

Automotive-grade N-channel 1000 V, 5.6 Ω typ., 2.2 A SuperMESH™ Power MOSFET Zener-protected in a DPAK

Datasheet - production data

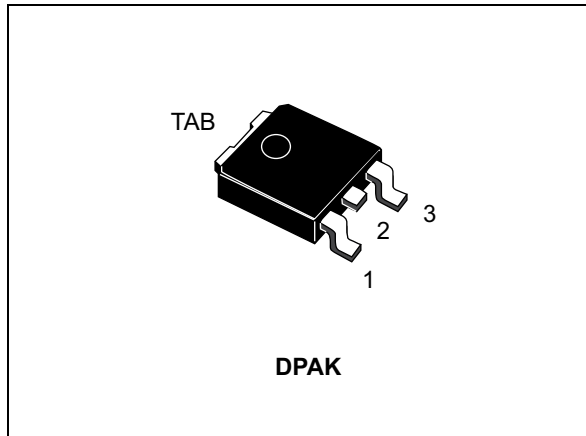
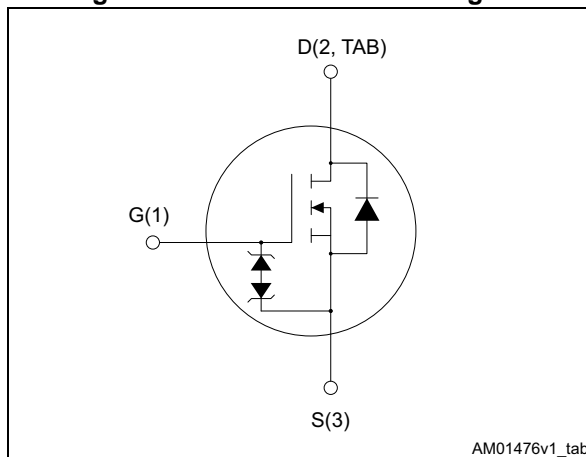


Figure 1. Internal schematic diagram



Features

| Order code | V _{DSS} | R _{DS(on)max} | I _D |
|------------|------------------|------------------------|----------------|
| STD4NK100Z | 1000 V | 6.8 Ω | 2.2 A |

- Designed for automotive applications and AEC-Q101 qualified
- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance
- Zener-protected

Applications

- Switching application

Description

This device is an N-channel Zener-protected Power MOSFET developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

Table 1. Device summary

| Order code | Marking | Package | Packaging |
|------------|---------|---------|---------------|
| STD4NK100Z | 4NK100Z | DPAK | Tape and reel |

Note: *HTRB test has been performed at 80% of V_{(BR)DSS} according to AEC-Q101 rev. C. All the other tests have been done according to the new rev. D.*

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|--------------------|--|------------|------------------|
| V_{DS} | Drain-source voltage | 1000 | V |
| V_{GS} | Gate-source voltage | ± 30 | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$ | 2.2 | A |
| I_D | Drain current (continuous) at $T_C=100\text{ }^\circ\text{C}$ | 1 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 8.8 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 90 | W |
| $V_{ESD(G-S)}$ | Gate source ESD (HBM-C=100pF, R=1.5 k Ω) | 3000 | V |
| $d_v/d_t^{(2)}$ | Peak diode recovery voltage slope | 4.5 | V/ns |
| T_J T_{stg} | Operating junction temperature Storage temperature | -55 to 150 | $^\circ\text{C}$ |

1. Pulse width limited by safe operating area
2. $I_{SD} \leq 2.2\text{ A}$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX}$.

Table 3. Thermal data

| Symbol | Parameter | Value | Unit |
|---------------------|--------------------------------------|-------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max | 1.39 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb max | 50 | $^\circ\text{C}/\text{W}$ |

1. When mounted on 1inch² FR-4 board, 2 oz Cu

Table 4. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------|--|-------|------|
| I_{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T_{JMAX}) | 2.2 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_J=25\text{ }^\circ\text{C}$, $I_D=I_{AR}$, $V_{DD}=50\text{ V}$) | 110 | mJ |

2 Electrical characteristics

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

Table 5. On/off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|--|------|------|----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1\text{ mA}, V_{GS} = 0$ | 1000 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 1000\text{ V},$ $V_{DS} = 1000\text{ V}, T_c = 125\text{ }^{\circ}\text{C}$ | | | 1 50 | μA μA |
| I_{GSS} | Gate body leakage current ($V_{GS} = 0$) | $V_{GS} = \pm 20\text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 50\text{ }\mu\text{A}$ | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}, I_D = 1.1\text{ A}$ | | 5.6 | 6.8 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------------|-------------------------------|--|------|------|------|------|
| C_{iss} | Input capacitance | $V_{DS} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GS} = 0$ | - | 601 | - | pF |
| C_{oss} | Output capacitance | | - | 53 | - | pF |
| C_{riss} | Reverse transfer capacitance | | - | 12 | - | pF |
| $C_{oss, eq}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0\text{ V to } 800\text{ V}$ | - | 15 | - | pF |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 500\text{ V}, I_D = 1.25\text{ A},$ $R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 16) | - | 15 | - | ns |
| t_r | Rise time | | - | 7.5 | - | ns |
| $t_{d(off)}$ | Off-voltage rise time | | - | 32 | - | ns |
| t_f | Fall time | | - | 39 | - | ns |
| Q_g | Total gate charge | $V_{DD} = 800\text{ V}, I_D = 2.5\text{ A}$ $V_{GS} = 10\text{ V}$ (see Figure 15) | - | 18 | - | nC |
| Q_{gs} | Gate-source charge | | - | 3.6 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 9.2 | - | nC |

1. $C_{oss, eq}$ 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 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 2.2 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 8.8 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD}=2.2\text{ A}, V_{GS}=0$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD}=2.5\text{ A},$ $di/dt = 100\text{ A}/\mu\text{s},$ $V_{DD}=100\text{ V}$ (see Figure 14) | - | 584 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 2.3 | | μC |
| I_{RRM} | Reverse recovery current | | - | 8 | | A |
| t_{rr} | Reverse recovery time | $I_{SD}=2.5\text{ A},$ $di/dt = 100\text{ A}/\mu\text{s},$ $V_{DD}=100\text{ V}, T_j=150\text{ }^\circ\text{C}$ (see Figure 14) | - | 628 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 2.5 | | μC |
| I_{RRM} | Reverse recovery current | | - | 8.1 | | A |

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

Table 8. Gate-source Zener diode

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

The built-in back-to-back Zener diodes have specifically been designed to enhance the device's ESD capability. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

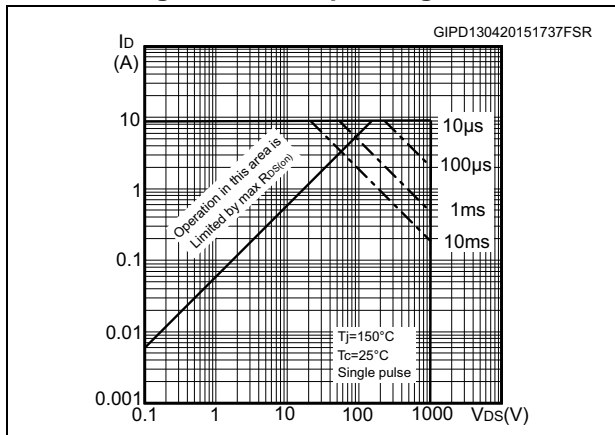


Figure 3. Thermal impedance

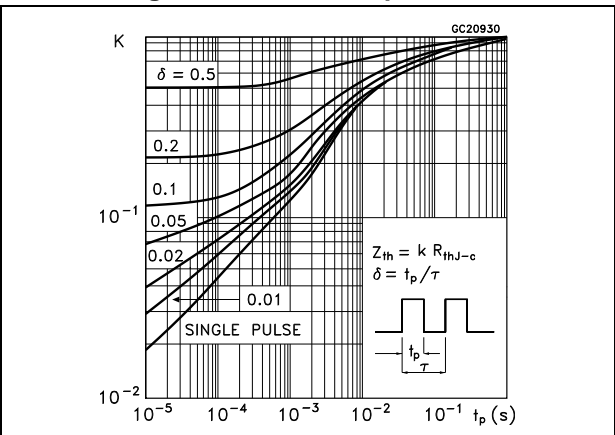


Figure 4. Output characteristics

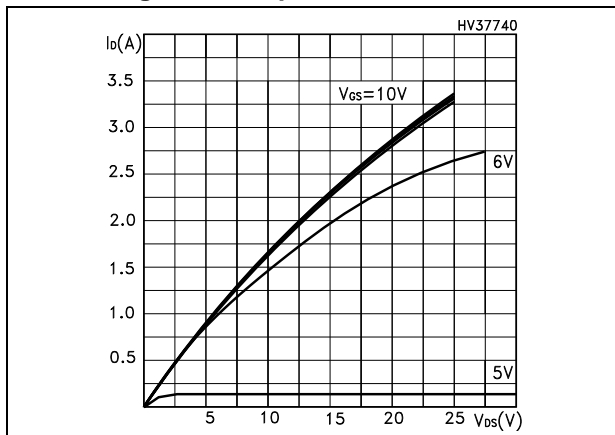


Figure 5. Transfer characteristics

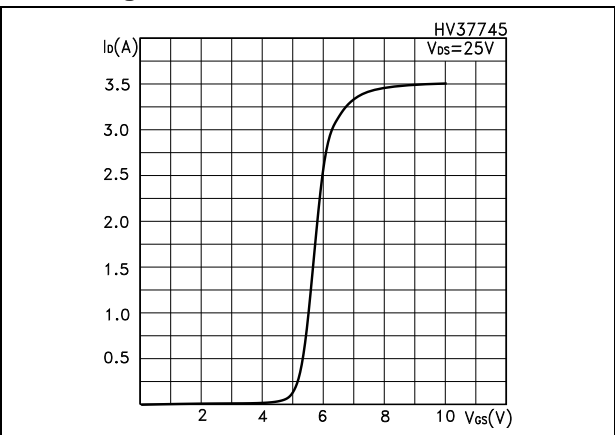


Figure 6. Normalized $V_{(BR)DSS}$ vs. temperature

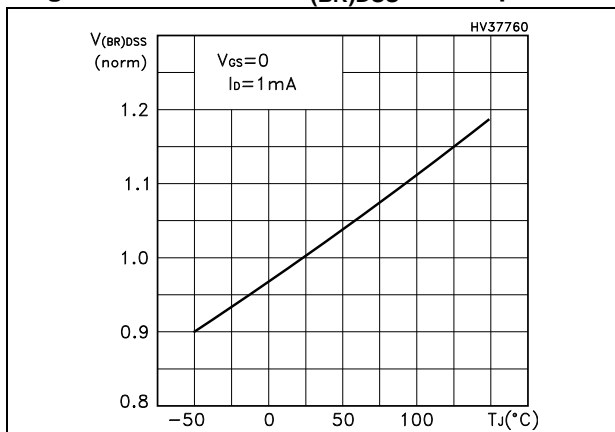


Figure 7. Static drain-source on-resistance

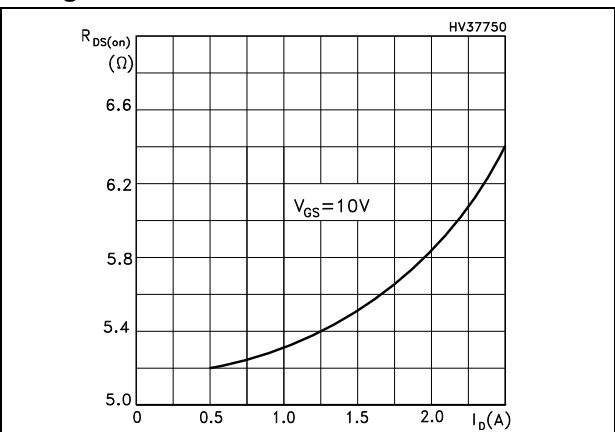


Figure 8. Gate charge vs. gate-source voltage

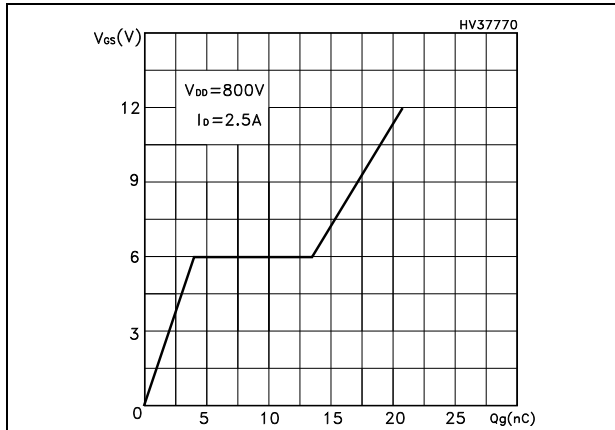


Figure 9. Capacitance variations

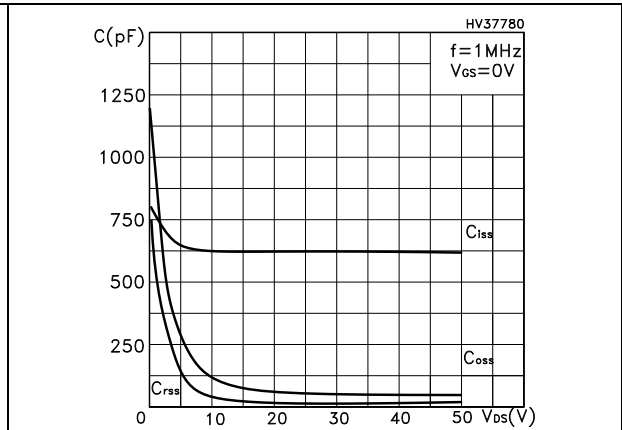


Figure 10. Normalized gate threshold voltage vs. temperature

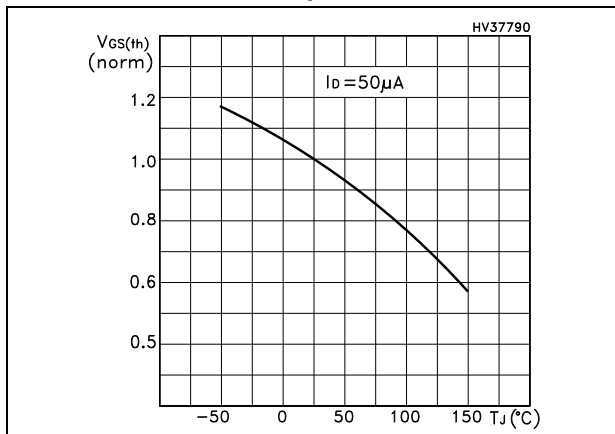


Figure 11. Normalized on-resistance vs. temperature

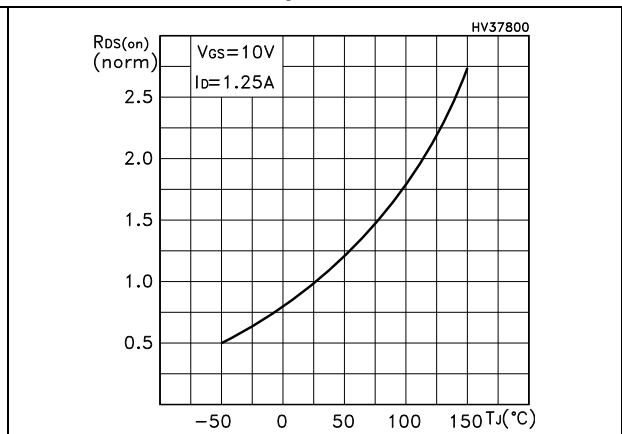


Figure 12. Source-drain diode forward characteristics

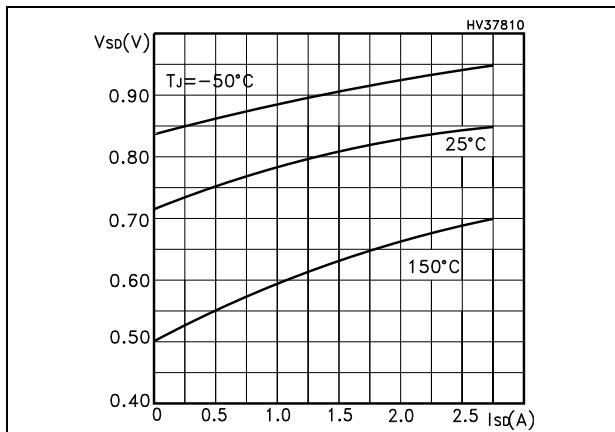
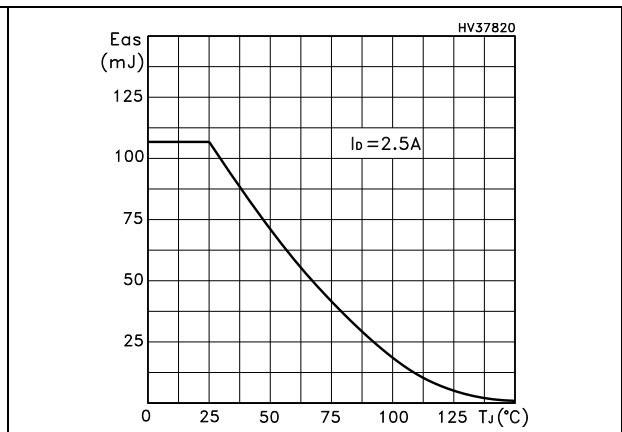


Figure 13. Maximum avalanche energy vs Tj



3 Test circuits

Figure 14. Switching times test circuit for resistive load

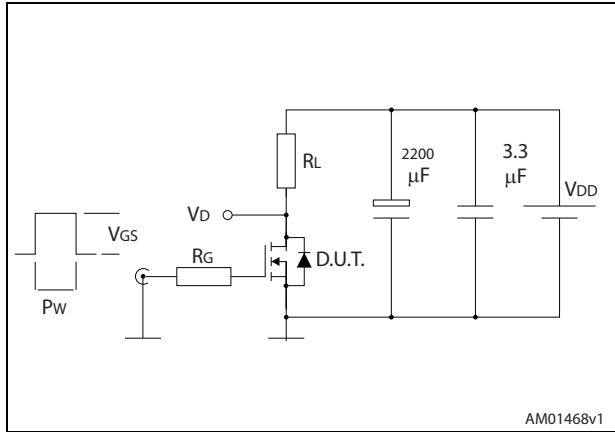


Figure 15. Gate charge test circuit

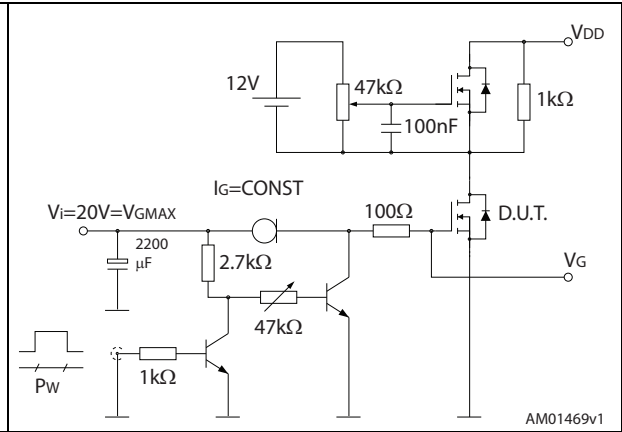


Figure 16. Test circuit for inductive load switching and diode recovery times

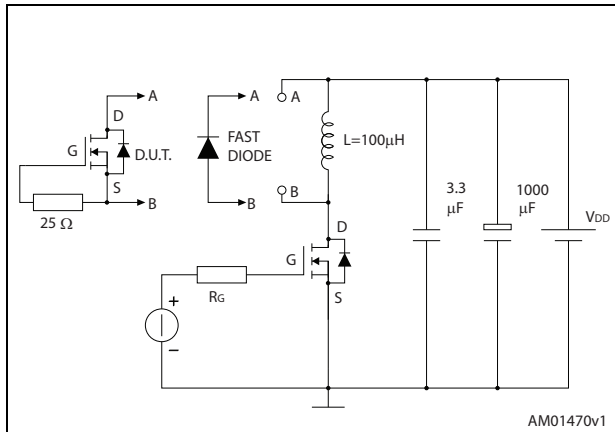


Figure 17. Unclamped inductive load test circuit

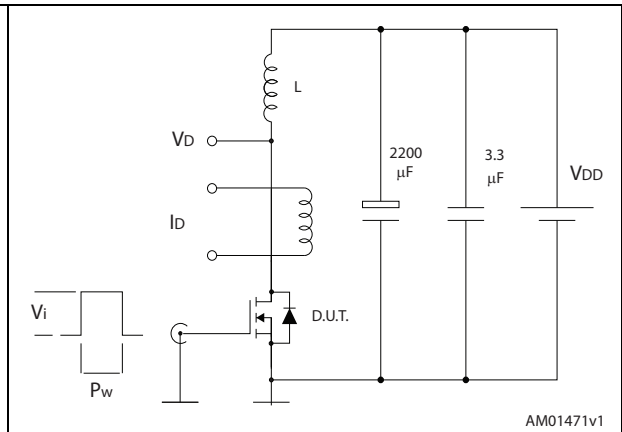


Figure 18. Unclamped inductive waveform

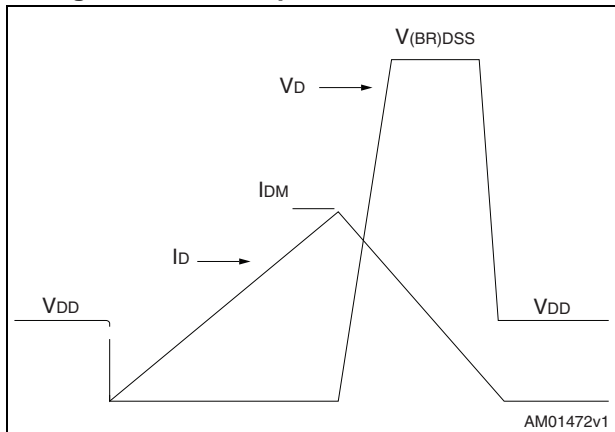
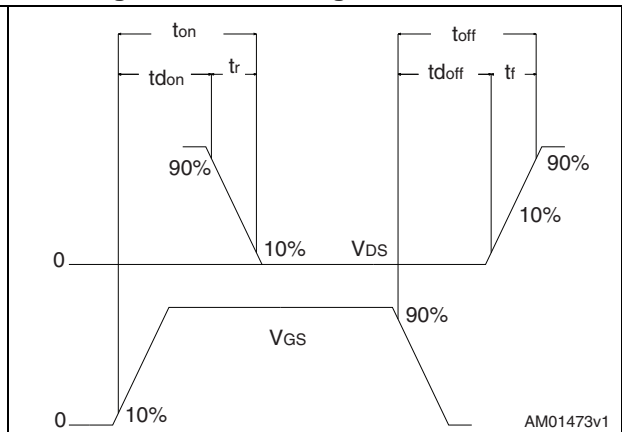


Figure 19. Switching time waveform



4 Package information

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. ECOPACK is an ST trademark.

Figure 20. DPAK (TO-252) type A2 outline

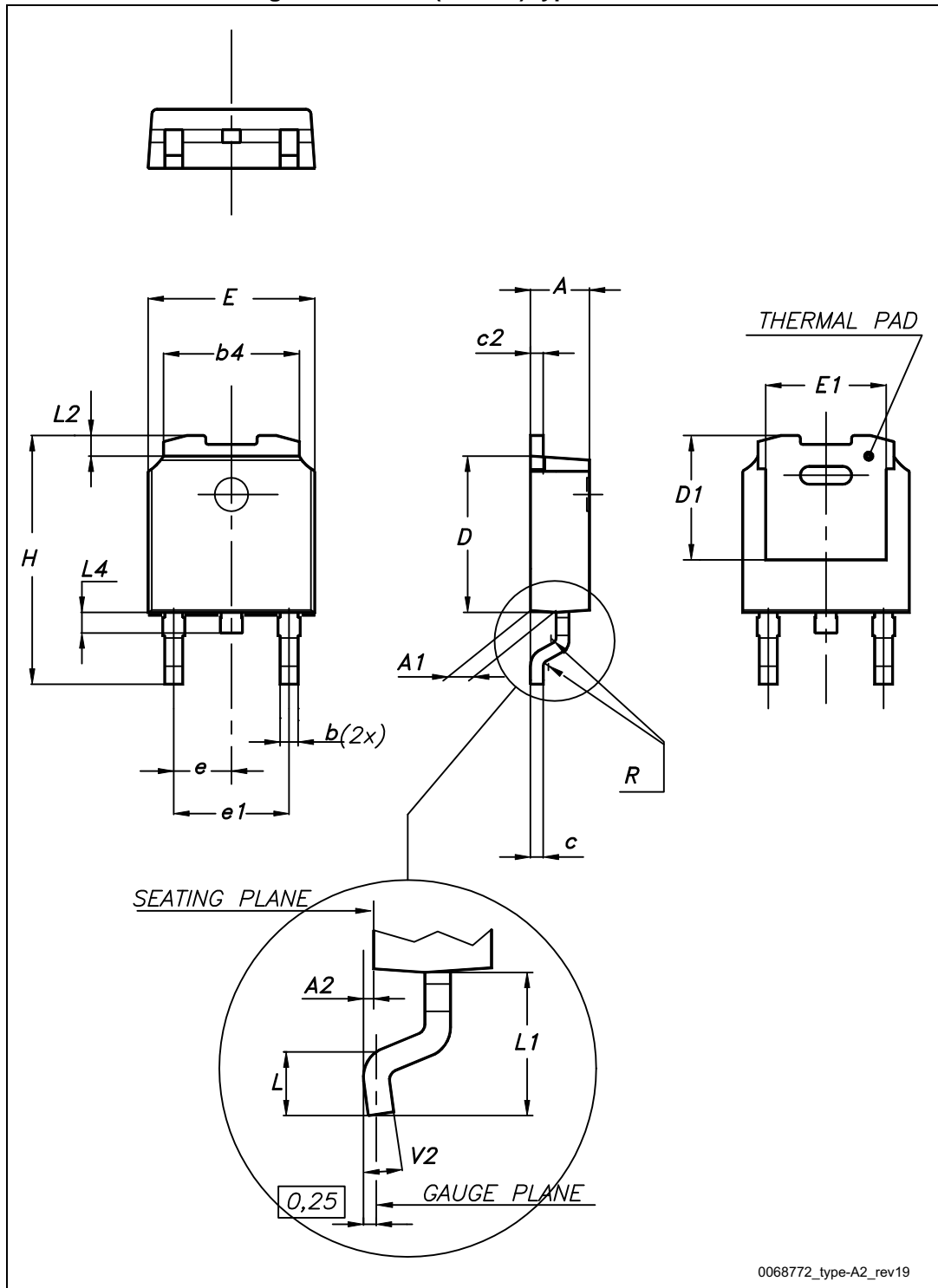
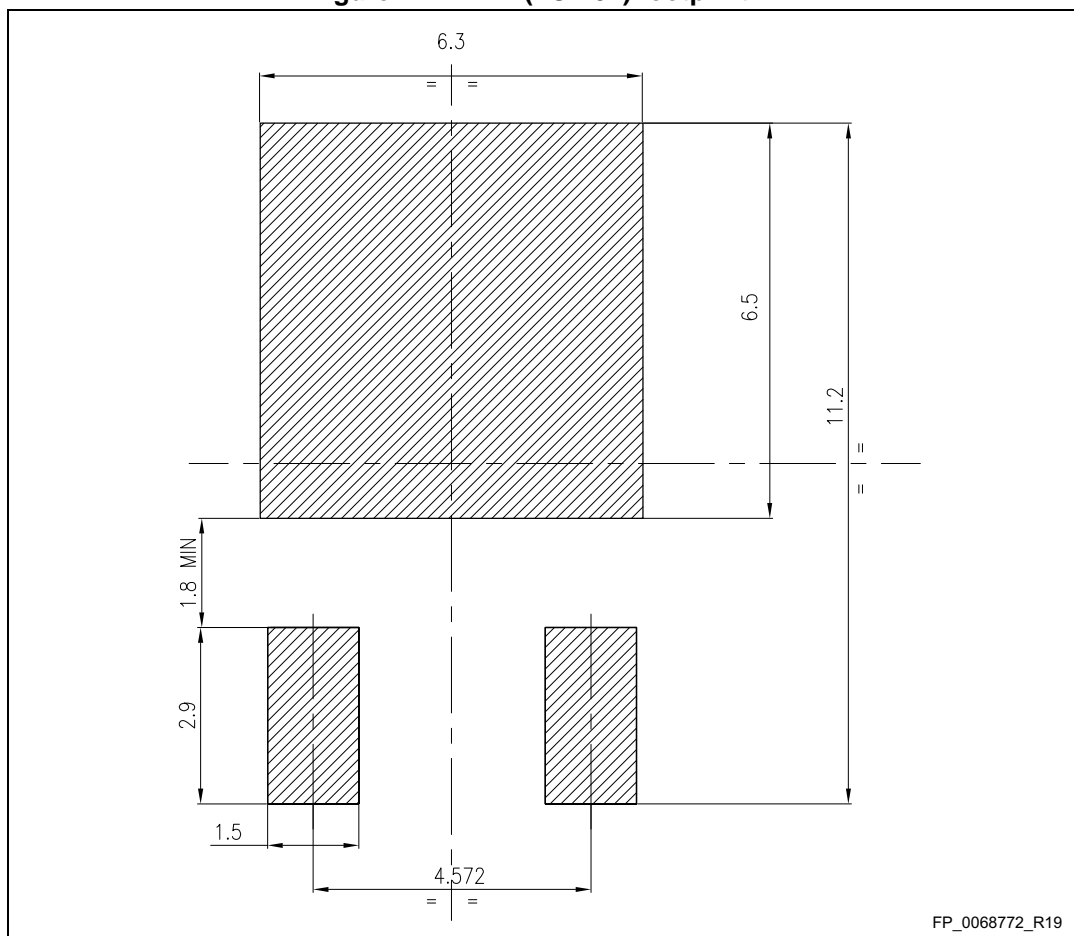


Table 9. DPAK (TO-252) type A2 mechanical data

| 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° |

Figure 21. DPAK (TO-252) footprint (a)



a. All dimensions are in millimeters

5 Packing information

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 | | | |

Figure 22. Tape for DPAK (TO-252)

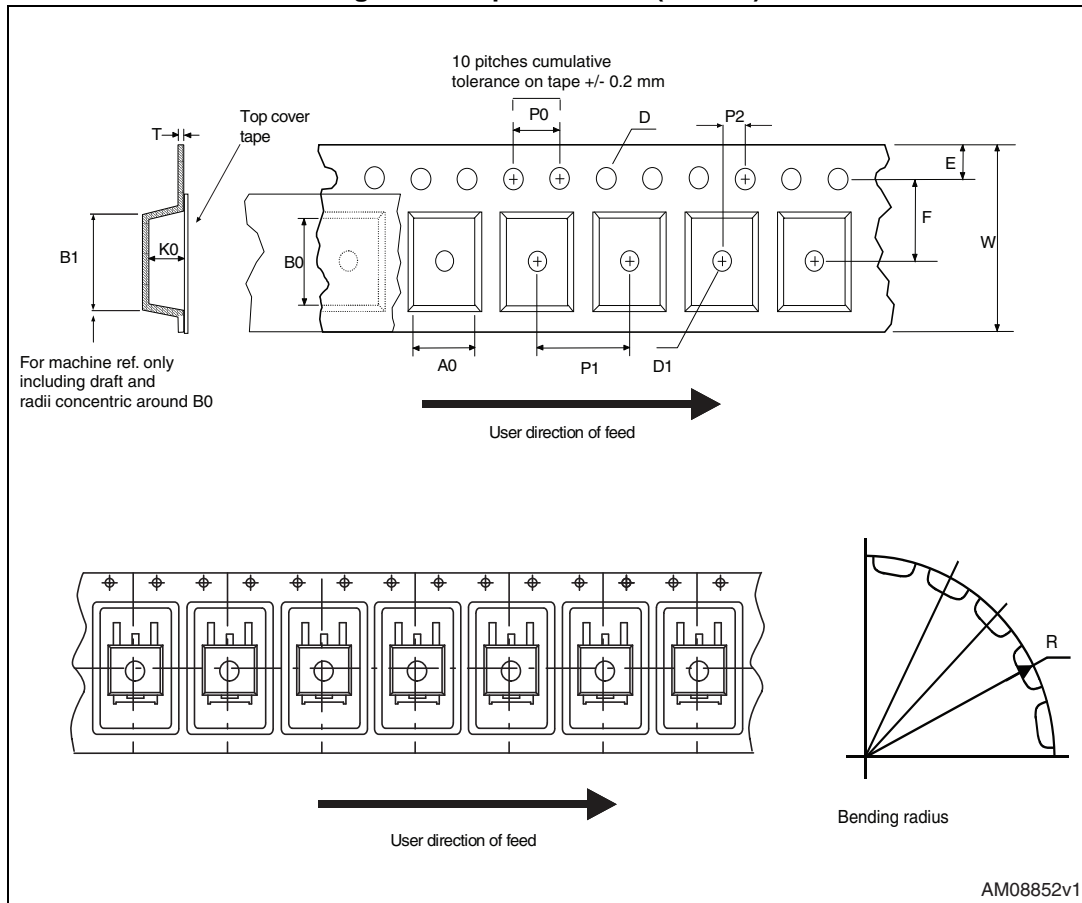
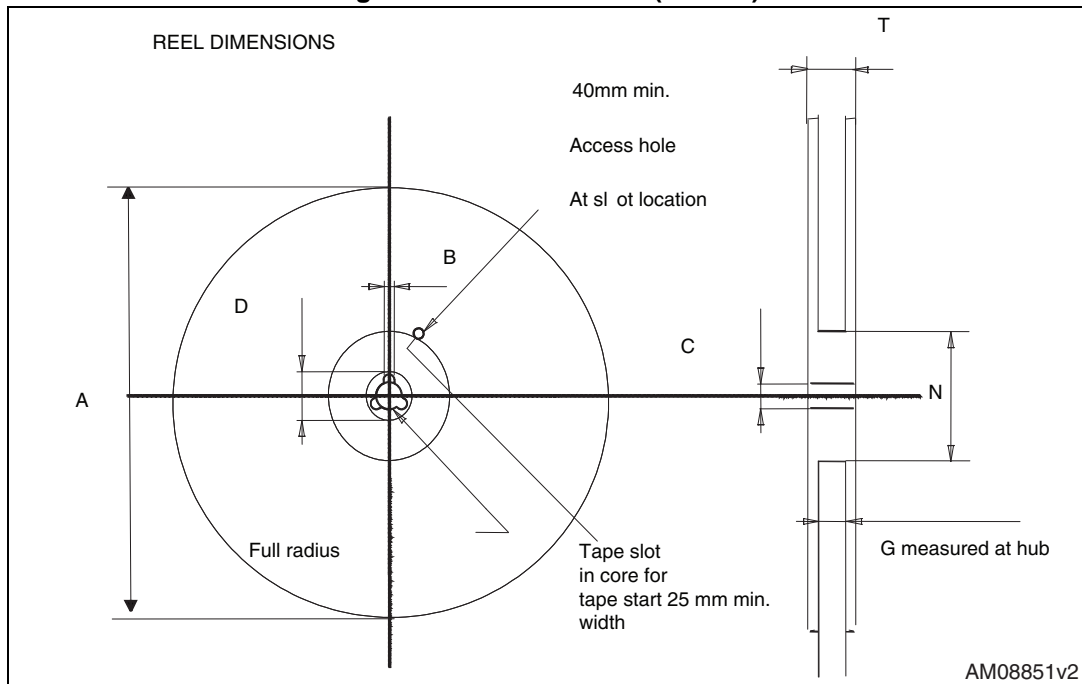


Figure 23. Reel for DPAK (TO-252)



6 Revision history

Table 11. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 01-Oct-2013 | 1 | First release. |
| 13-Apr-2015 | 2 | Document status promoted from preliminary to production data. Updated title and features in cover page. Updated Section 2.1: Electrical characteristics (curves) and Section 4: Package information . Minor text changes. |

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