# STD5N52U, STF5N52U

## N-channel 525 V, 1.25 Ω typ., 4.4 A UltraFASTmesh™ Power MOSFETs in DPAK and TO-220FP packages

**Datasheet - production data**

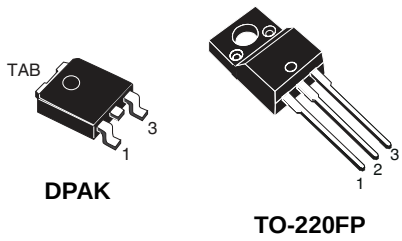
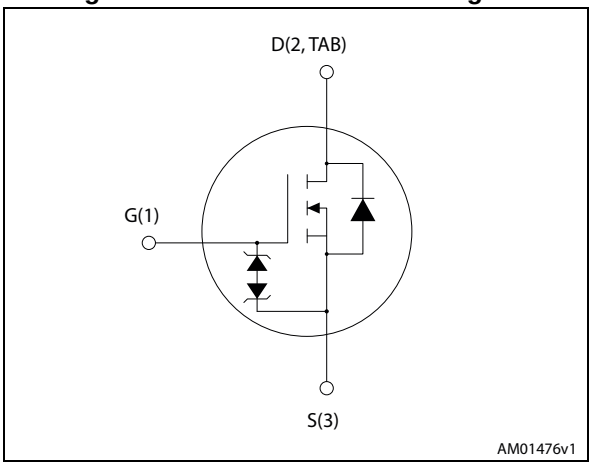



**Figure 1. Internal schematic diagram**




## Features

| Order codes | $V_{DS}$ | $R_{DS(on)}$ max | $I_D$ | $P_{TOT}$ |
|---|---|---|---|---|
| STD5N52U | 525 V | 1.5 Ω | 4.4 A | 70 W |
| STF5N52U | | | | 25 W |

- Outstanding dv/dt capability
- Gate charge minimized
- Very low intrinsic capacitances
- Very low $R_{DS(on)}$
- Extremely low $t_{rr}$

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using UltraFASTmesh™ technology, which combines the advantages of reduced on-resistance, Zener gate protection and very high dv/dt capability with an enhanced fast body-drain recovery diode.

**Table 1. Device summary**

| Order codes | Marking | Package | Packaging |
|---|---|---|---|
| STD5N52U | 5N52U | DPAK | Tape and reel |
| STF5N52U | | TO-220FP | Tube |

# Contents

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | DPAK | TO-220FP | |
| $V_{GS}$ | Gate- source voltage | ± 30 | | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 4.4 | | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 2.8 | | A |
| $I_{DM}$ (1) | Drain current (pulsed) | 17.6 | | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 70 | 25 | W |
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max) | 4.4 | | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 170 | | mJ |
| dv/dt(2) | Peak diode recovery voltage slope | 20 | | V/ns |
| ESD | Gate-source human body model (R = 1.5 kΩ, C = 100 pF) | 2.8 | | kV |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s;$T_C$=25 °C) | | 2500 | V |
| $T_J$ | Operating junction temperature | -55 to 150 | | °C |
| $T_{stg}$ | Storage temperature | | | °C |

1. Pulse width limited by safe operating area.
2. $I_{SD}$ ≤ 4.4 A, di/dt ≤ 400 A/µs, peak $V_{DS} \leq V_{(BR)DSS}$

**Table 3. Thermal data**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | DPAK | TO-220FP | |
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 1.79 | 5 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient max | | 62.5 | °C/W |
| $R_{thj\text{-}pcb}$ (1) | Thermal resistance junction-pcb | 50 | | °C/W |

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

# 2 Electrical characteristics

(Tcase =25 °C unless otherwise specified).

**Table 4. On /off states**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage ($V_{GS}$ = 0) | $I_D$ = 1 mA | 525 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = 525 V | | | 10 | µA |
| | | $V_{DS}$ = 525 V, $T_C$=125 °C | | | 500 | µA |
| $I_{GSS}$ | Gate-body leakage current ($V_{DS}$ = 0) | $V_{GS}$ = 20 V | | | ±10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 50 µA | 3 | 3.75 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 2.2 A | | 1.25 | 1.5 | Ω |

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$ = 25 V, f = 1 MHz, $V_{GS}$ = 0 | - | 529 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 71 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 13.4 | - | pF |
| $C_{o(tr)}$(1) | Equivalent capacitance time related | $V_{DS}$ = 0 to 420 V, $V_{GS}$ = 0 | - | 11 | - | pF |
| $R_g$ | Gate input resistance | f=1 MHz open drain | - | 6 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 416 V, $I_D$ = 4.4 A, $V_{GS}$ = 10 V *(see Figure 17)* | - | 16.9 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 4.2 | - | nC |
| $Q_{gd}$ | Gate-drain charge | | - | 8.4 | - | nC |

1. $C_{oss\ eq.}$ time related 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. Switching times**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 260 V, $I_D$ = 2.2 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V *(see Figure 16)* | - | 11.4 | - | ns |
| $t_r$ | Rise time | | - | 13.6 | - | ns |
| $t_{d(off)}$ | Turn-off-delay time | | - | 23.1 | - | ns |
| $t_f$ | Fall time | | - | 15 | - | ns |

**Table 7. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 4.4 | A |
| $I_{SDM}$ (1) | Source-drain current (pulsed) | | - | | 17.6 | A |
| $V_{SD}$ (2) | Forward on voltage | $I_{SD}$ = 4.4 A, $V_{GS}$ = 0 | - | | 1.6 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 4.4 A, di/dt = 100 A/µs $V_{DD}$= 60 V *(see Figure 18)* | - | 55 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 95 | | nC |
| $I_{RRM}$ | Reverse recovery current | | - | 3.5 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 4.4 A, di/dt = 100 A/µs $V_{DD}$= 60 V $T_J$ = 150 °C *(see Figure 18)* | - | 120 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 266 | | nC |
| $I_{RRM}$ | Reverse recovery current | | - | 4.5 | | 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 | $I_{GS}$ = ± 1mA, $I_D$=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 for DPAK**

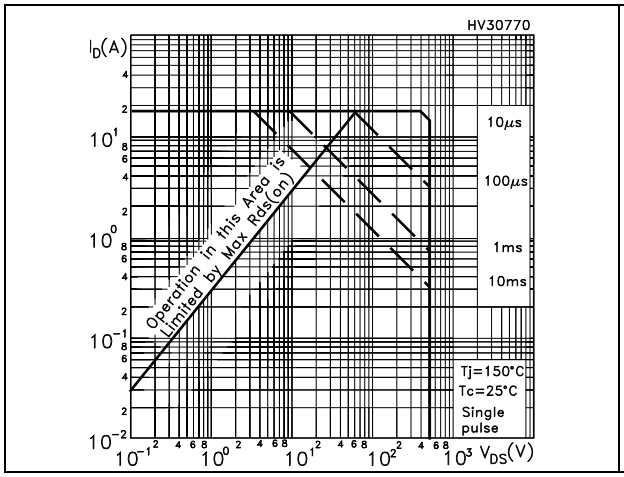



**Figure 3. Thermal impedance for DPAK**

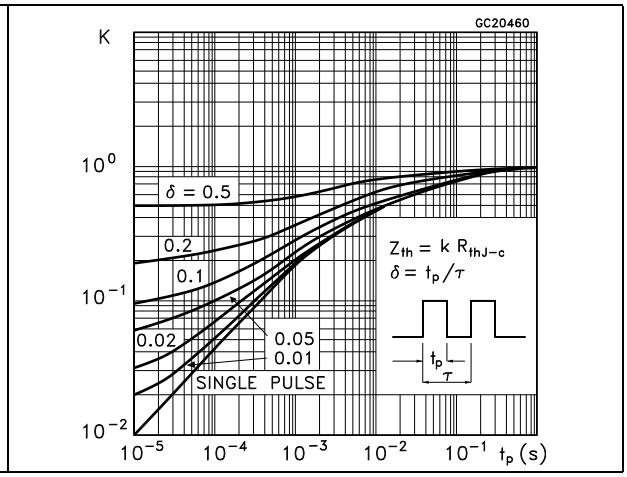



**Figure 4. Safe operating area for TO-220FP**

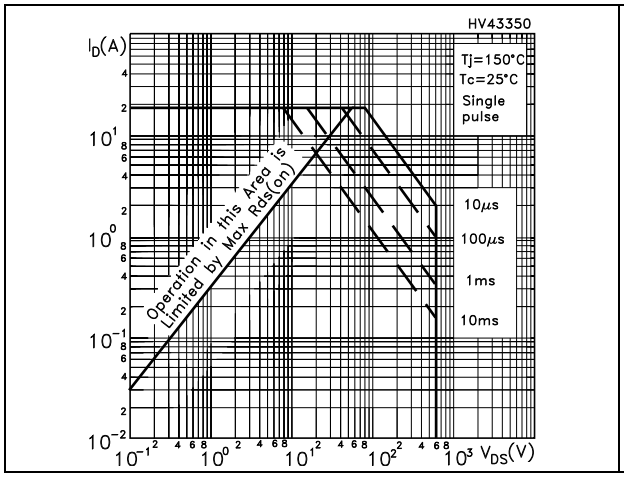



**Figure 5. Thermal impedance for TO-220FP**

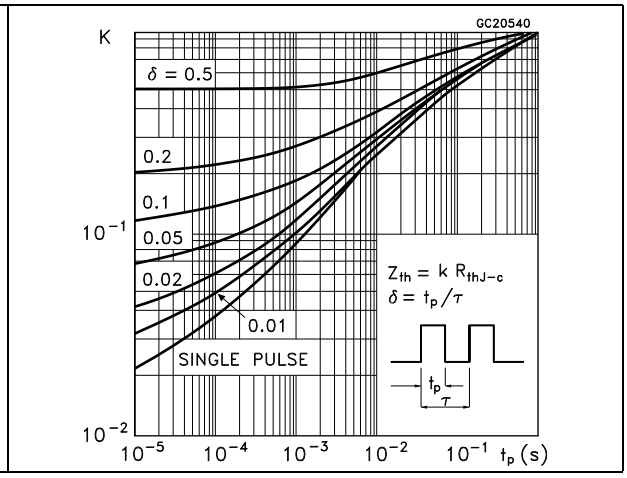



**Figure 6. Output characteristics**

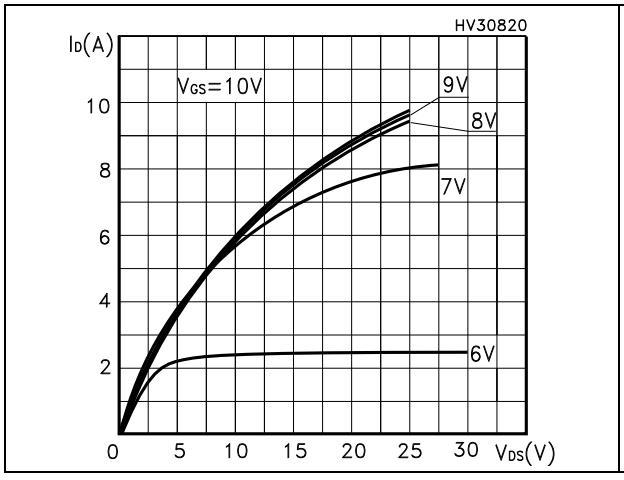



**Figure 7. Transfer characteristics**

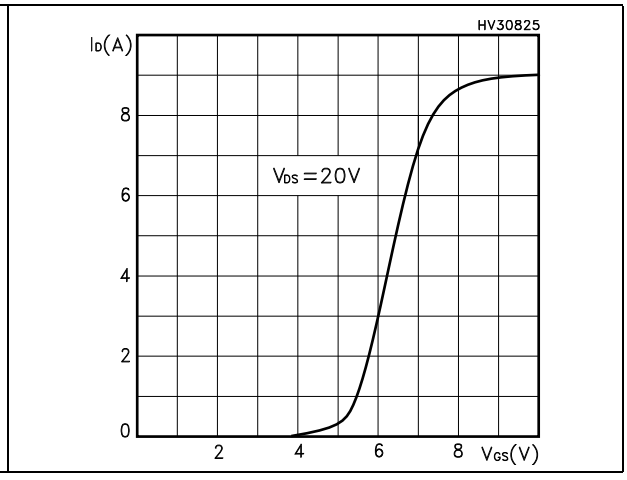


**Figure 8. Normalized $V_{(BR)DSS}$ vs temperature**

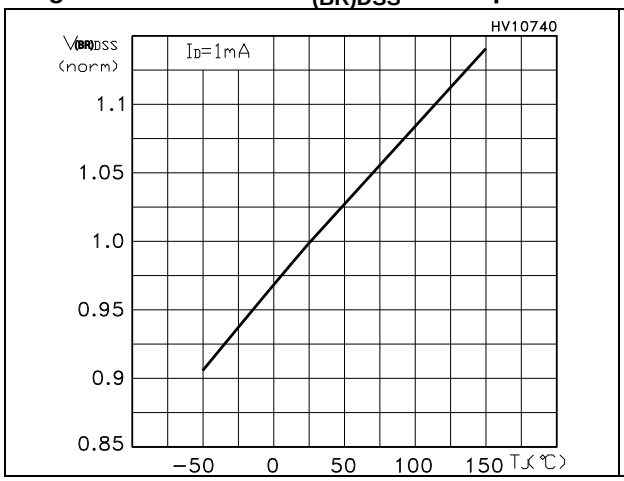



**Figure 9. Static drain-source on-resistance**

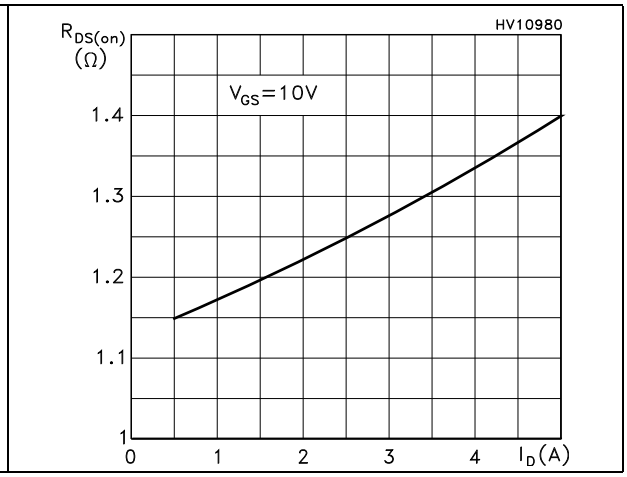



**Figure 10. Gate charge vs gate-source voltage**

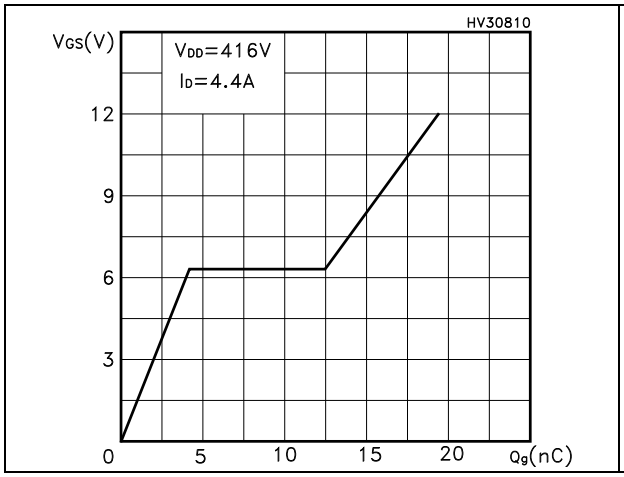



**Figure 11. Capacitance variations**

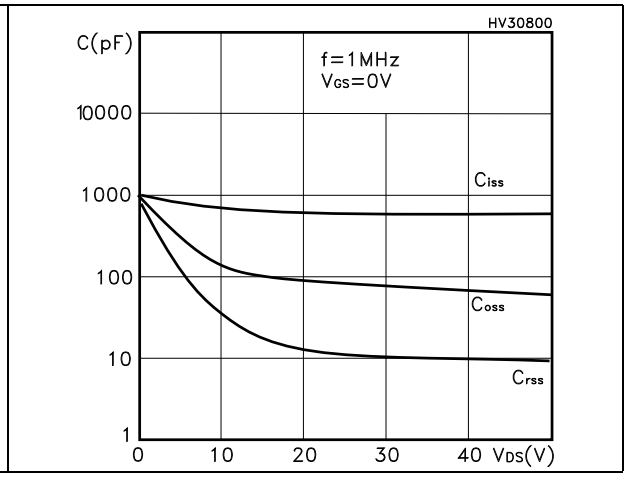



**Figure 12. Normalized gate threshold voltage vs temperature**

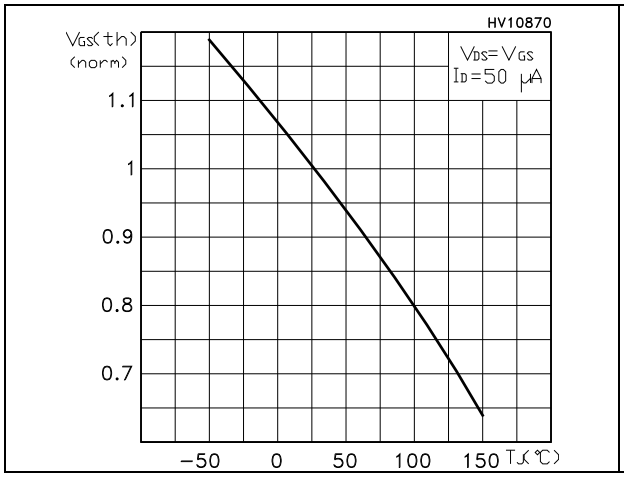



**Figure 13. Normalized on-resistance vs temperature**

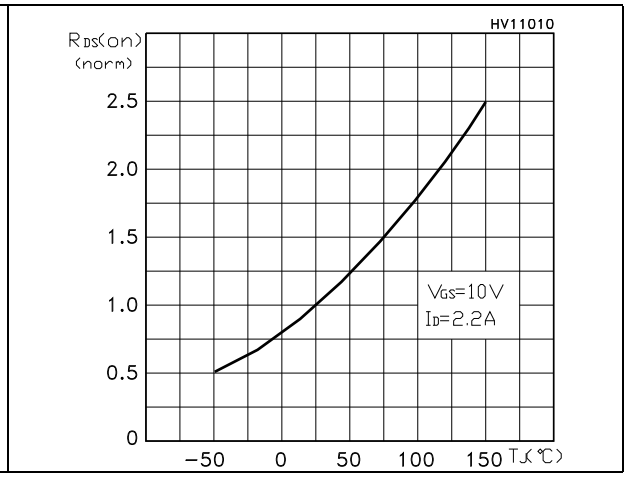


**Figure 14. Source-drain diode forward characteristics**

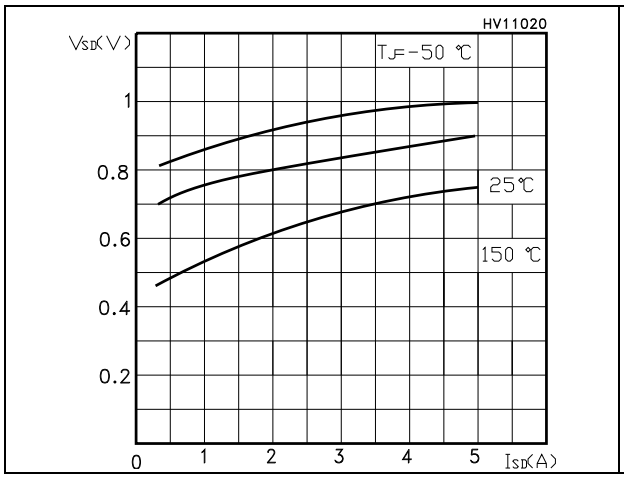
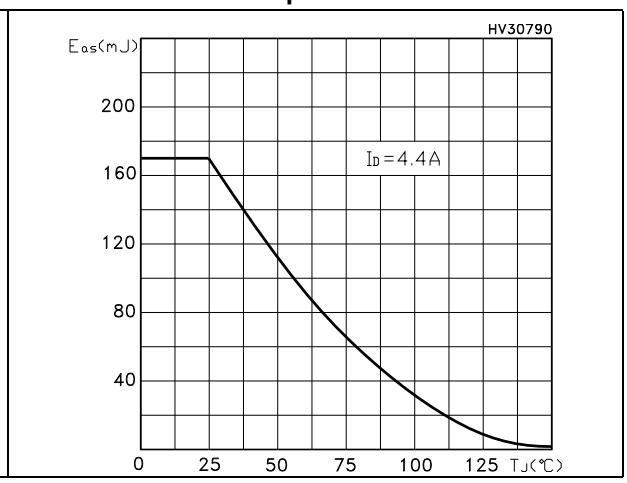



**Figure 15. Maximum avalanche energy vs temperature**



# 3 Test circuits

**Figure 16. Switching times test circuit for resistive load**

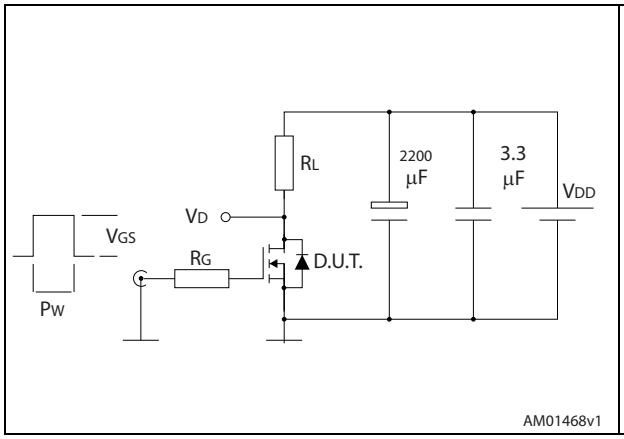



**Figure 17. Gate charge test circuit**

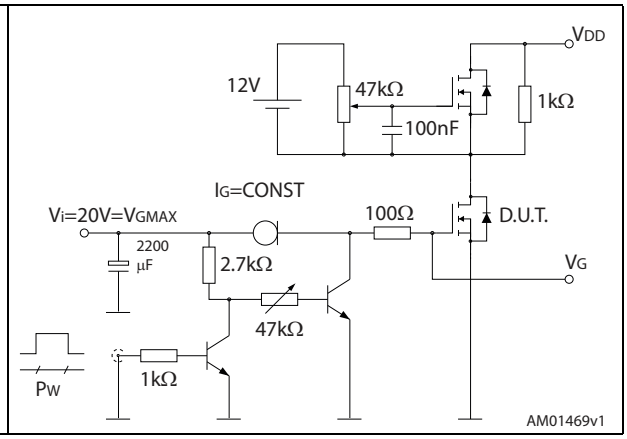



**Figure 18. Test circuit for inductive load switching and diode recovery times**

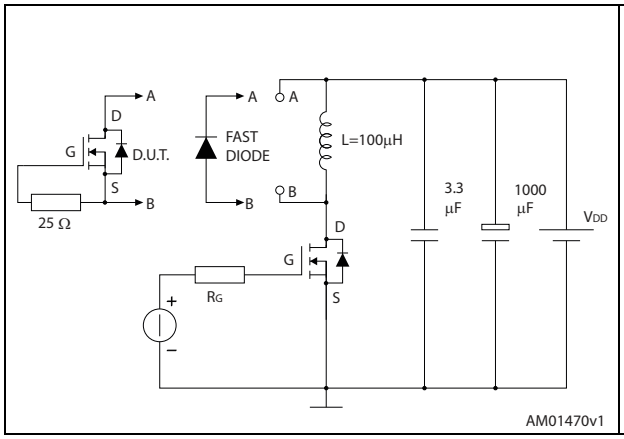



**Figure 19. Unclamped inductive load test circuit**

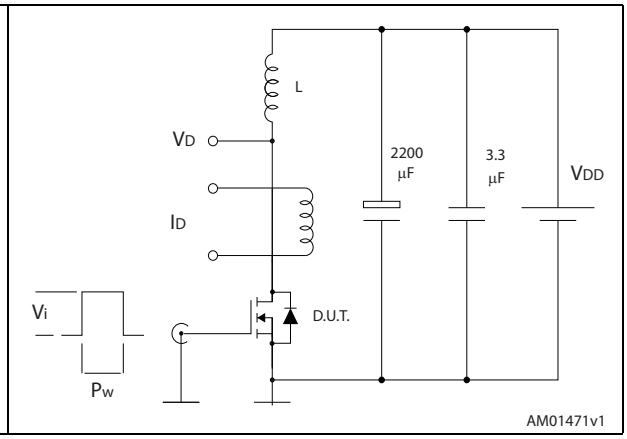



**Figure 20. Unclamped inductive waveform**

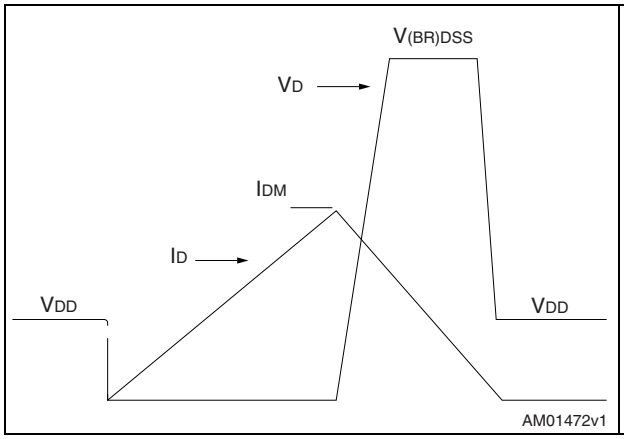
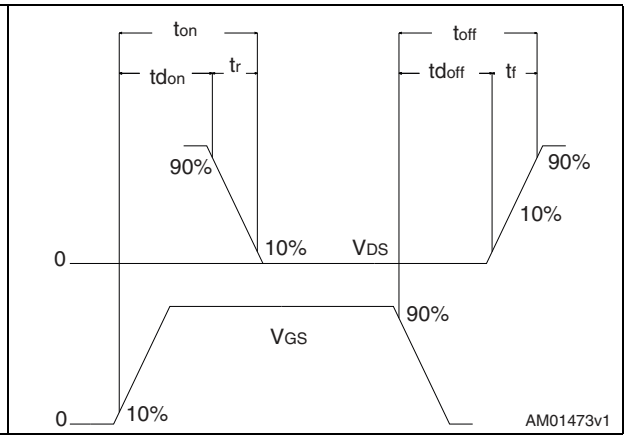



**Figure 21. Switching time waveform**



# 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*.
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## 4.1 DPAK, STD5N52U

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

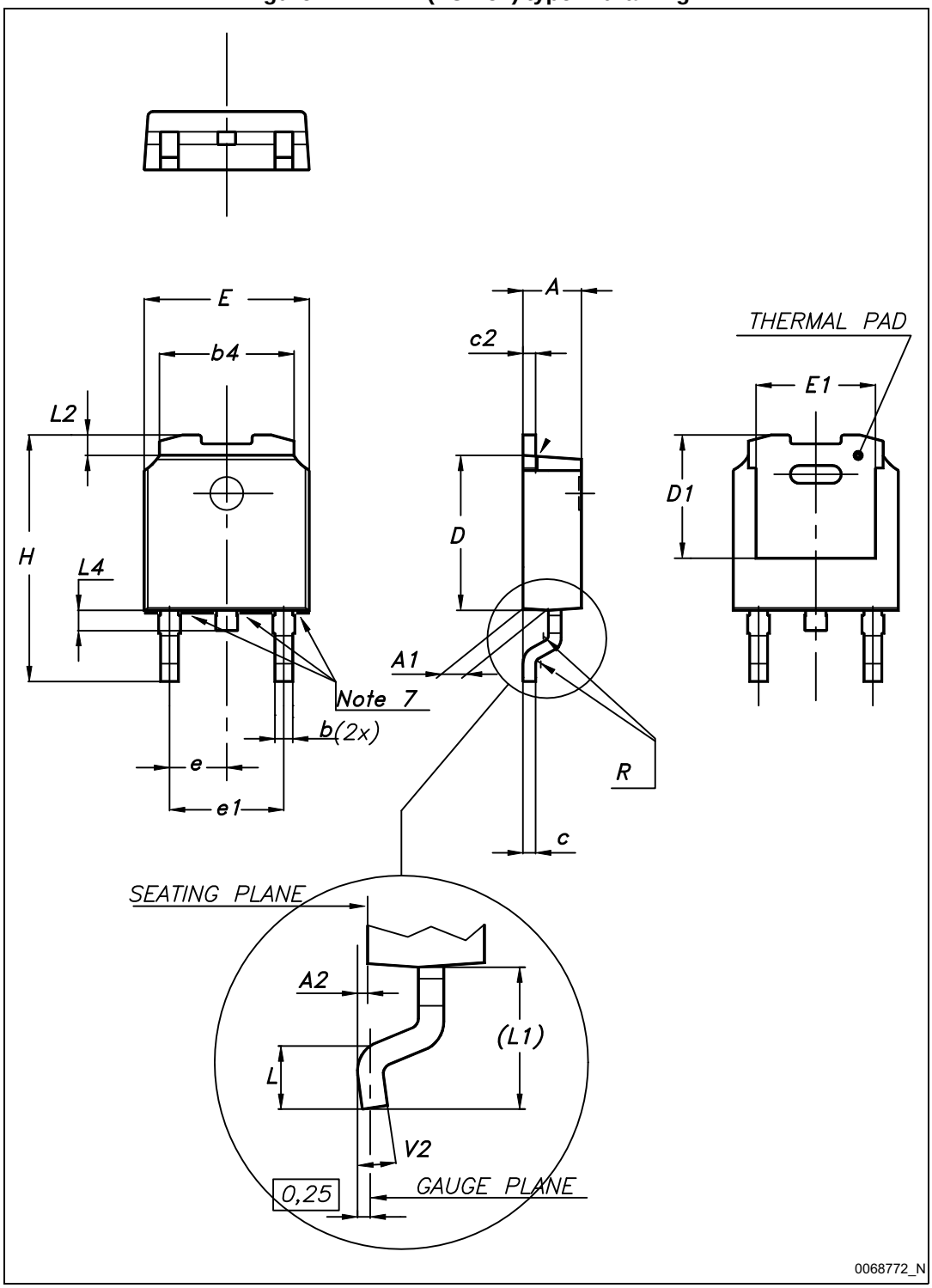
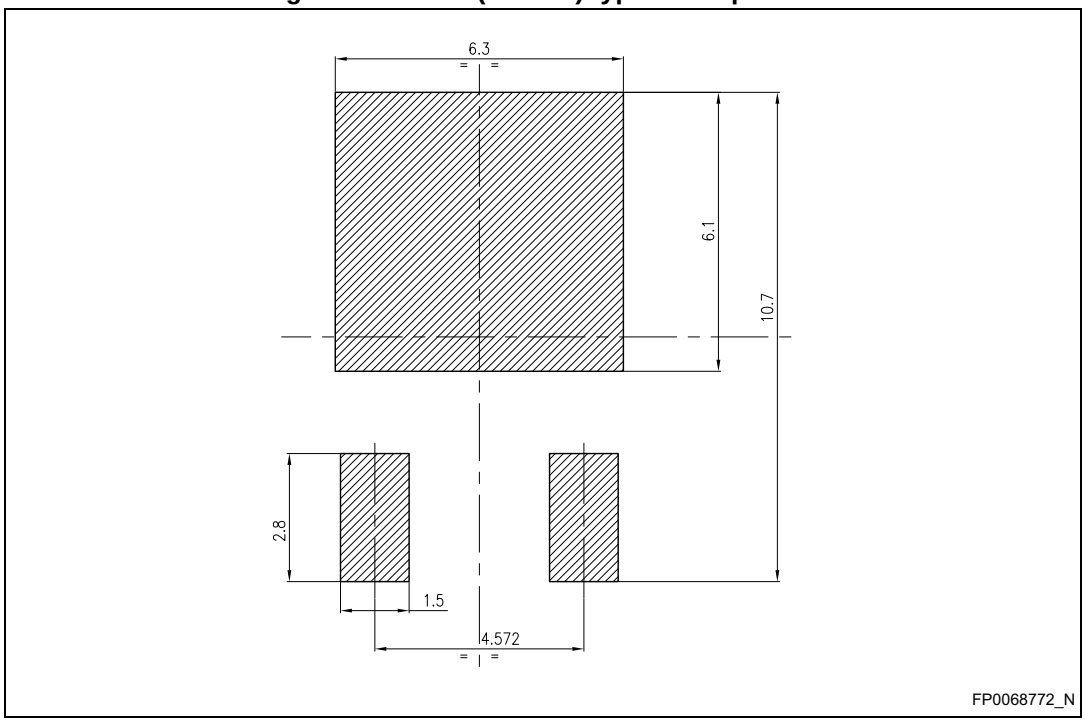


Table 9. DPAK (TO-252) type A mechanical data

| 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, STF5N52U

Figure 24. TO-220FP drawing

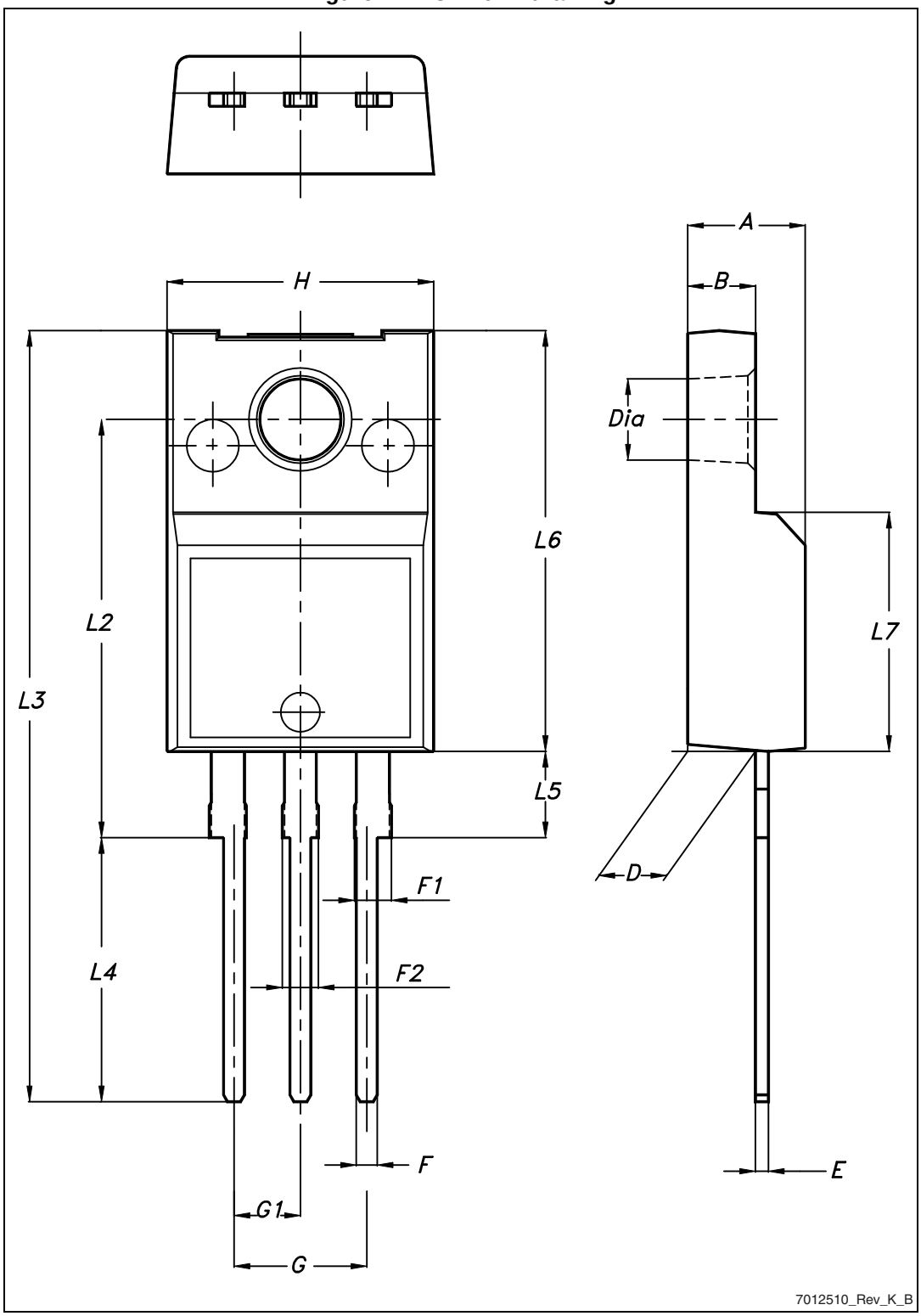


Table 10. TO-220FP mechanical data

| 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)**

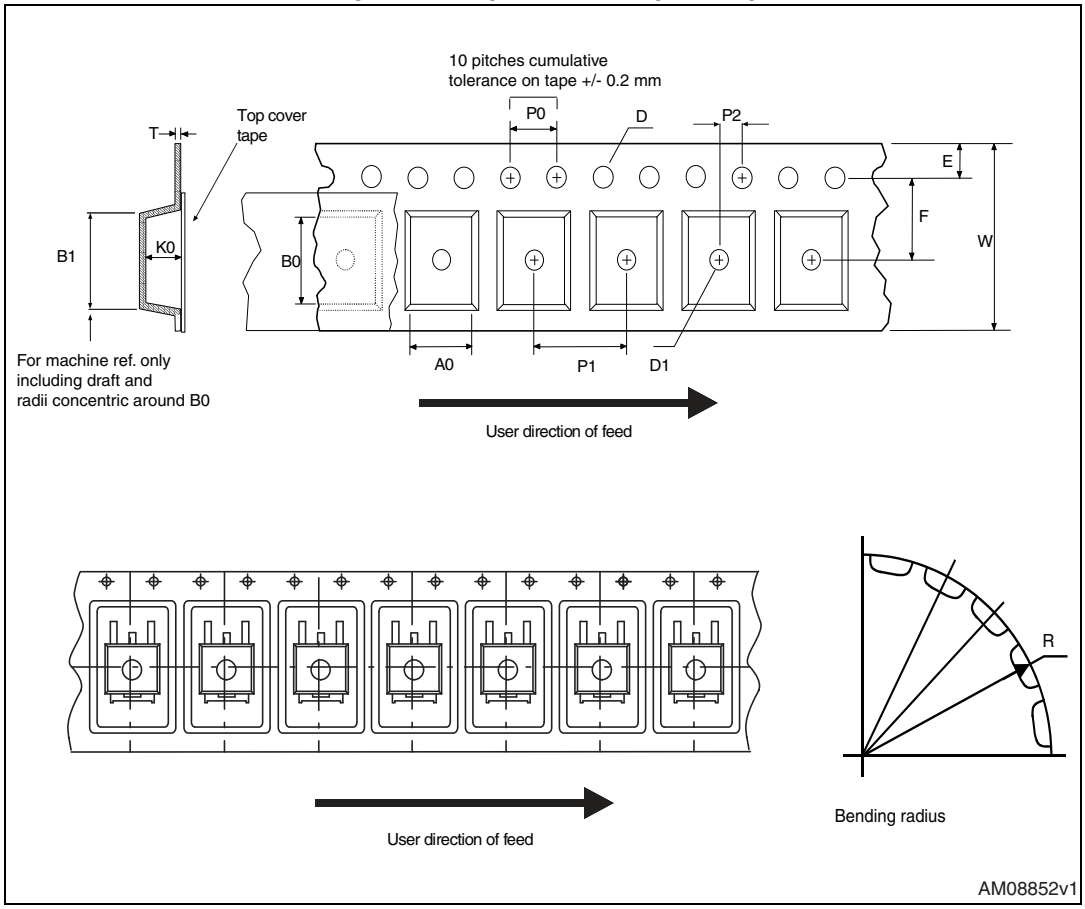


**Figure 26. Reel for DPAK (TO-252)**

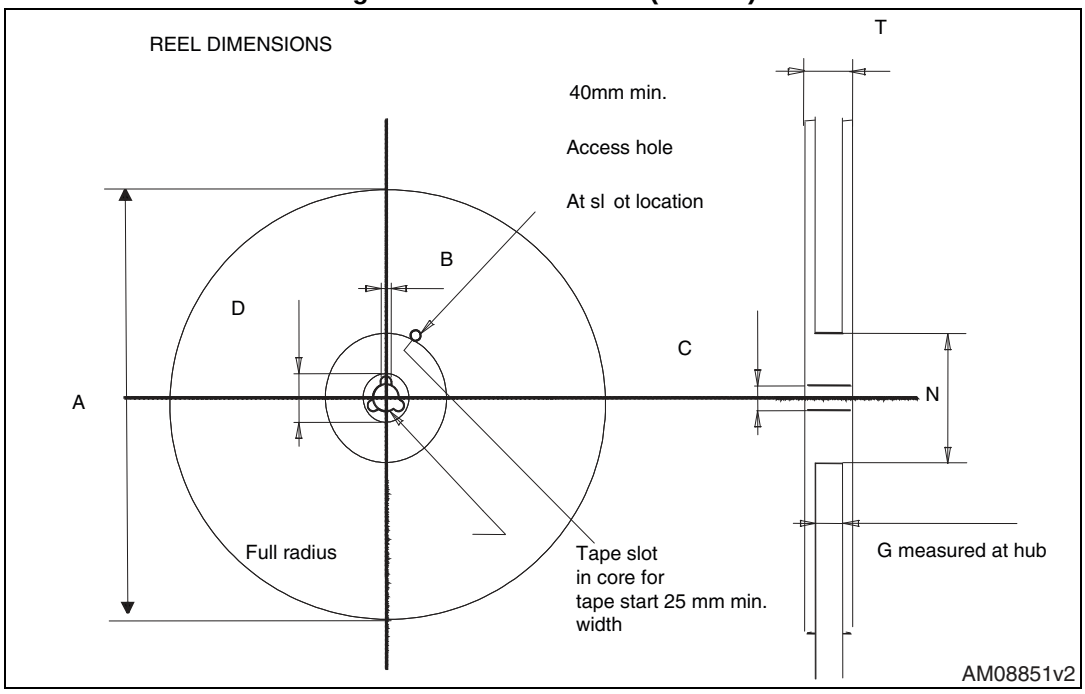



**Table 11. DPAK (TO-252) tape and reel mechanical data**

| 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 |
|---|---|---|
| 06-May-2009 | 1 | First release. |
| 28-Sep-2011 | 2 | – Inserted new device in $I^2PAK$.<br>– Updated tables *1*, *2* and *3* with the new package.<br>– Updated *Section 4: Package mechanical data* with the new package and *Section 5: Packaging mechanical data*.<br>– Minor text changes. |
| 24-Apr-2014 | 3 | – Updated *Section 4.1: DPAK, STD5N52U*<br>– Modified: $Q_{rr}$ unit in *Table 7*<br>– Modified: *Figure 8* and *11*<br>– The part number STI5N52U has been moved to a separate datasheet |

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