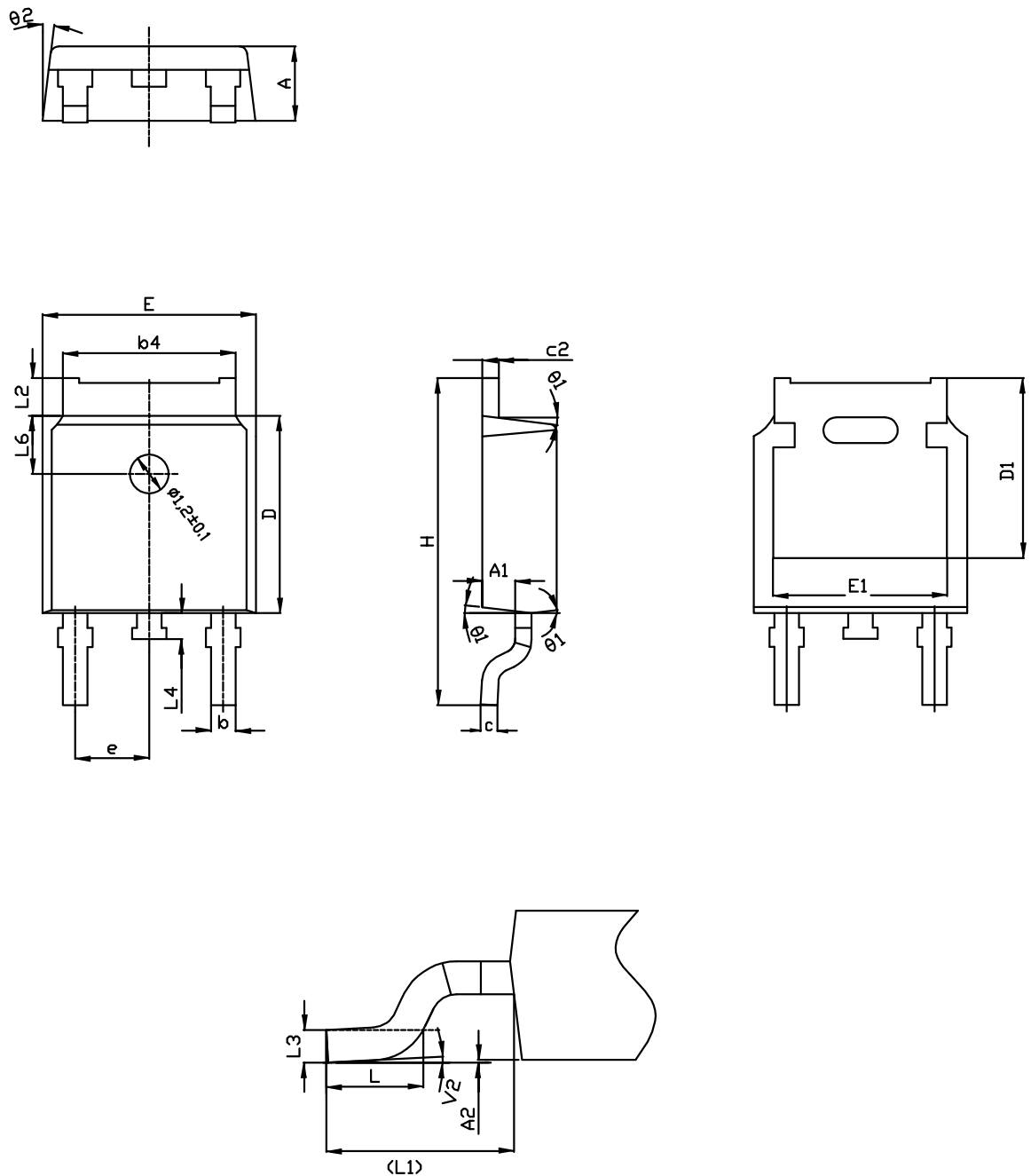
0068772\_type-A2\_rev24

**Table 8. DPAK (TO-252) type A2 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   | 5.10 | 5.20 | 5.30  |
| e    | 2.16 | 2.28 | 2.40  |
| e1   | 4.40 |      | 4.60  |
| 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 C2 package information

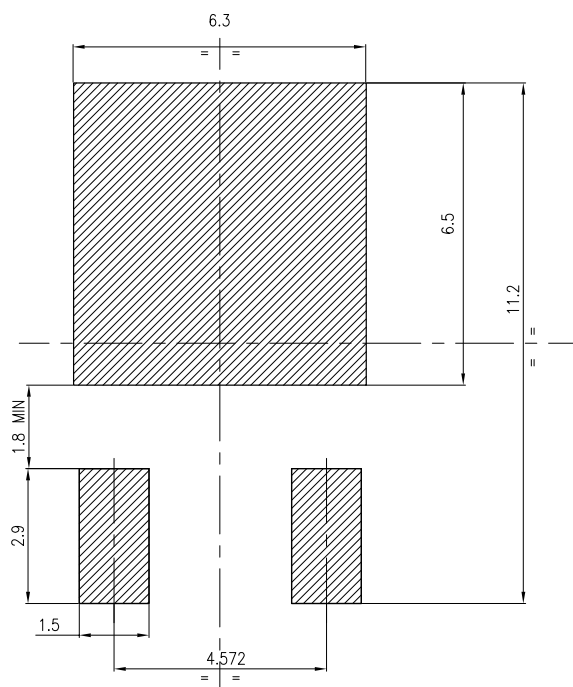
Figure 23. DPAK (TO-252) type C2 package outline



0068772\_C2\_24

**Table 9. DPAK (TO-252) type C2 mechanical data**

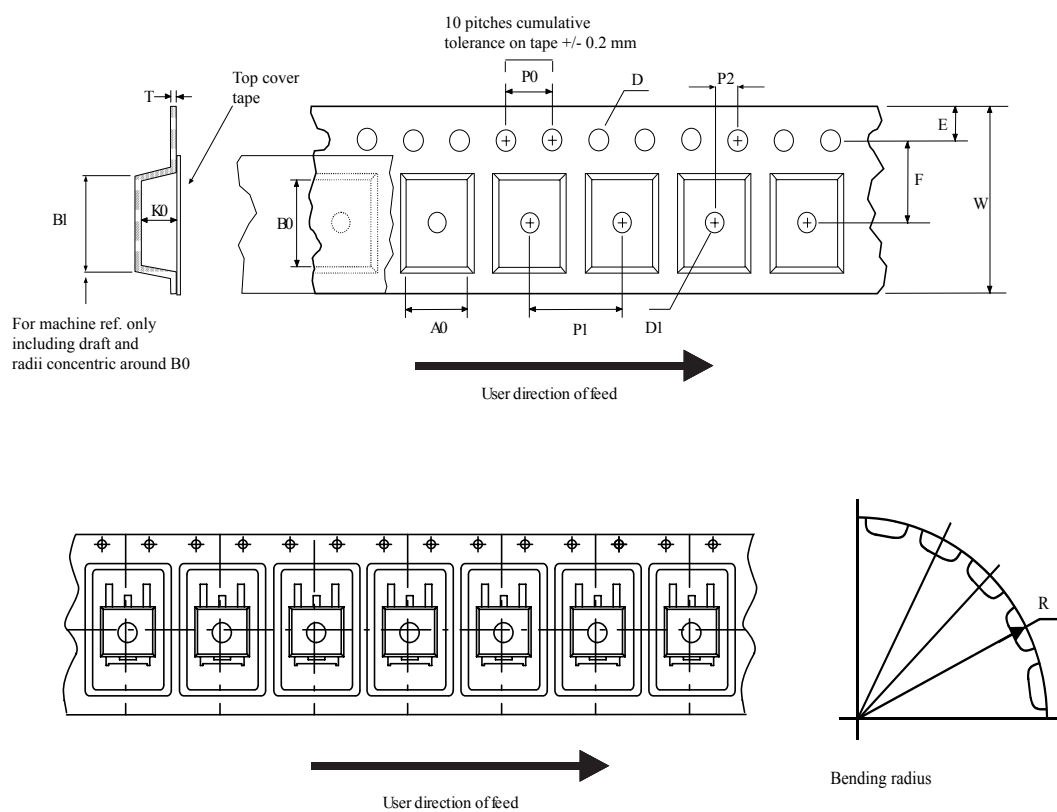
| Dim. | mm       |       |       |
|------|----------|-------|-------|
|      | Min.     | Typ.  | Max.  |
| A    | 2.20     | 2.30  | 2.38  |
| A1   | 0.90     | 1.01  | 1.10  |
| A2   | 0.00     |       | 0.10  |
| b    | 0.72     |       | 0.85  |
| b4   | 5.13     | 5.33  | 5.46  |
| c    | 0.47     |       | 0.60  |
| c2   | 0.47     |       | 0.60  |
| D    | 6.00     | 6.10  | 6.20  |
| D1   | 5.10     |       | 5.60  |
| E    | 6.50     | 6.60  | 6.70  |
| E1   | 5.20     |       | 5.50  |
| e    | 2.186    | 2.286 | 2.386 |
| H    | 9.80     | 10.10 | 10.40 |
| L    | 1.40     | 1.50  | 1.70  |
| L1   | 2.90 REF |       |       |
| L2   | 0.90     |       | 1.25  |
| L3   | 0.51 BSC |       |       |
| L4   | 0.60     | 0.80  | 1.00  |
| L6   | 1.80 BSC |       |       |
| θ1   | 5°       | 7°    | 9°    |
| θ2   | 5°       | 7°    | 9°    |
| V2   | 0°       |       | 8°    |

**Figure 24. DPAK (TO-252) recommended footprint (dimensions are in mm)**


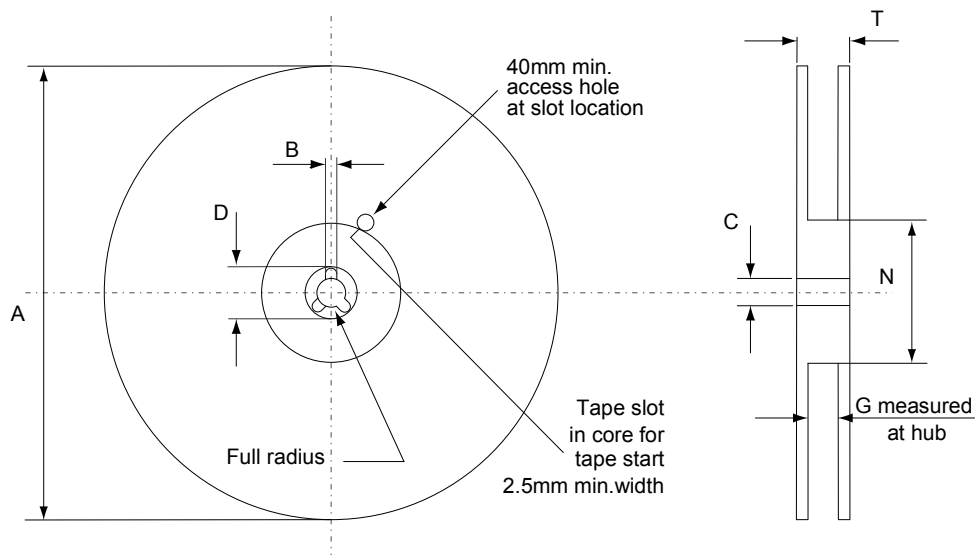
FP\_0068772\_24

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

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



AM08852v1

**Figure 26. DPAK (TO-252) reel outline**


AM06038v1

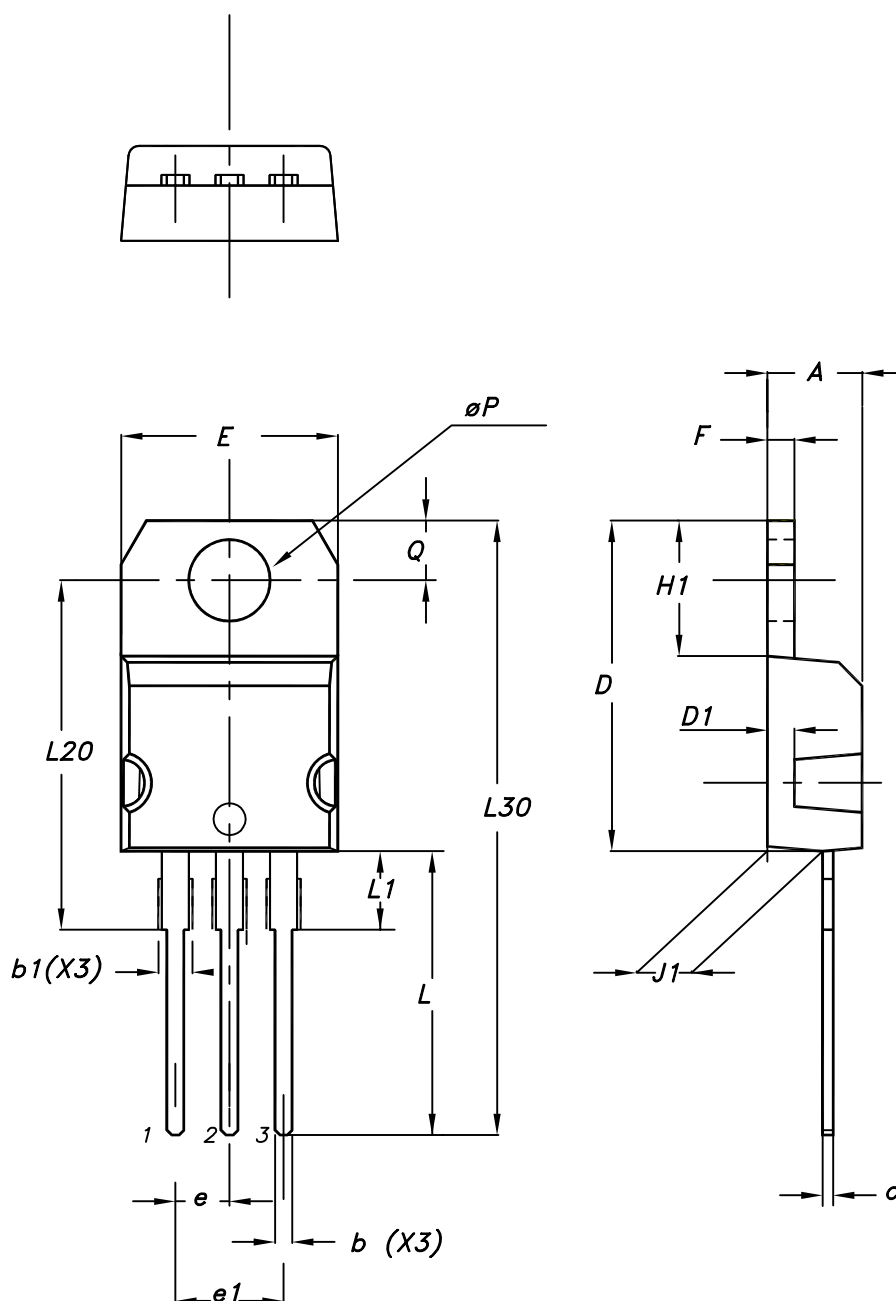
**Table 10. DPAK (TO-252) tape and reel mechanical data**

| 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 27. TO-220 type A package outline



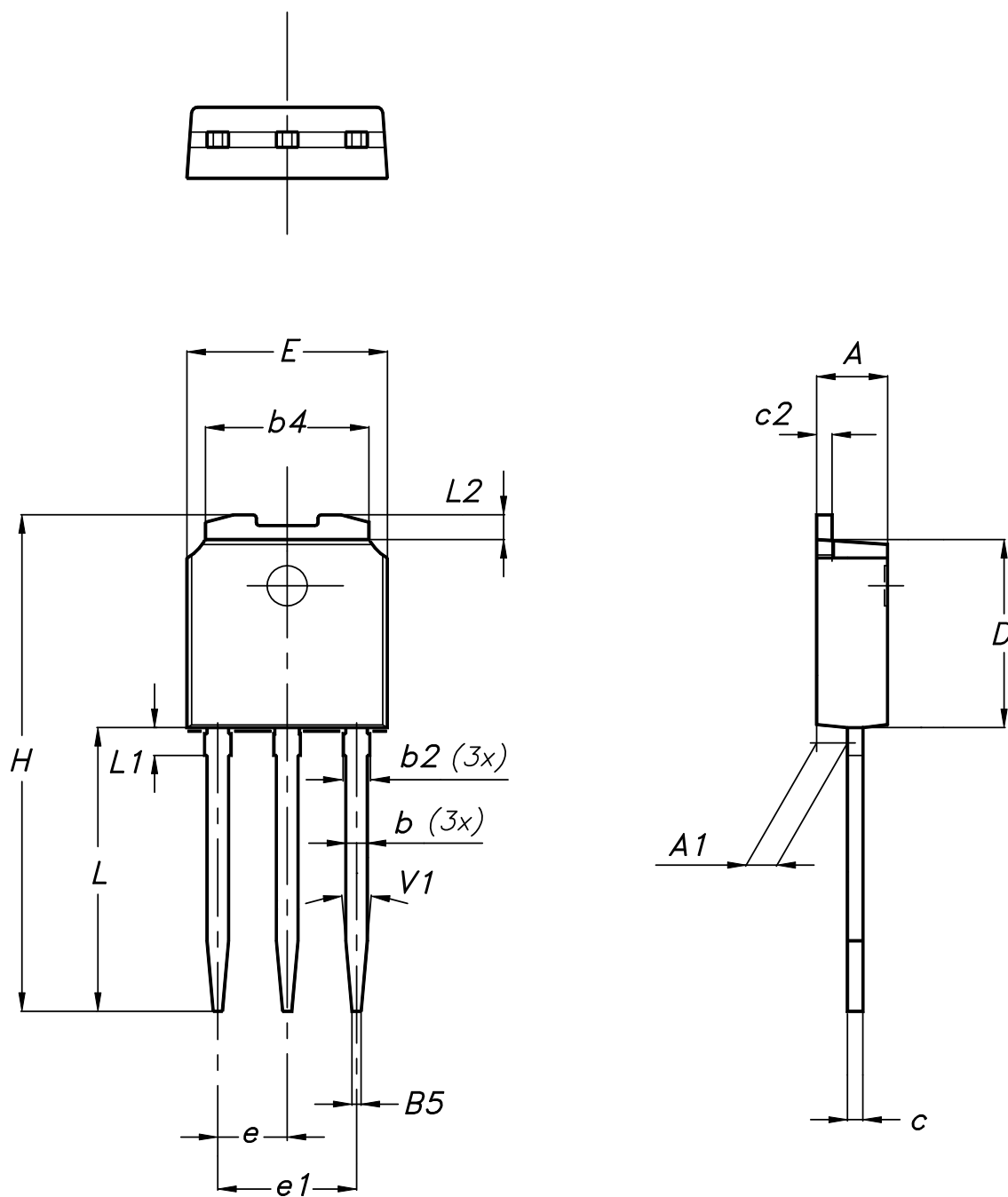
0015988\_typeA\_Rev\_21

**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 IPAK (TO-251) type A package information

Figure 28. IPAK (TO-251) type A package outline



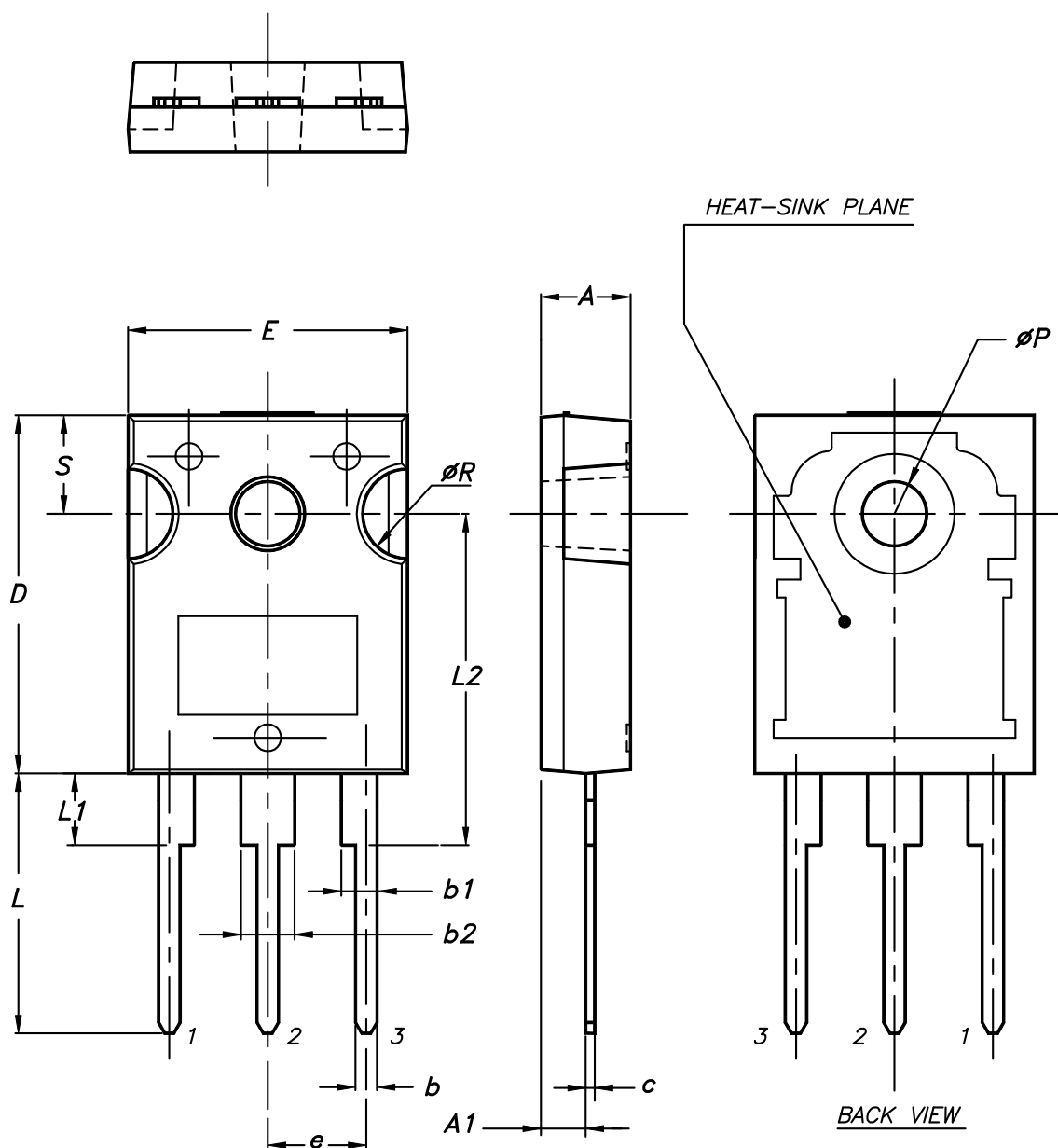
0068771\_IK\_typeA\_rev14

**Table 12. IPAK (TO-251) type A package mechanical data**

| Dim. | mm   |       |      |
|------|------|-------|------|
|      | Min. | Typ.  | Max. |
| A    | 2.20 |       | 2.40 |
| A1   | 0.90 |       | 1.10 |
| b    | 0.64 |       | 0.90 |
| b2   |      |       | 0.95 |
| b4   | 5.20 |       | 5.40 |
| B5   |      | 0.30  |      |
| c    | 0.45 |       | 0.60 |
| c2   | 0.48 |       | 0.60 |
| D    | 6.00 |       | 6.20 |
| E    | 6.40 |       | 6.60 |
| e    |      | 2.28  |      |
| e1   | 4.40 |       | 4.60 |
| H    |      | 16.10 |      |
| L    | 9.00 |       | 9.40 |
| L1   | 0.80 |       | 1.20 |
| L2   |      | 0.80  | 1.00 |
| V1   |      | 10°   |      |

## 4.6 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. Ordering information**

| Order code | Marking | Package | Packing       |
|------------|---------|---------|---------------|
| STD6N95K5  | 6N95K5  | DPAK    | Tape and reel |
| STP6N95K5  | 6N95K5  | TO-220  | Tube          |
| STU6N95K5  | 6N95K5  | IPAK    | Tube          |
| STW6N95K5  | 6N95K5  | TO-247  | Tube          |

## Revision history

**Table 15. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12-Jan-2010 | 1        | First release.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 01-Jul-2010 | 2        | Document status promoted from preliminary data to datasheet.                                                                                                                                                                                                                                                                                                                                                                                                             |
| 31-Aug-2012 | 3        | Inserted new device in IPAK.<br>Updated <i>Table 1: Device summary</i> , <i>Table 2: Absolute maximum ratings</i> , and <i>Table 3: Thermal data</i> .<br>Updated <i>Section 4: Package mechanical data</i> and <i>Section 5: Packaging mechanical data</i> .<br>Minor text changes in the cover page.                                                                                                                                                                   |
| 16-May-2014 | 4        | The part number STF6N95K5 has been moved to a separate datasheet.<br>Added: MOSFET dv/dt ruggedness parameter in <i>Table 2</i><br>Updated: <i>Section 4: Package mechanical data</i><br>Minor text changes                                                                                                                                                                                                                                                              |
| 22-Mar-2018 | 5        | Removed maturity status indication and updated title and description from cover page.<br>The document status is production data.<br>Updated <a href="#">Section 1 Electrical ratings</a> , <a href="#">Section 2 Electrical characteristics</a> .<br>Updated <a href="#">Figure 9. Capacitance variations</a> and <a href="#">Figure 12. Normalized on-resistance vs temperature</a> .<br>Updated <a href="#">Section 4 Package information</a> .<br>Minor text changes. |



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