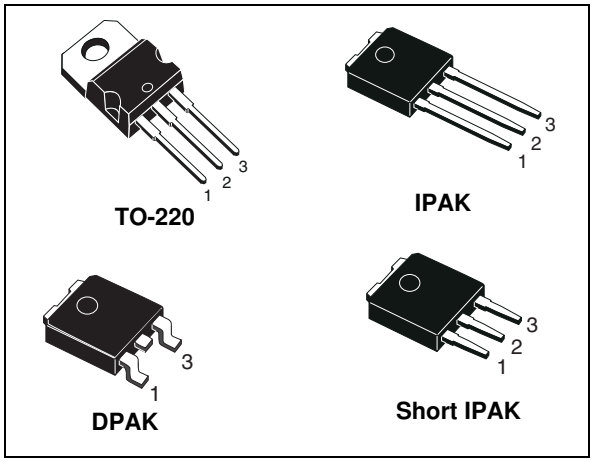
# STD60N3LH5, STP60N3LH5
# STU60N3LH5, STU60N3LH5-S

N-channel 30 V, 0.0072 Ω, 48 A DPAK, IPAK, Short IPAK, TO-220
STripFET™ V Power MOSFET

## Features

| Order codes | $V_{DSS}$ | $R_{DS(on)}$ max | $I_D$ |
|---|---|---|---|
| STD60N3LH5 | 30 V | 0.008 Ω | 48 A |
| STP60N3LH5 | 30 V | 0.0084 Ω | 48 A |
| STU60N3LH5 | 30 V | 0.0084 Ω | 48 A |
| STU60N3LH5-S | 30 V | 0.0084 Ω | 48 A |

- $R_{DS(on)}$ * $Q_g$ industry benchmark
- Extremely low on-resistance $R_{DS(on)}$
- Very low switching gate charge
- High avalanche ruggedness
- Low gate drive power losses




## Application

Switching applications

## Description

This STripFET™V Power MOSFET technology is among the latest improvements, which have been especially tailored to achieve very low on-state resistance providing also one of the best-in-class figure of merit.

**Figure 1. Internal schematic diagram**

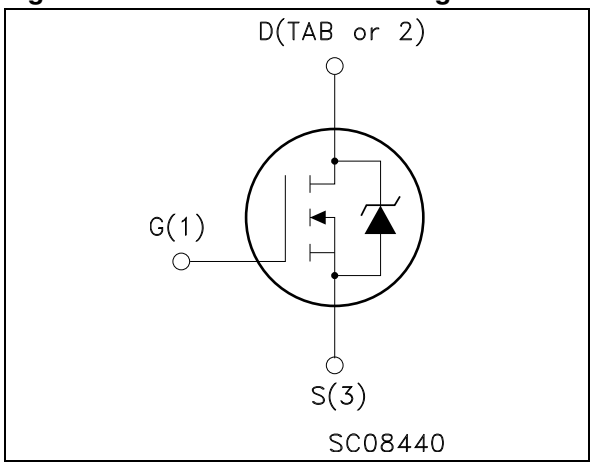



**Table 1. Device summary**

| Order codes | Marking | Package | Packaging |
|---|---|---|---|
| STD60N3LH5 | 60N3LH5 | DPAK | Tape and reel |
| STP60N3LH5 | 60N3LH5 | TO-220 | Tube |
| STU60N3LH5 | 60N3LH5 | IPAK | |
| STU60N3LH5-S | 60N3LH5 | Short IPAK | |

# Contents

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6 Revision history . . . . . 20

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain-source voltage ($V_{GS}$ = 0) | 30 | V |
| $V_{DS}$ | Drain-source voltage ($V_{GS}$ = 0) @ $T_{JMAX}$ | 35 | V |
| $V_{GS}$ | Gate-Source voltage | ± 20 | V |
| $I_D$ (1) | Drain current (continuous) at $T_C$ = 25 °C | 48 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 42.8 | A |
| $I_{DM}$ (2) | Drain current (pulsed) | 192 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 60 | W |
| | Derating factor | 0.4 | W/°C |
| $E_{AS}$ (3) | Single pulse avalanche energy | 160 | mJ |
| $T_j$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature | -55 to 175 | °C |

1. Limited by wire bonding.
2. Pulse width limited by safe operating area.
3. Starting Tj = 25 °C, $I_D$ = 24 A, $V_{DD}$ = 12 V.

**Table 3. Thermal resistance**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| Rthj-case | Thermal resistance junction-case max. | 2.5 | °C/W |
| Rthj-amb | Thermal resistance junction-case max. | 100 | °C/W |
| $T_j$ | Maximum lead temperature for soldering purpose | 275 | °C |

# 2 Electrical characteristics

($T_{CASE}$ = 25 °C unless otherwise specified)

**Table 4. Static**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown Voltage | $I_D$ = 250 µA, $V_{GS}$= 0 | 30 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = 30 V<br>$V_{DS}$ = 30 V,Tc = 125 °C | | | 1<br>10 | µA<br>µA |
| $I_{GSS}$ | Gate body leakage current ($V_{DS}$ = 0) | $V_{GS}$ = ± 20 V | | | ±100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$= $V_{GS}$, $I_D$ = 250 µA | 1 | 1.8 | 3 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$= 10 V, $I_D$= 24 A SMD version | | 0.0072 | 0.008 | Ω |
| | | $V_{GS}$= 10 V, $I_D$= 24 A | | 0.0076 | 0.0084 | Ω |
| | | $V_{GS}$= 5 V, $I_D$= 24 A SMD version | | 0.0088 | 0.011 | Ω |
| | | $V_{GS}$= 5 V, $I_D$= 24 A | | 0.0092 | 0.0114 | Ω |

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS}$ =25 V, f=1 MHz, $V_{GS}$=0 | - | 1350<br>265<br>32 | 1620<br>318<br>38 | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$=15 V, $I_D$ = 48 A<br>$V_{GS}$ =5 V<br>*(Figure 14)* | - | 8.8<br>4.7<br>2.2 | 12.3<br>6.6<br>3.1 | nC<br>nC<br>nC |
| $Q_{gs1}$<br>$Q_{gs2}$ | Pre $V_{th}$ gate-to-source charge<br>Post $V_{th}$ gate-to-source charge | $V_{DD}$=15 V, $I_D$ = 48 A<br>$V_{GS}$ =5 V<br>*(Figure 19)* | - | 2.2<br>2.5 | 3.1<br>3.5 | nC<br>nC |
| $R_G$ | Gate input resistance | f=1 MHz gate bias<br>Bias= 0 test signal level=20 mV<br>open drain | - | 1.1 | 1.3 | Ω |

**Table 6. Switching on/off (resistive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$<br>$t_r$ | Turn-on delay time<br>Rise time | $V_{DD}$=10 V, $I_D$= 24 A,<br>$R_G$=4.7 Ω, $V_{GS}$= 10 V<br>*(Figure 13 and Figure 18)* | - | 6<br>33 | - | ns<br>ns |
| $t_{d(off)}$<br>$t_f$ | Turn-off delay time<br>Fall time | $V_{DD}$=10 V, $I_D$= 24 A,<br>$R_G$=4.7 Ω, $V_{GS}$= 10 V<br>*(Figure 13 and Figure 18)* | - | 19<br>4.2 | - | ns<br>ns |

**Table 7. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$<br>$I_{SDM}$ | Source-drain current<br>Source-drain current (pulsed)(1) | | - | | 48<br>192 | A<br>A |
| $V_{SD}$ | Forward on voltage | $I_{SD}$=24 A, $V_{GS}$=0 | - | | 1.1 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$=48 A,<br>di/dt =100 A/µs,<br>$V_{DD}$=20 V, *(Figure 15)* | - | 25<br>18.5<br>1.5 | | ns<br>nC<br>A |

1. Pulsed: pulse duration = 300µs, duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area**

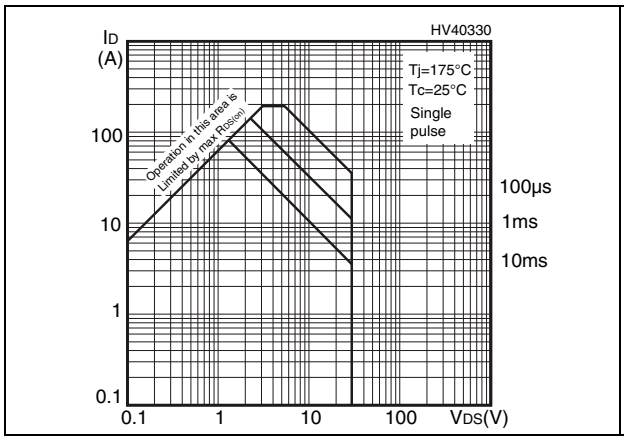



**Figure 3. Thermal impedance**

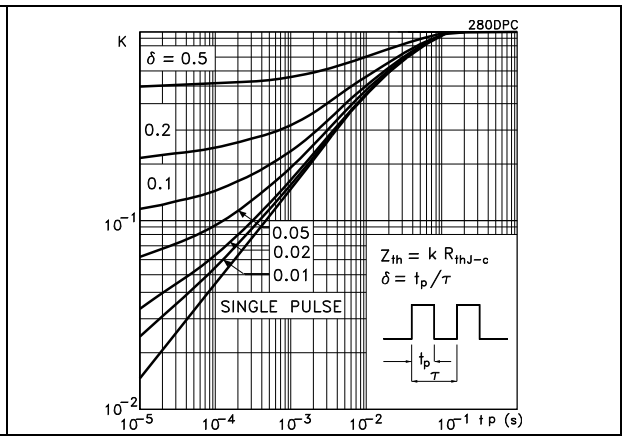



**Figure 4. Output characteristics**

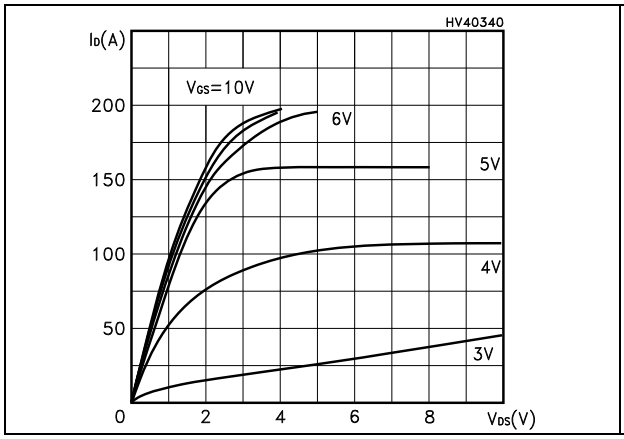



**Figure 5. Transfer characteristics**

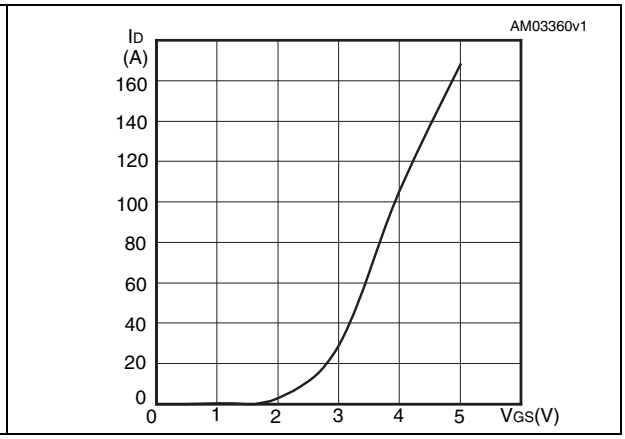



**Figure 6. Normalized $B_{VDSS}$ vs temperature**

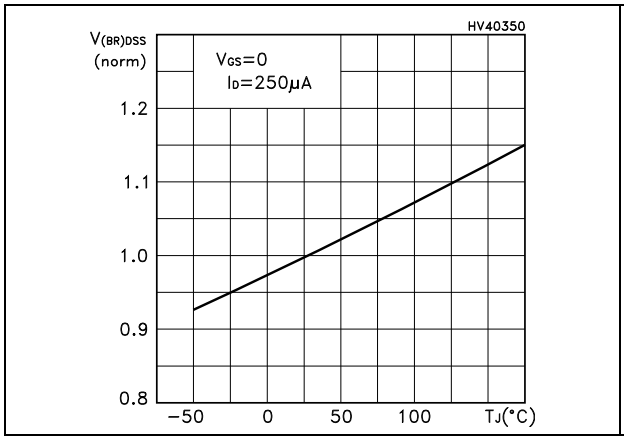



**Figure 7. Static drain-source on resistance**

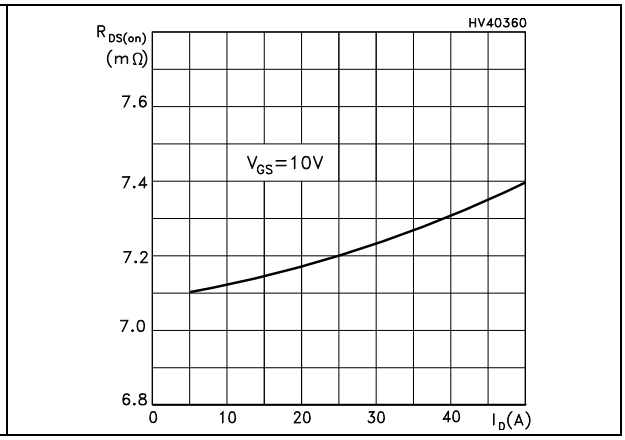


**Figure 8. Gate charge vs gate-source voltage**

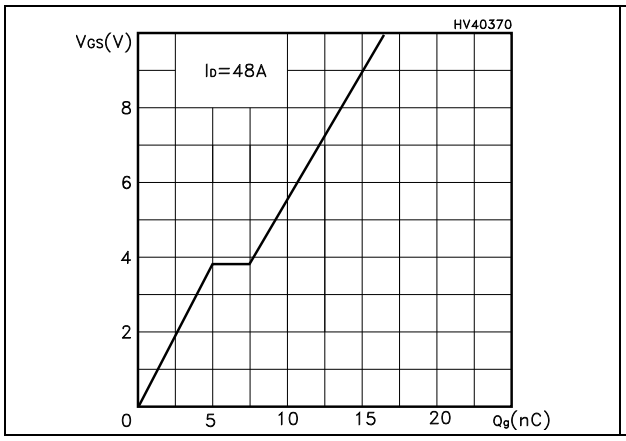



**Figure 9. Capacitance variations**

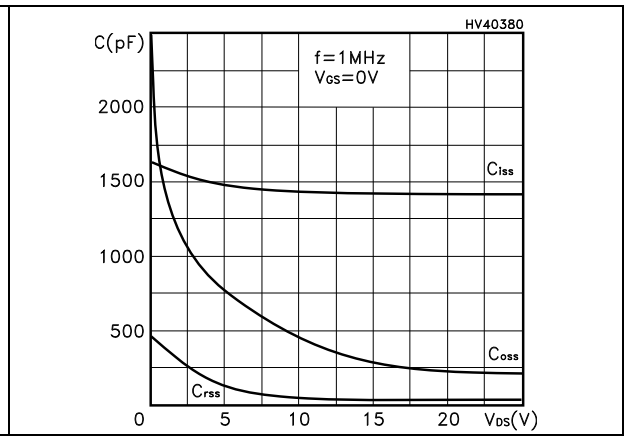



**Figure 10. Normalized gate threshold voltage vs temperature**

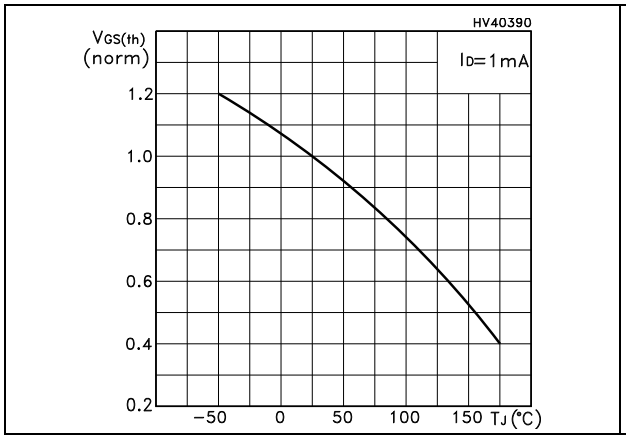



**Figure 11. Normalized on resistance vs temperature**

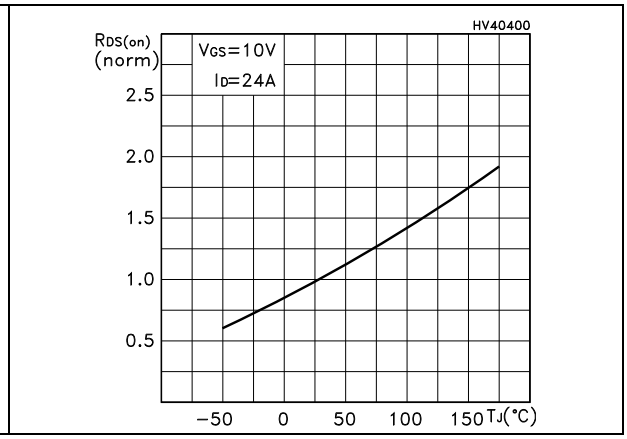
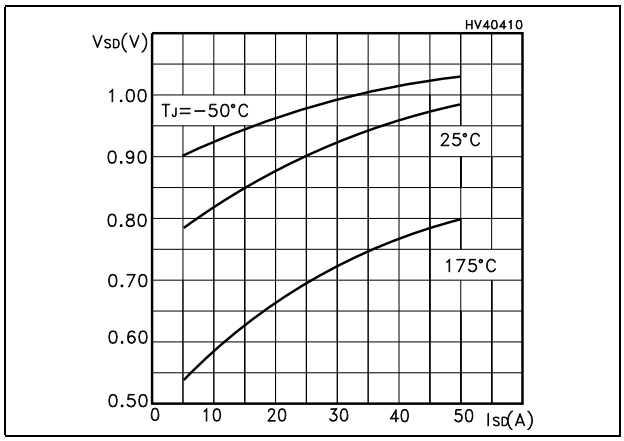



**Figure 12. Source-drain diode forward characteristics**



# 3 Test circuits

**Figure 13. Switching times test circuit for resistive load**

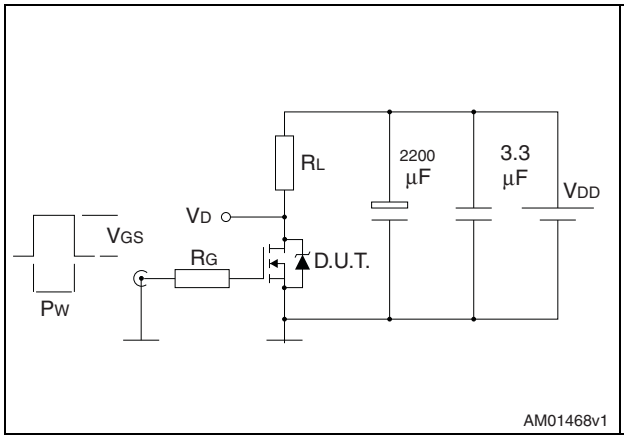



**Figure 14. Gate charge test circuit**

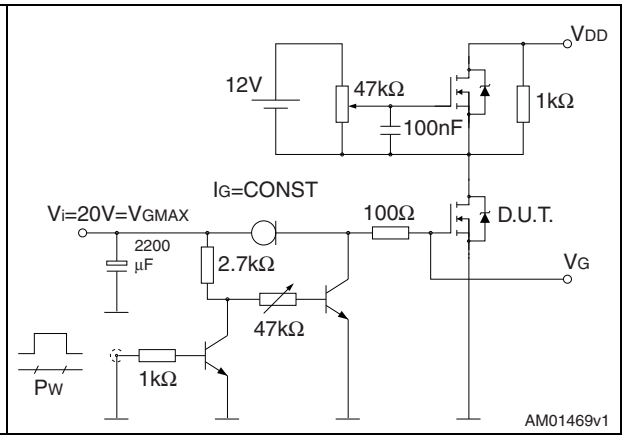



**Figure 15. Test circuit for inductive load switching and diode recovery times**

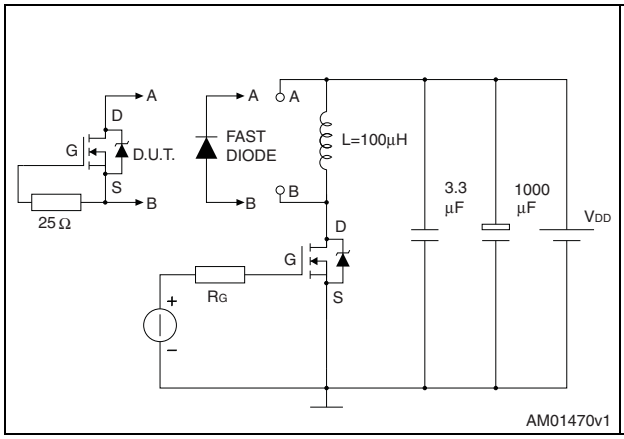



**Figure 16. Unclamped inductive load test circuit**

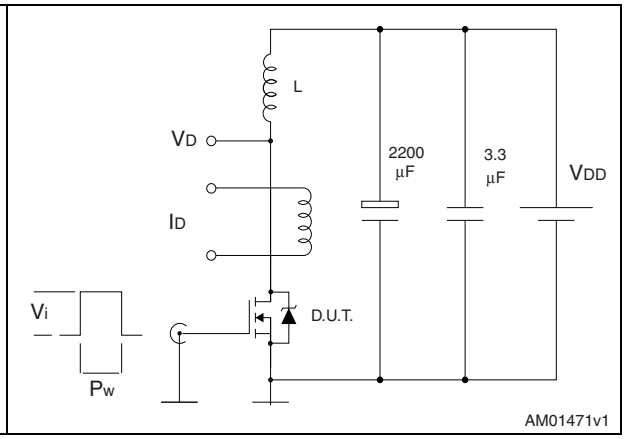



**Figure 17. Unclamped inductive waveform**

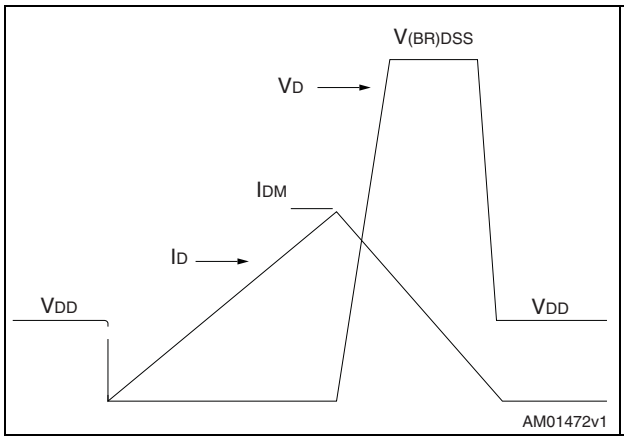



**Figure 18. Switching time waveform**

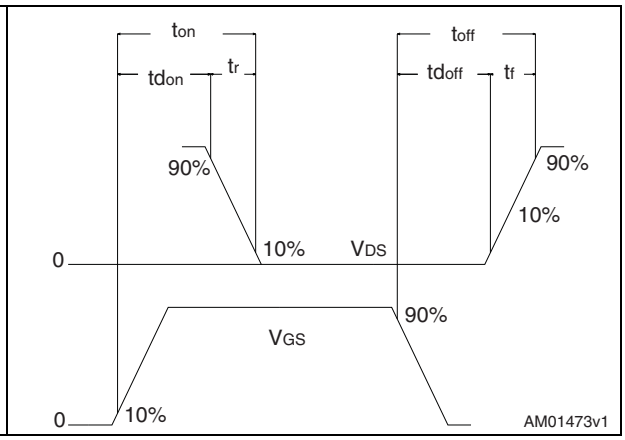
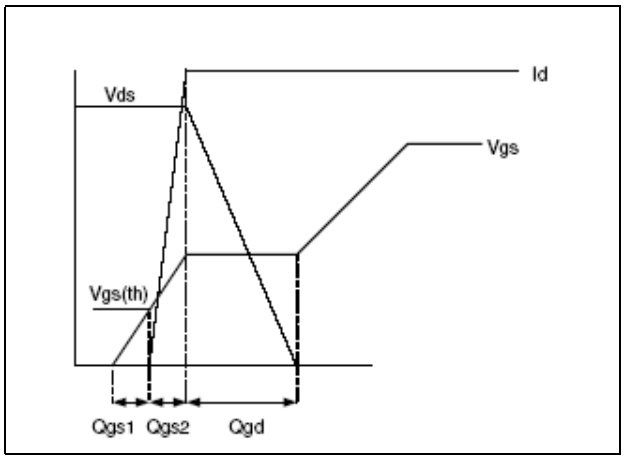


**Figure 19. Gate charge waveform**



# 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.

**Table 8. Short IPAK mechanical dimensions**

| 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 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |
| E | 6.40 | | 6.60 |
| e | | 2.25 | |
| e1 | 4.40 | | 4.60 |
| H | 9.80 | | 10.40 |
| L | 3.00 | | 3.40 |
| L1 | 0.80 | | 1.20 |
| L2 | | 0.80 | 1.00 |

**Figure 20. Short IPAK mechanical drawing**

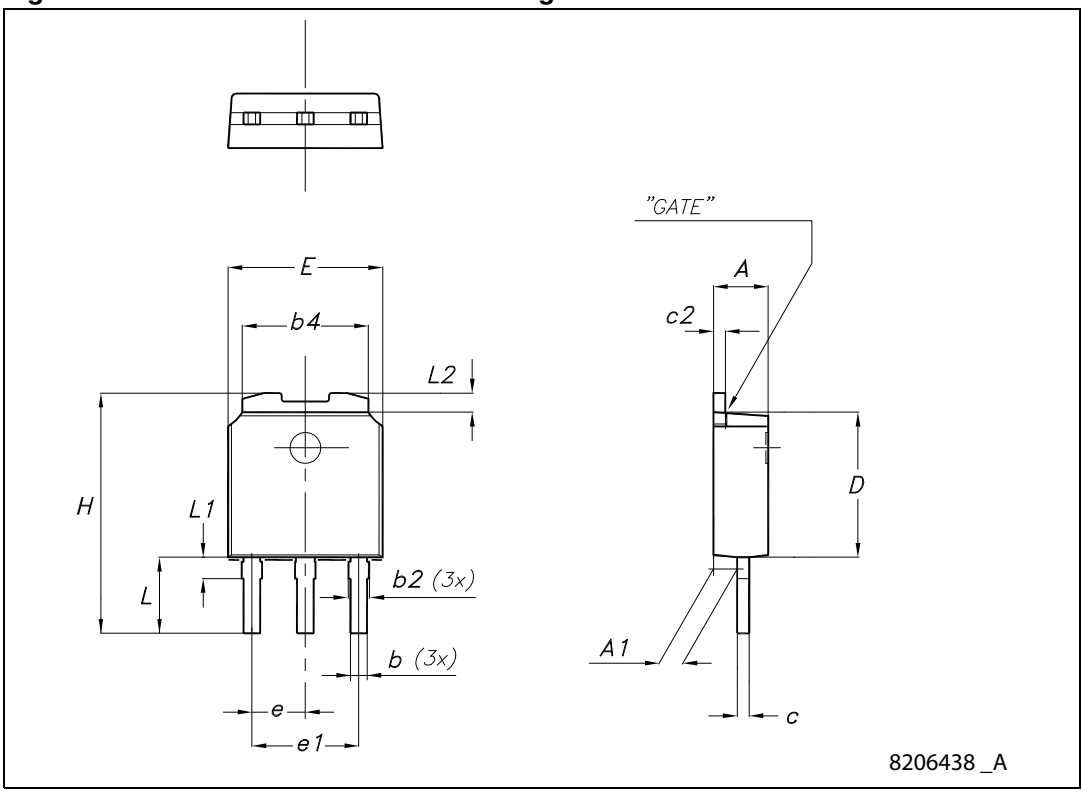
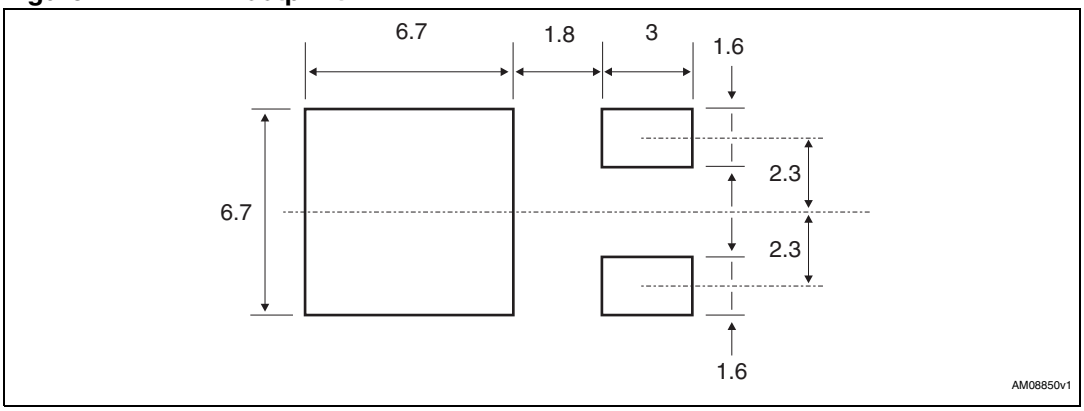


**Table 9. DPAK (TO-252) mechanical data**

| 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 | | |
| L1 | | 2.80 | |
| L2 | | 0.80 | |
| L4 | 0.60 | | 1 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

**Figure 21. DPAK footprint[a]**




a. All dimension are in millimeters

**Figure 22. DPAK (TO-252) drawing**

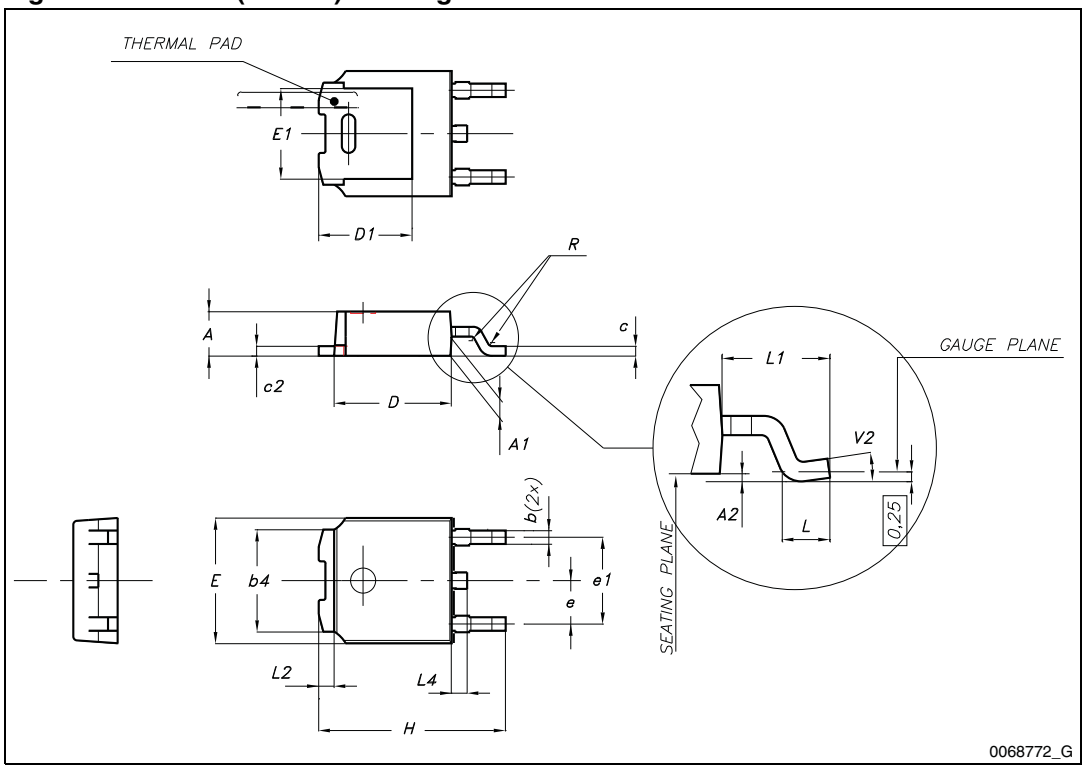


Table 10. IPAK (TO-251) mechanical data

| 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 | | 0.3 | |
| 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 | | $10^{o}$ | |

**Figure 23. IPAK (TO-251) drawing**

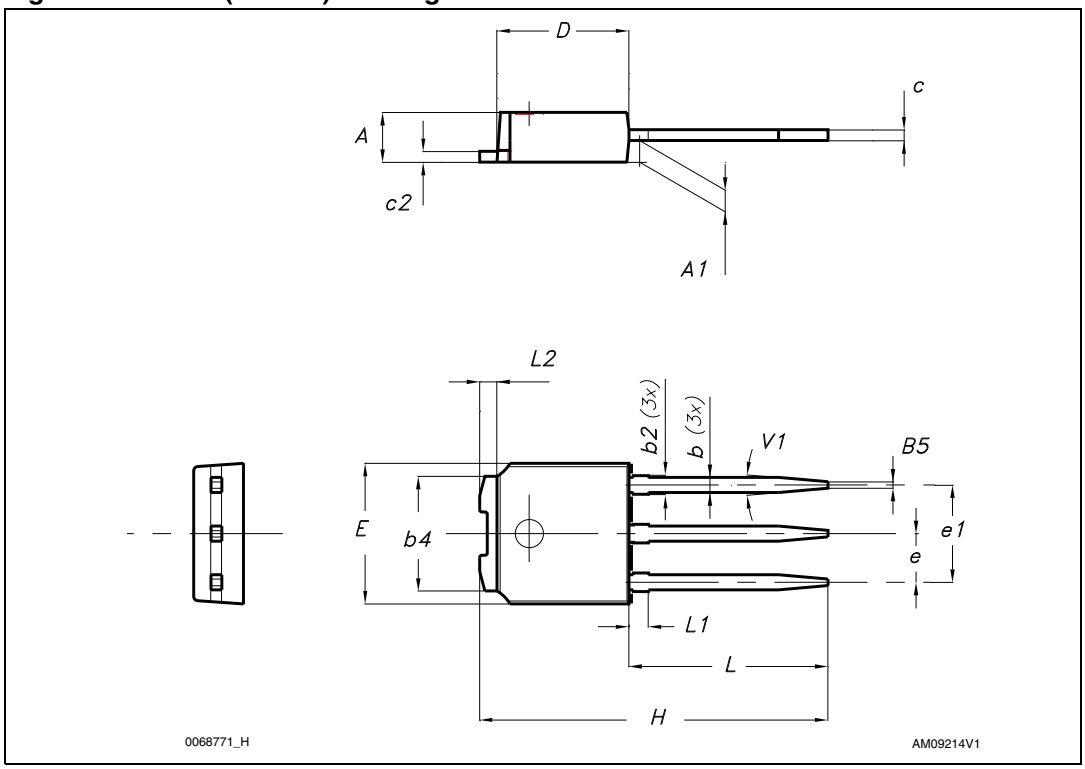
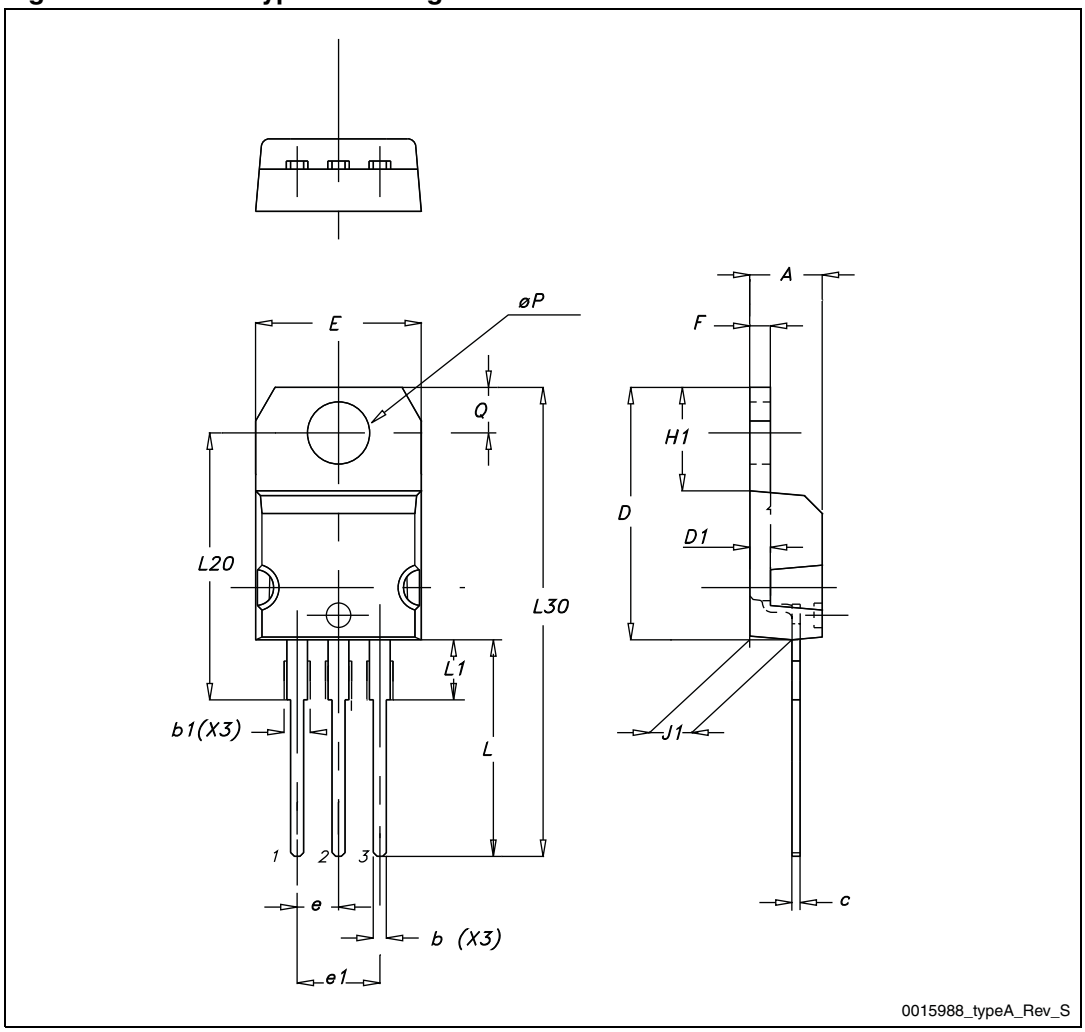


**Table 11. TO-220 type A mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.70 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10 | | 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 | | 14 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| ∅P | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

**Figure 24. TO-220 type A drawing**



# 5 Packaging mechanical data

**Table 12. 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 25. Tape for DPAK (TO-252)**

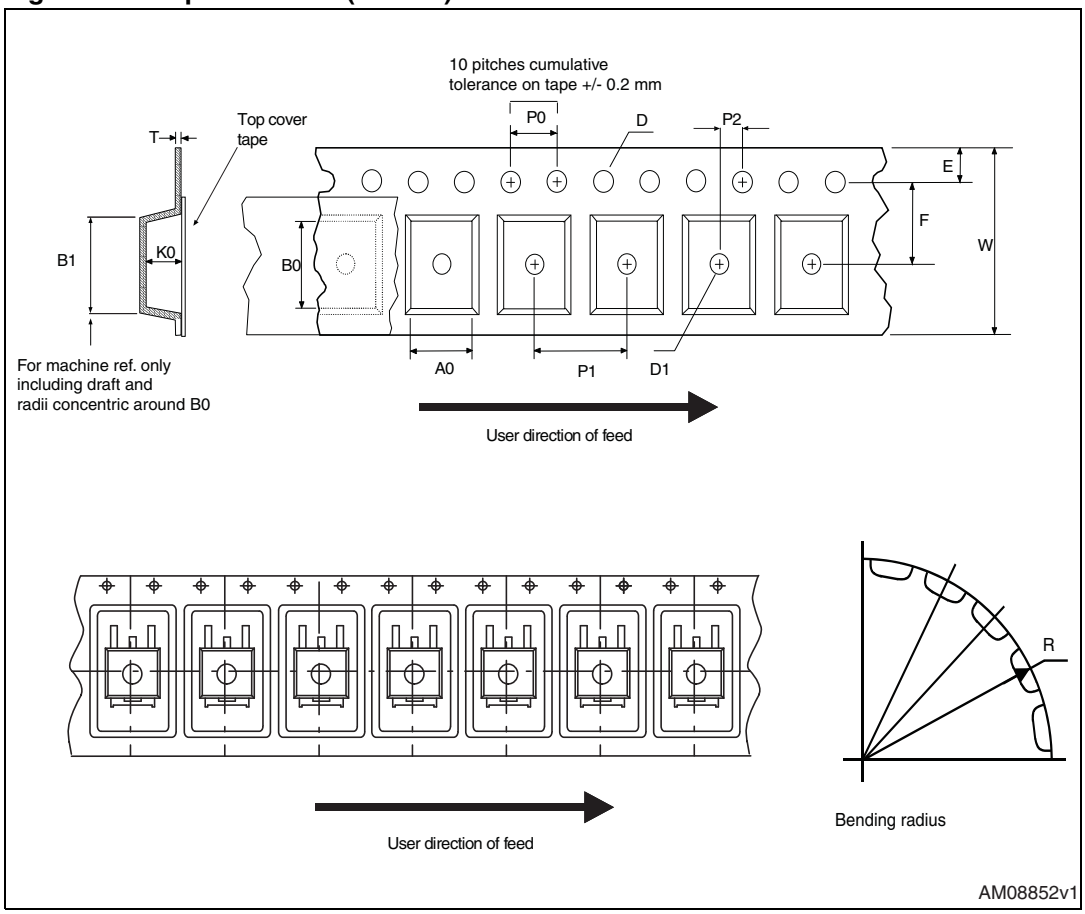
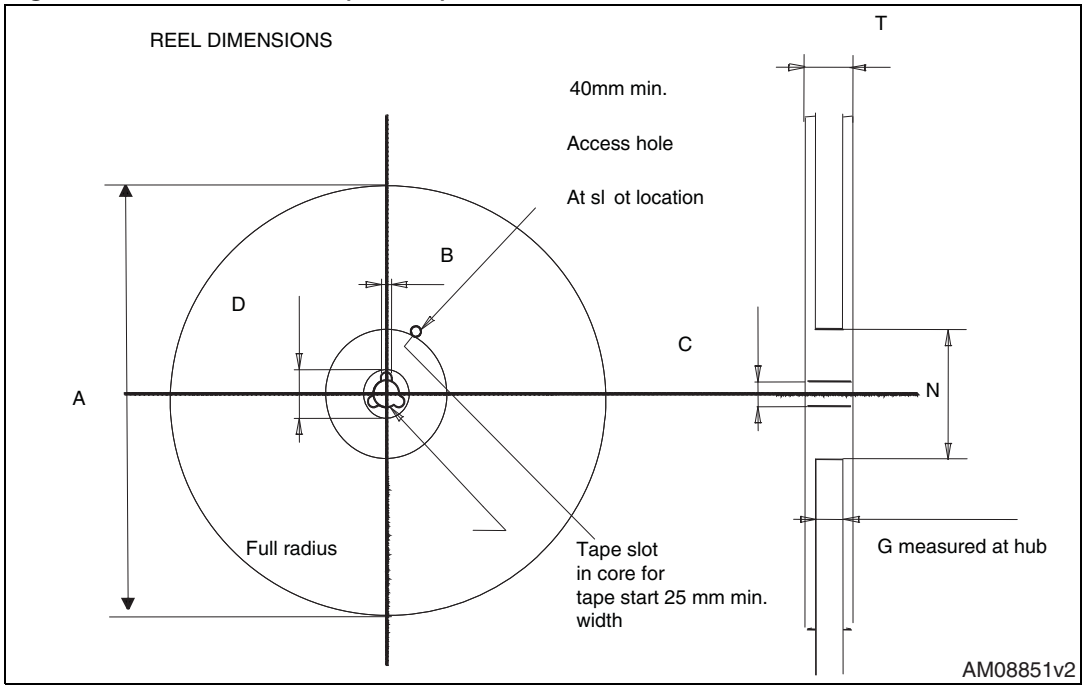



**Figure 26. Reel for DPAK (TO-252)**



# 6 Revision history

**Table 13. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 19-Oct-2007 | 1 | First release |
| 23-Sep-2008 | 2 | $V_{GS}$ value has been changed on *Table 2* and *Table 5* |
| 20-Apr-2009 | 3 | – Inserted typical adn maximum value in $V_{GS(th)}$ parameter<br>– *Figure 5: Transfer characteristics* has been updated<br>– Added device in TO-220 |
| 05-Apr-2011 | 4 | – Added device in Short IPAK<br>– Added max values in *Table 5: Dynamic*<br>– $V_{GS}$ value has been changed in *Table 2* and *Table 4* |

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