

N-channel 500 V, 0.45 Ω typ, 8 A, MDmesh II Plus™ low Qg Power MOSFETs in DPAK and TO-220FP packages

Datasheet - preliminary data

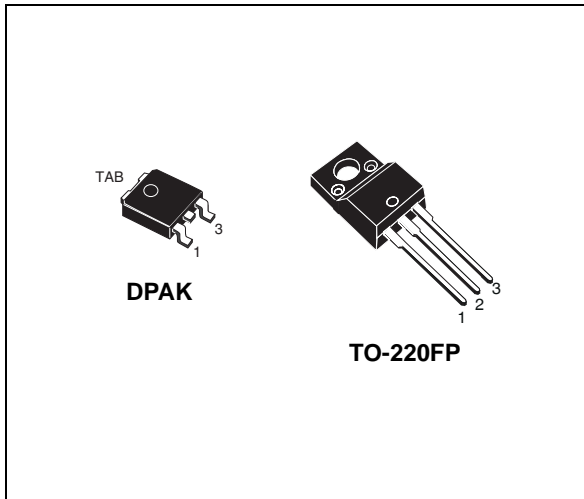
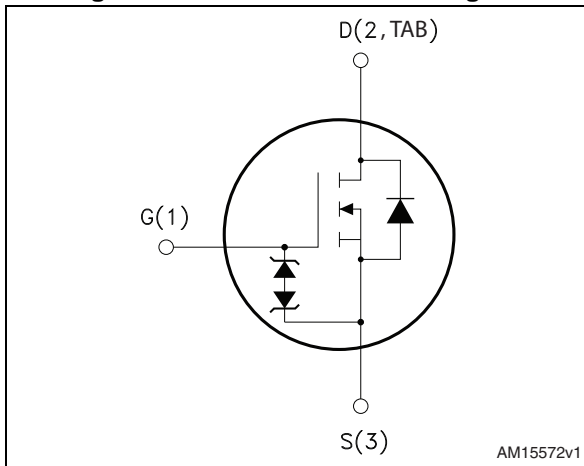


Figure 1. Internal schematic diagram



Features

| Order codes | $V_{DS} @ T_{Jmax}$ | $R_{DS(on) max}$ | I_D |
|-------------|---------------------|------------------|-------|
| STD11N50M2 | 550 V | 0.53 Ω | 8 A |
| STF11N50M2 | | | |

- Extremely low gate charge
- Lower $R_{DS(on)}$ x area vs previous generation
- Low gate input resistance
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using a new generation of MDmesh™ technology: MDmesh II Plus™ low Q_g . These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|----------|---------------|
| STD11N50M2 | 11N50M2 | DPAK | Tape and reel |
| STF11N50M2 | | TO-220FP | Tube |

Contents

- 1 Electrical ratings 3**
- 2 Electrical characteristics 4**
 - 2.1 Electrical characteristics (curves) 6
- 3 Test circuits 9**
- 4 Package mechanical data 10**
 - 4.1 DPAK, STD11N50M211
 - 4.2 TO-220FP, STF11N50M2 14
- 5 Packaging mechanical data 16**
- 6 Revision history 18**



1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|----------------|---|-------------|----------|------|
| | | DPAK | TO-220FP | |
| V_{GS} | Gate-source voltage | ± 25 | | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ °C}$ | 8 | | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ °C}$ | 5 | | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 32 | | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 85 | 25 | W |
| $dv/dt^{(1)}$ | Peak diode recovery voltage slope | 15 | | V/ns |
| $dv/dt^{(2)}$ | MOSFET dv/dt ruggedness | 50 | | |
| V_{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink ($t=1\text{ s}$; $T_C = 25\text{ °C}$) | 2500 | | |
| T_{stg} | Storage temperature | - 55 to 150 | | °C |
| T_j | Max. operating junction temperature | | | |

1. $I_{SD} \leq 8\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$; $V_{DS\ peak} < V_{(BR)DSS}$, $V_{DD}=400\text{ V}$
2. $V_{DS} \leq 400\text{ V}$

Table 3. Thermal data

| Symbol | Parameter | Value | | Unit |
|----------------|--|-------|----------|------|
| | | DPAK | TO-220FP | |
| $R_{thj-case}$ | Thermal resistance junction-case max | 1.47 | 5 | °C/W |
| $R_{thj-pcb}$ | Thermal resistance junction-pcb max ⁽¹⁾ | 50 | | °C/W |
| $R_{thj-amb}$ | Thermal al resistance junction-ambient max | 62.5 | | °C/W |

1. When mounted on 1 inch² FR-4, 2 Oz copper board

Table 4. Avalanche characteristics

| Symbol | Parameter | Value | | Unit |
|----------|--|-------|----------|------|
| | | DPAK | TO-220FP | |
| I_{AR} | Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax}) | 2 | | A |
| E_{AS} | Single pulse avalanche energy (starting $T_j=25\text{ °C}$, $I_D= I_{AR}$; $V_{DD}=50$) | 190 | | mJ |

2 Electrical characteristics

($T_C = 25\text{ °C}$ unless otherwise specified)

Table 5. On /off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------------------|--|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS} = 0, I_D = 1\text{ mA}$ | 500 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0, V_{DS} = 500\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0, V_{DS} = 500\text{ V}, T_C = 125\text{ °C}$ | | | 100 | μA |
| I_{GSS} | Gate-body leakage current | $V_{DS} = 0, V_{GS} = \pm 25\text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 2 | 3 | 4 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}, I_D = 4\text{ A}$ | | 0.45 | 0.53 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|---|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{GS} = 0, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$ | - | 395 | - | pF |
| C_{oss} | Output capacitance | | - | 26 | - | pF |
| C_{riss} | Reverse transfer capacitance | | - | 1 | - | pF |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0\text{ to }400\text{ V}$ | - | 108 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}, I_D = 0$ | - | 6.3 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 400\text{ V}, I_D = 8\text{ A}, V_{GS} = 10\text{ V}$ (see Figure 17) | - | 12 | - | nC |
| Q_{gs} | Gate-source charge | | - | 2 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 6.4 | - | nC |

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 7. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 250\text{ V}, I_D = 4\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 16 and Figure 21) | - | 11 | - | ns |
| t_r | Rise time | | - | 9 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 8 | - | ns |
| t_f | Fall time | | - | 28.5 | - | ns |

Table 8. 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 | $V_{GS} = 0, I_{SD} = 8 \text{ A}$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 8 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see Figure 18) | - | 258 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.84 | | μC |
| I_{RRM} | Reverse recovery current | | - | 14.3 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 8 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}, T_j = 150 \text{ }^\circ\text{C}$ (see Figure 18) | - | 370 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 2.87 | | μC |
| I_{RRM} | Reverse recovery current | | - | 15.5 | | A |

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK

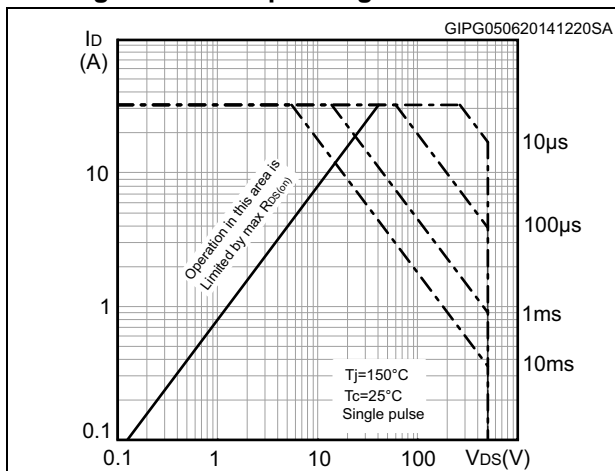


Figure 3. Thermal impedance for DPAK

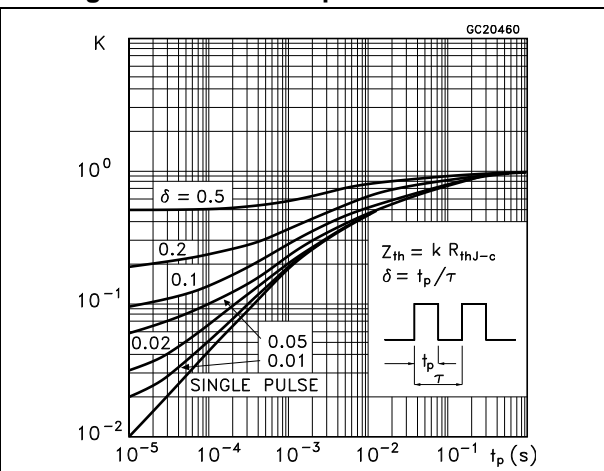


Figure 4. Safe operating area for TO-220FP

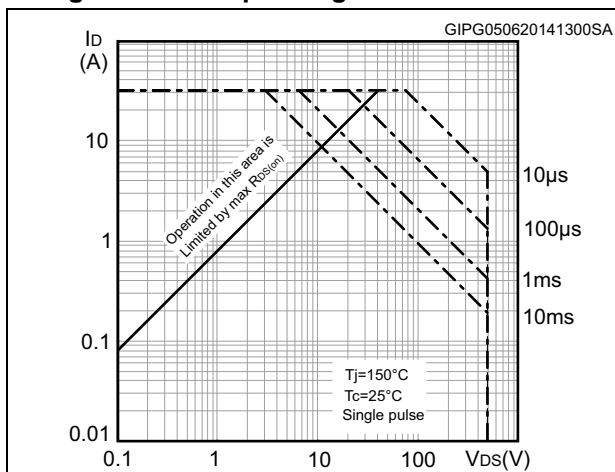


Figure 5. Thermal impedance for TO-220FP

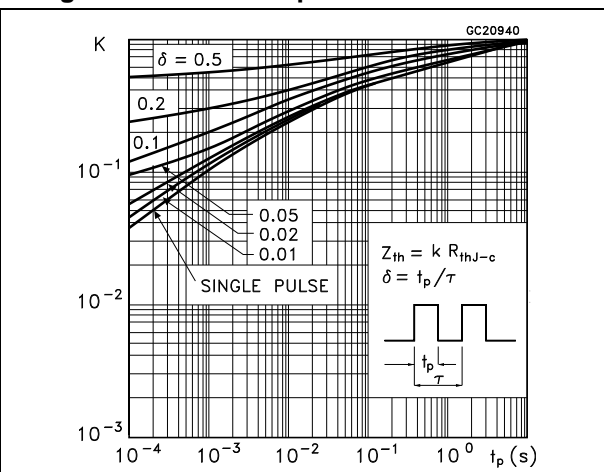


Figure 6. Output characteristics

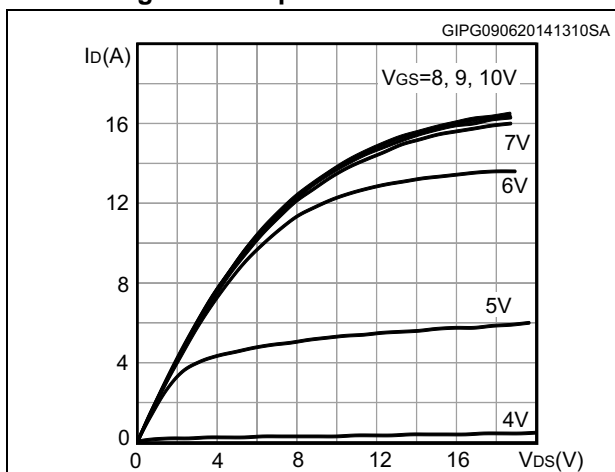


Figure 7. Transfer characteristics

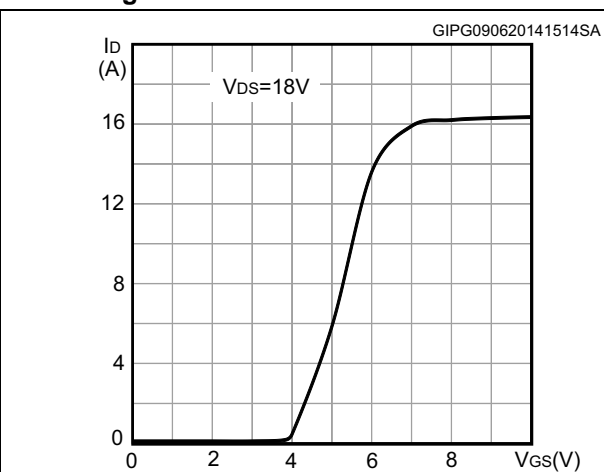


Figure 8. Gate charge vs gate-source voltage

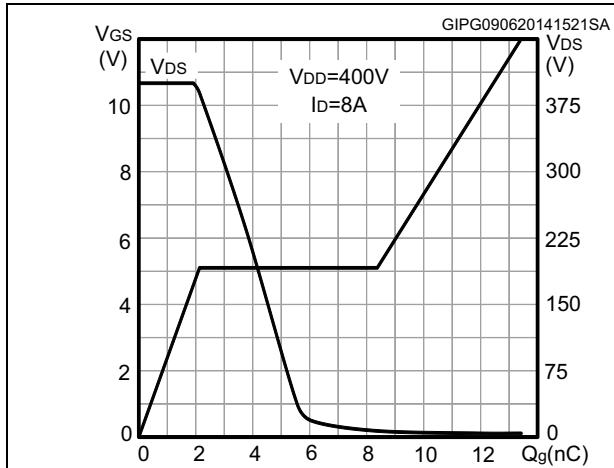


Figure 9. Static drain-source on-resistance

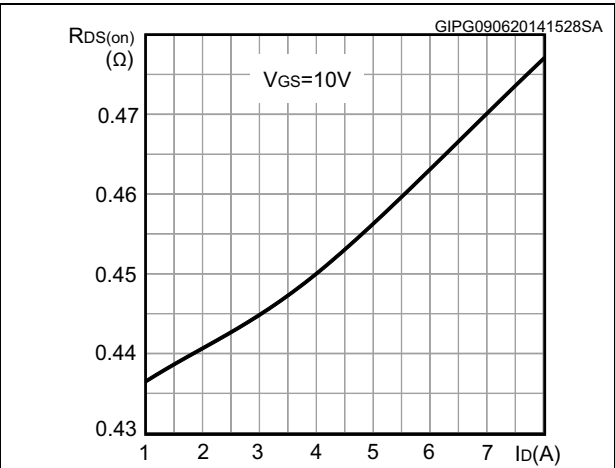


Figure 10. Capacitance variations

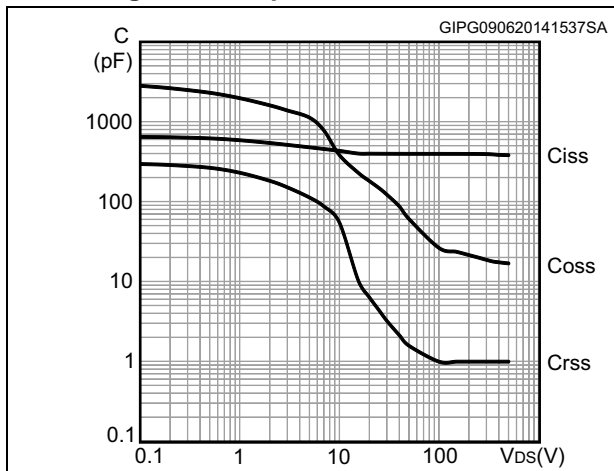


Figure 11. Output capacitance stored energy

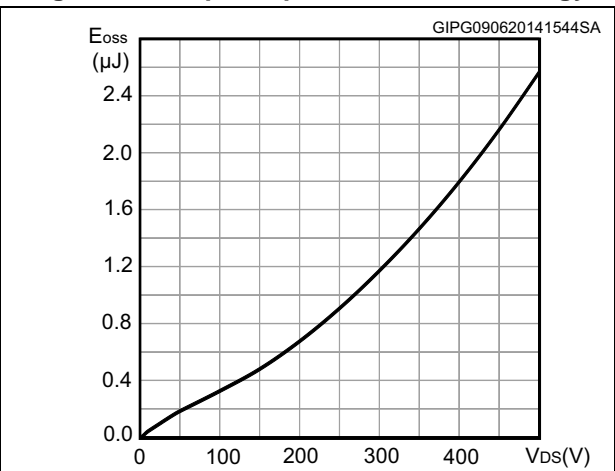


Figure 12. Normalized gate threshold voltage vs temperature

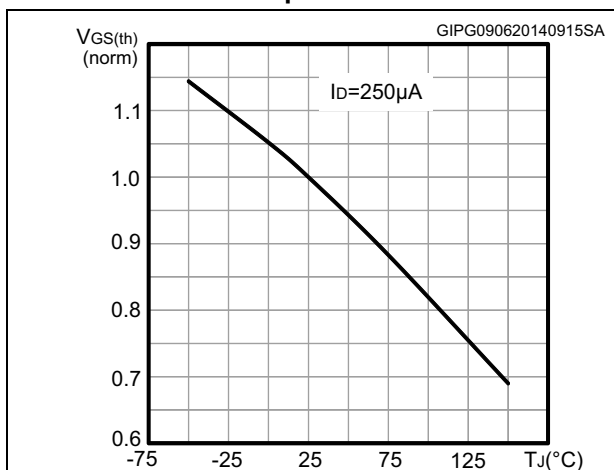


Figure 13. Normalized on-resistance vs temperature

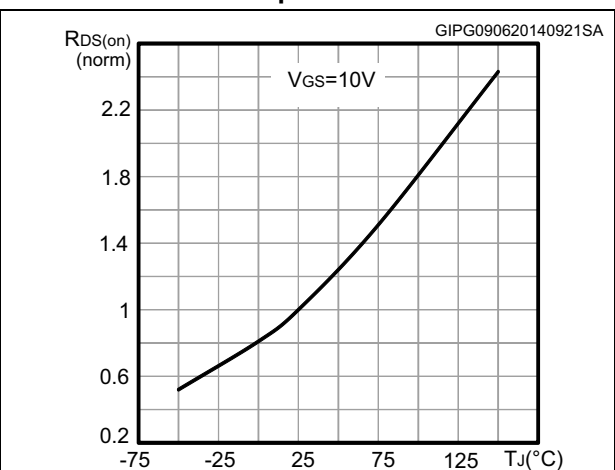


Figure 14. Normalized $V_{(BR)DSS}$ vs temperature

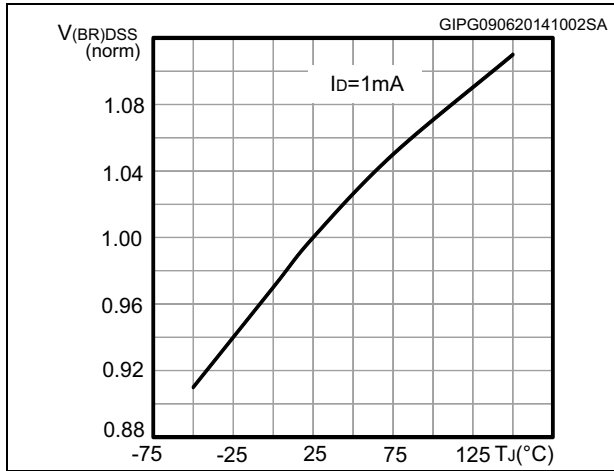
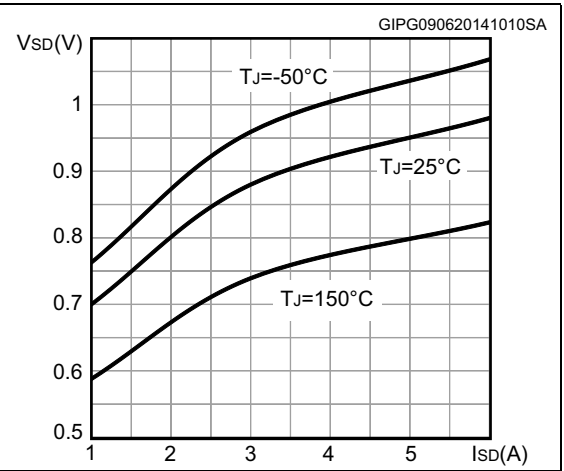


Figure 15. Source-drain diode forward characteristics



3 Test circuits

Figure 16. Switching times test circuit for resistive load

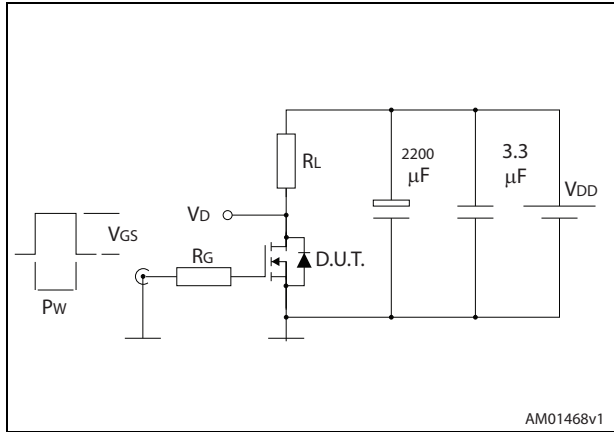


Figure 17. Gate charge test circuit

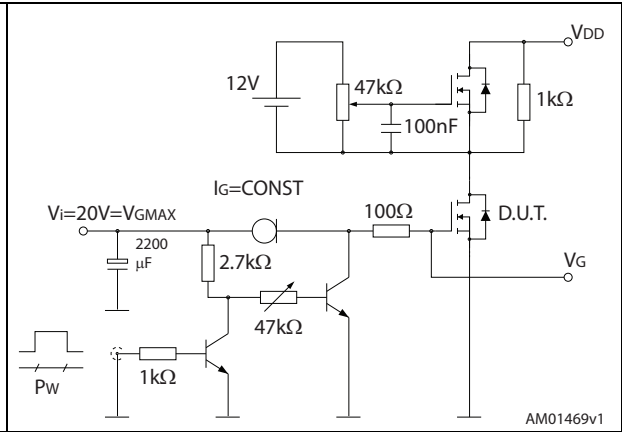


Figure 18. Test circuit for inductive load switching and diode recovery times

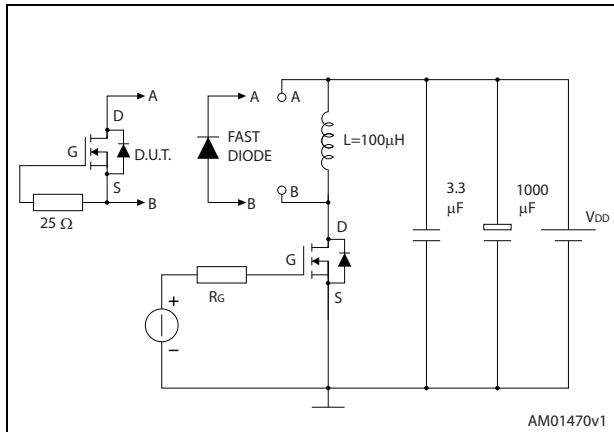


Figure 19. Unclamped inductive load test circuit

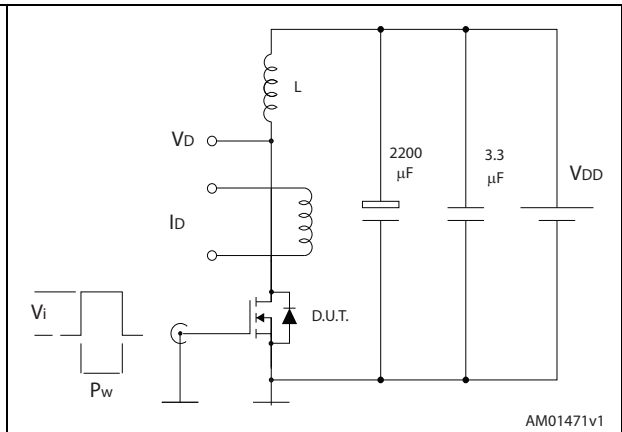


Figure 20. Unclamped inductive waveform

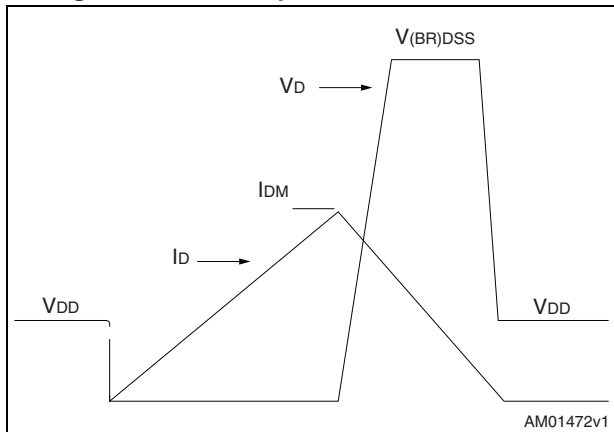
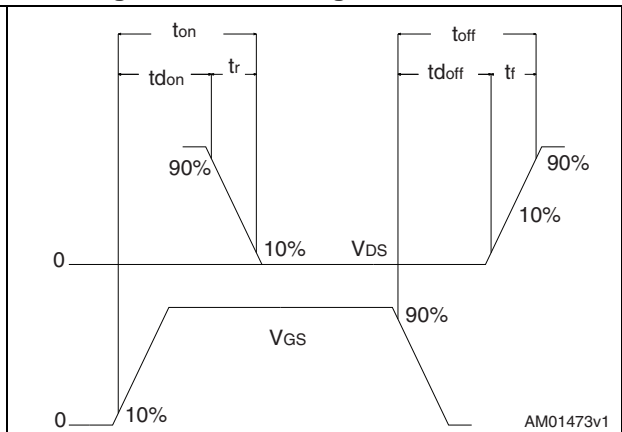


Figure 21. Switching time waveform



4 Package mechanical data

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.

4.1 DPAK, STD11N50M2

Figure 22. DPAK (TO-252) type A drawing

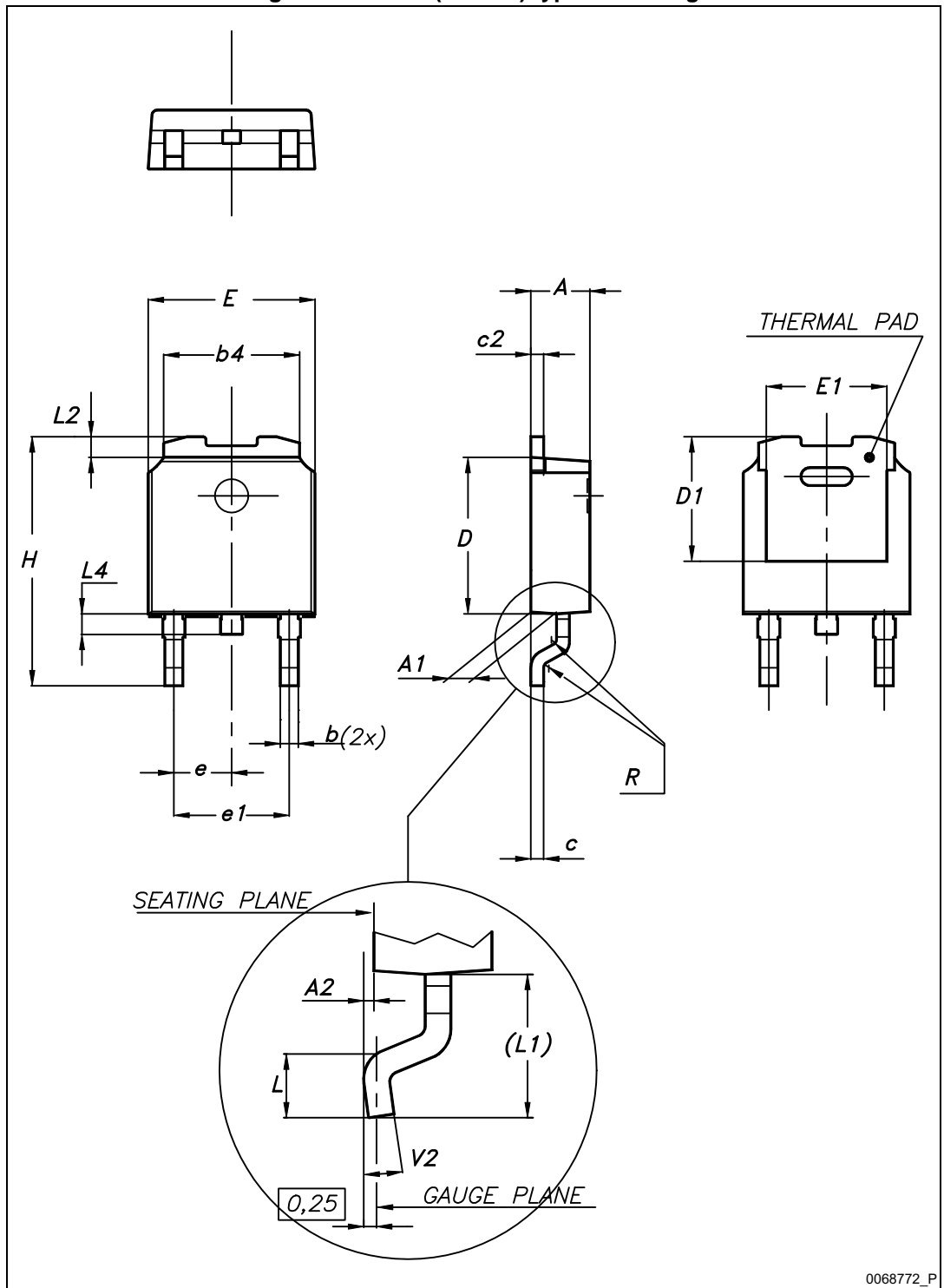
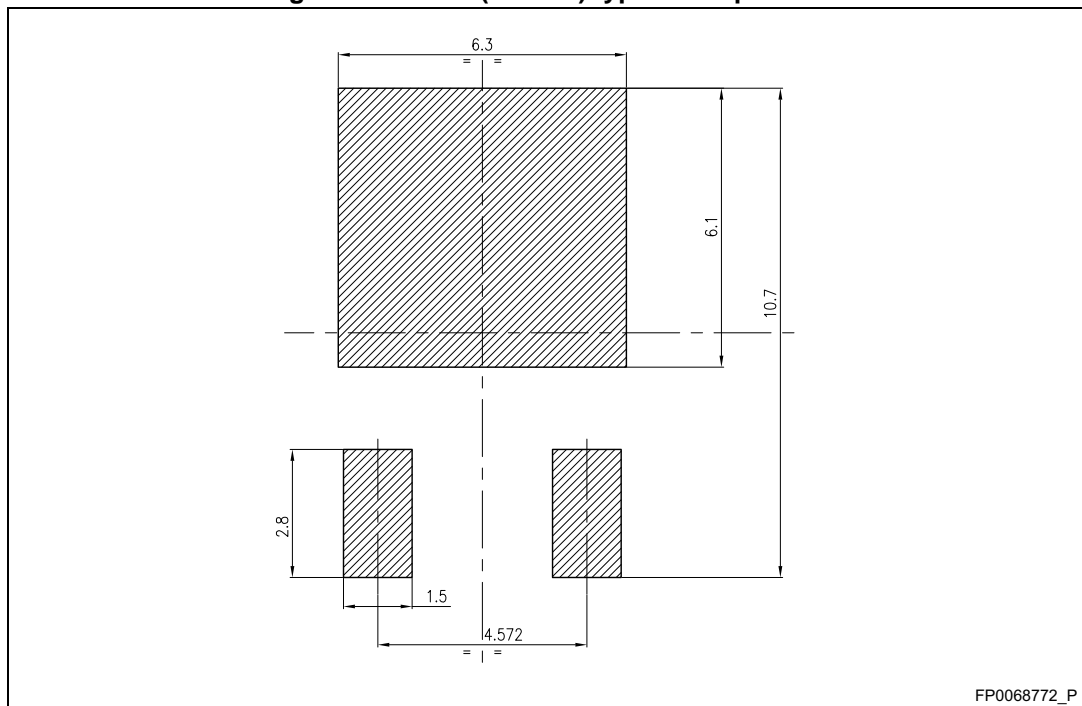


Table 9. DPAK (TO-252) type A mechanical data

| 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 | | 5.10 | |
| E | 6.40 | | 6.60 |
| E1 | | 4.70 | |
| e | | 2.28 | |
| e1 | 4.40 | | 4.60 |
| H | 9.35 | | 10.10 |
| L | 1.00 | | 1.50 |
| (L1) | | 2.80 | |
| L2 | | 0.80 | |
| L4 | 0.60 | | 1.00 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

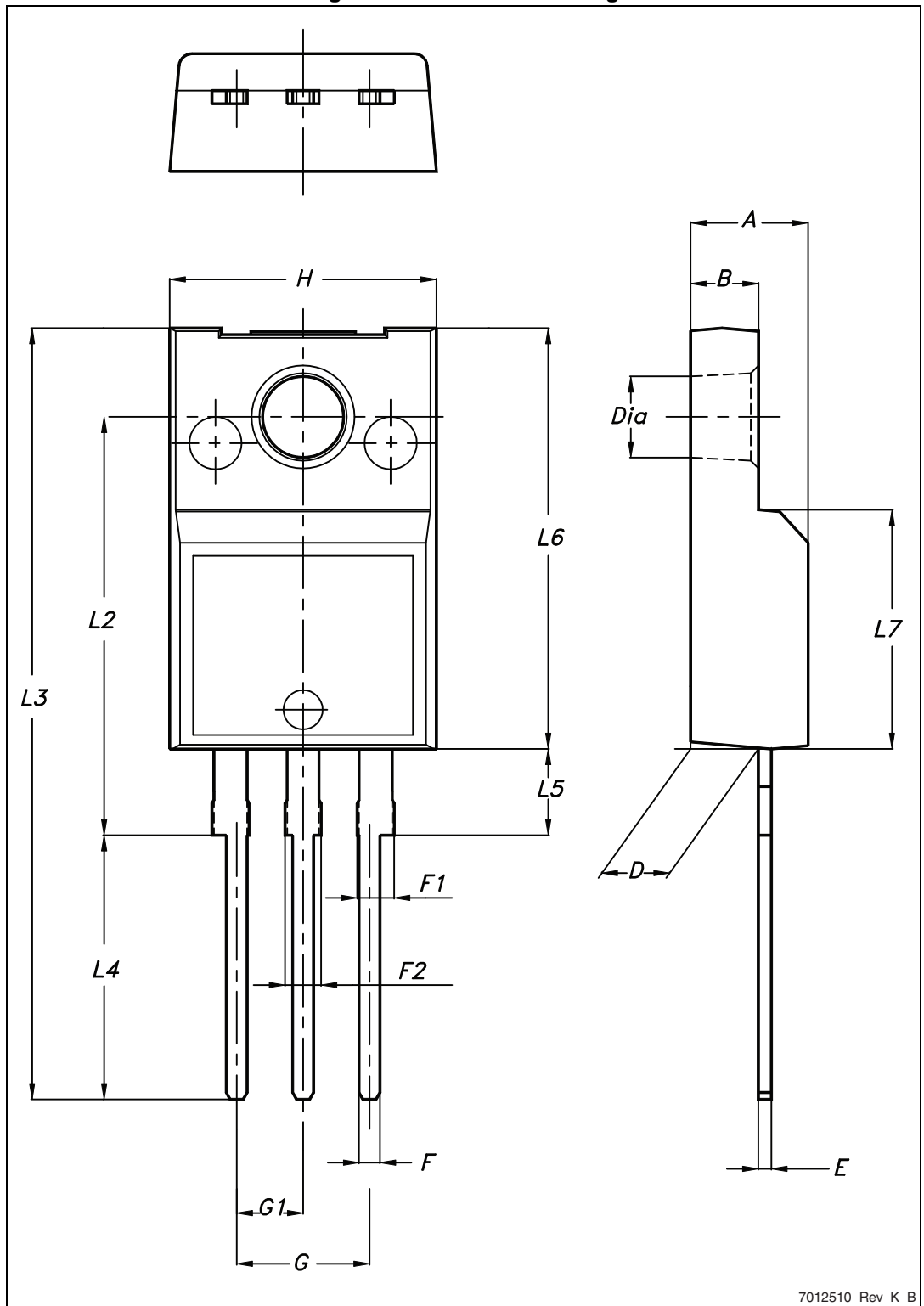
Figure 23. DPAK (TO-252) type A footprint (a)



a. All dimensions are in millimeters

4.2 TO-220FP, STF11N50M2

Figure 24. TO-220FP drawing



7012510_Rev_K_B

Table 10. TO-220FP 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 |
| Ø | 3 | | 3.2 |

5 Packaging mechanical data

Figure 25. Tape for DPAK (TO-252)

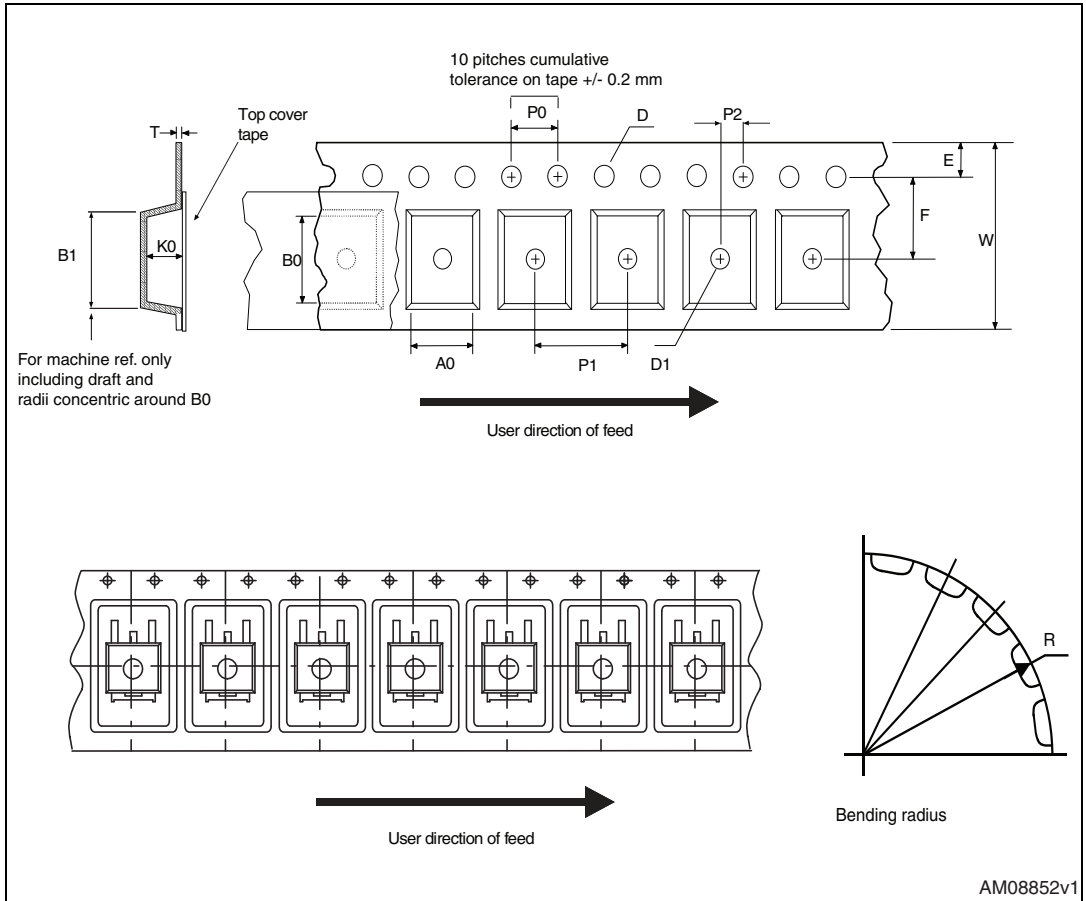


Figure 26. Reel or DPAK (TO-252)

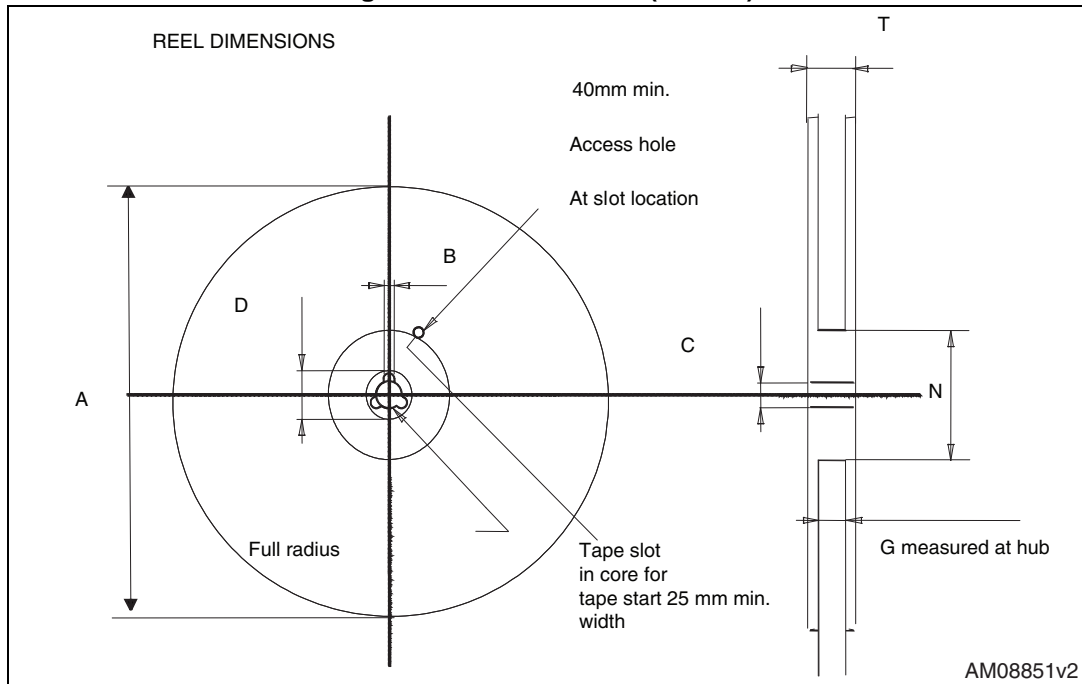


Table 11. DPAK (TO-252) tape and reel mechanical data

| 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 | | | |

6 Revision history

Table 12. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 12-Feb-2014 | 1 | First release. |
| 17-Jun-2014 | 2 | <ul style="list-style-type: none">– Modified: title– Modified: dv/dt values in Table 2– Modified: values in Table 4– Modified: $R_{DS(on)}$ value in Table 5– Modified: the entire typical values in Table 6, 7 and 8– Added: Section 2.1: Electrical characteristics (curves)– Updated: Section 4: Package mechanical data– Minor text changes |

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