



STx25NM60ND

N-channel 600 V, 0.13 Ω , 21 A FDmesh™ II Power MOSFET
(with fast diode) in D²PAK, TO-220FP, TO-220, TO-247

Features

| Type | V _{DSS} @ T _{JMAX} | R _{DS(on)} max | I _D |
|-------------|---|-------------------------|---------------------|
| STB25NM60ND | 650 V | 0.16 Ω | 21 A |
| STF25NM60ND | | | 21 A ⁽¹⁾ |
| STP25NM60ND | | | 21 A |
| STW25NM60ND | | | 21 A |

- Limited only by maximum temperature allowed
- The worldwide best R_{DS(on)}*area amongst the fast recovery diode devices
 - 100% avalanche tested
 - Low input capacitance and gate charge
 - Low gate input resistance
 - Extremely high dv/dt and avalanche capabilities

Application

- Switching applications

Description

These FDmesh™ II Power MOSFETs with intrinsic fast-recovery body diode are produced using the second generation of MDmesh™ technology. Utilizing a new strip-layout vertical structure, these revolutionary devices feature extremely low on-resistance and superior switching performance. They are ideal for bridge topologies and ZVS phase-shift converters.

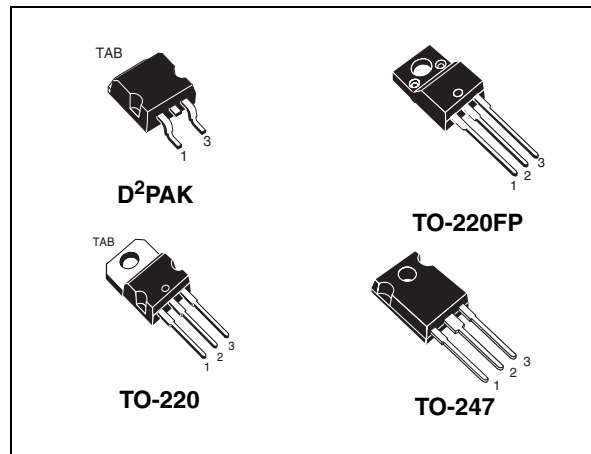


Figure 1. Internal schematic diagram

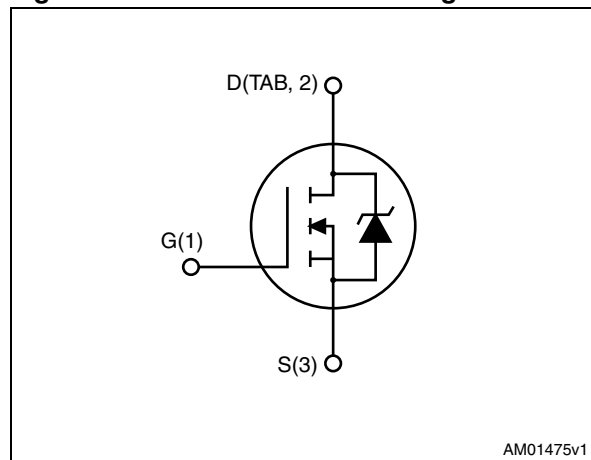


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|----------|--------------------|---------------|
| STB25NM60ND | 25NM60ND | D ² PAK | Tape and reel |
| STF25NM60ND | 25NM60ND | TO-220FP | Tube |
| STP25NM60ND | 25NM60ND | TO-220 | Tube |
| STW25NM60ND | 25NM60ND | TO-247 | Tube |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|--|------------------------------------|-------------------|------|
| | | D ² PAK, TO-220, TO-247 | TO-220FP | |
| V _{DS} | Drain-source voltage | 600 | | V |
| V _{GS} | Gate-source voltage | ±25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 21 | 21 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 13 | 13 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 84 | 84(1) | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 160 | 40 | W |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 40 | | V/ns |
| V _{iso} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C) | | 2500 | V |
| T _{stg} | Storage temperature | -55 to 150 | | °C |
| T _J | Max. operating junction temperature | 150 | | °C |

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} ≤ 21 A, di/dt ≤ 600 A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 3. Thermal data

| Symbol | Parameter | D ² PAK | TO-220FP | TO-220 | TO-247 | Unit |
|-------------------------------------|---|--------------------|----------|--------|--------|------|
| R _{thj-case} | Thermal resistance junction-case max | 0.78 | 3.1 | 0.78 | | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient max | | 62.5 | | 50 | °C/W |
| R _{thj-pcb} ⁽¹⁾ | Thermal resistance junction-ambient max | 30 | | | | °C/W |

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

Table 4. Avalanche characteristics

| Symbol | Parameter | Max value | Unit |
|-----------------|--|-----------|------|
| I _{AS} | Avalanche current, repetitive or not-repetitive (pulse width limited by T _J max) | 10 | A |
| E _{AS} | Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AS} , V _{DD} = 50 V) | 850 | mJ |

2 Electrical characteristics

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

Table 5. On/off states

| Symbol | Parameter | Test conditions | Value | | | Unit |
|---------------|--|--|-------|------|-----------|--------------------------------|
| | | | Min. | Typ. | Max. | |
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1\text{ mA}, V_{GS} = 0$ | 600 | | | V |
| $dv/dt^{(1)}$ | Drain source voltage slope | $V_{DD} = 480\text{ V}, I_D = 21\text{ A}, V_{GS} = 10\text{ V}$ | 48 | | | V/ns |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 600\text{ V}$ $V_{DS} = 600\text{ V} @ T_C = 125\text{ °C}$ | | | 1 100 | μA μA |
| I_{GSS} | Gate-body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 20\text{ V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10\text{ V}, I_D = 10.5\text{ A}$ | | 0.13 | 0.16 | Ω |

1. Characteristic value at turn off on inductive load.

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|--|------|----------------------|------|----------------------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} = 15\text{ V}, I_D = 10.5\text{ A}$ | - | 17 | - | S |
| C_{iss} C_{oss} C_{rss} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{DS} = 50\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$ | - | 2400 150 15 | - | pF pF pF |
| $C_{oss\text{ eq.}}^{(2)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0\text{ to }480\text{ V}$ | - | 320 | - | pF |
| $t_{d(on)}$ t_r $t_{d(off)}$ t_f | Turn-on delay time Rise time Turn-off delay time Fall time | $V_{DD} = 300\text{ V}, I_D = 10.5\text{ A}$ $R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 23), (see Figure 18) | - | 60 30 50 40 | - | ns ns ns ns |
| Q_g Q_{gs} Q_{gd} | Total gate charge Gate-source charge Gate-drain charge | $V_{DD} = 480\text{ V}, I_D = 21\text{ A}, V_{GS} = 10\text{ V},$ (see Figure 19) | - | 80 15 40 | - | nC nC nC |
| R_g | Gate input resistance | $f=1\text{ MHz}$ gate DC bias=0 Test signal level = 20 mV open drain | - | 1.6 | - | Ω |

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

2. $C_{oss\text{ eq.}}$ 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. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 21 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 84 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 21\text{ A}, V_{GS} = 0$ | - | | 1.3 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 21\text{ A}, V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ <i>(see Figure 20)</i> | - | 160 | | ns |
| Q_{rr} | Reverse recovery charge | | | 1 | | μC |
| I_{RRM} | Reverse recovery current | | | 15 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 21\text{ A}, V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, $T_J = 150\text{ }^\circ\text{C}$ <i>(see Figure 20)</i> | - | 230 | | ns |
| Q_{rr} | Reverse recovery charge | | | 2 | | μC |
| I_{RRM} | Reverse recovery current | | | 19 | | 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 D²PAK and TO-220

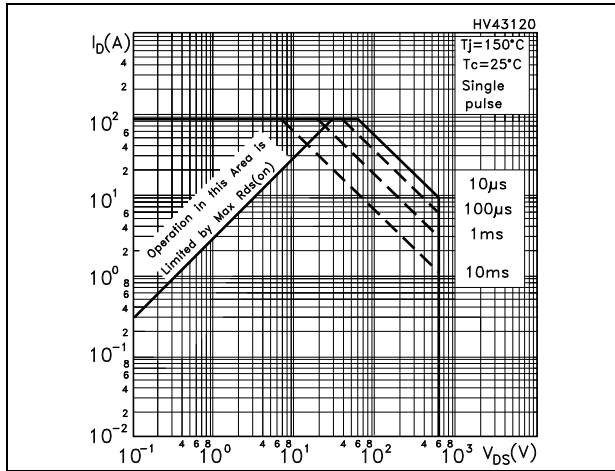


Figure 3. Thermal impedance for D²PAK and TO-220

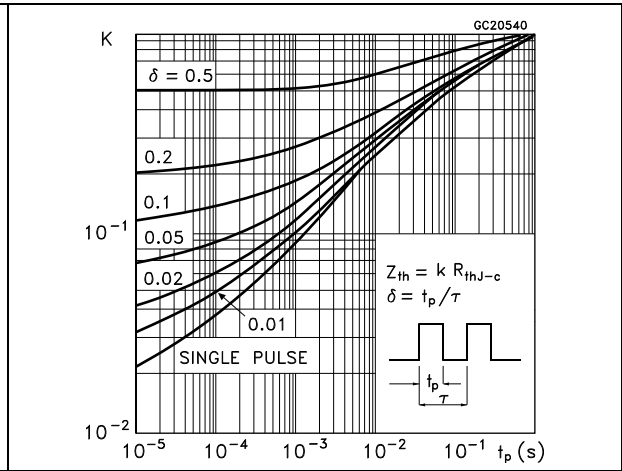


Figure 4. Safe operating area for TO-220FP

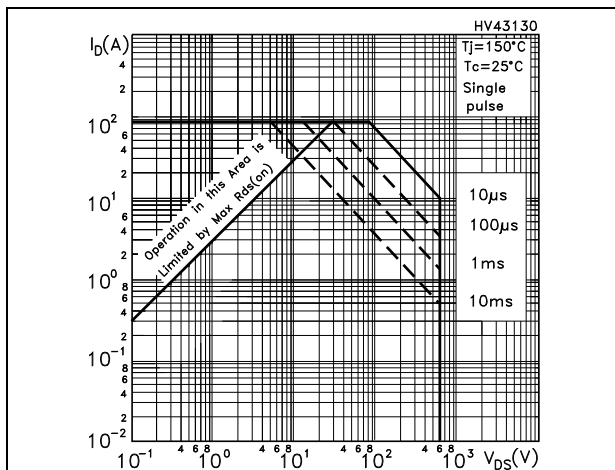


Figure 5. Thermal impedance for TO-220FP

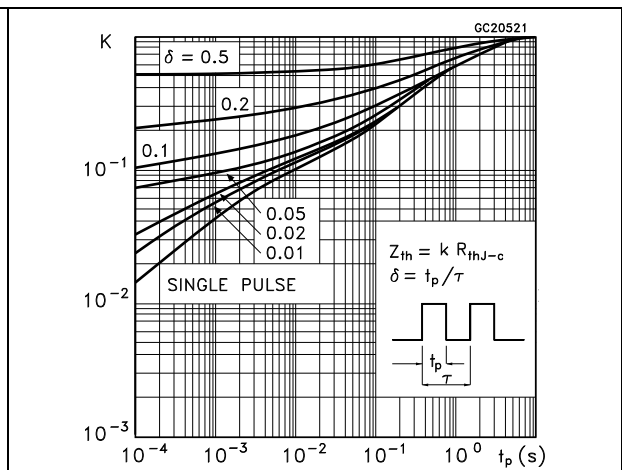


Figure 6. Safe operating area for TO-247

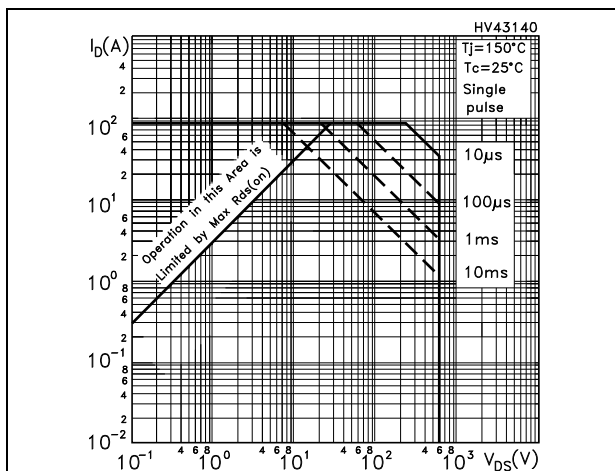


Figure 7. Thermal impedance for TO-247

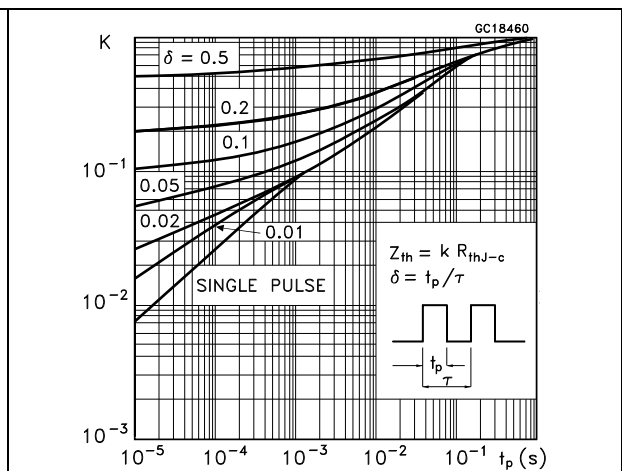


Figure 8. Output characteristics

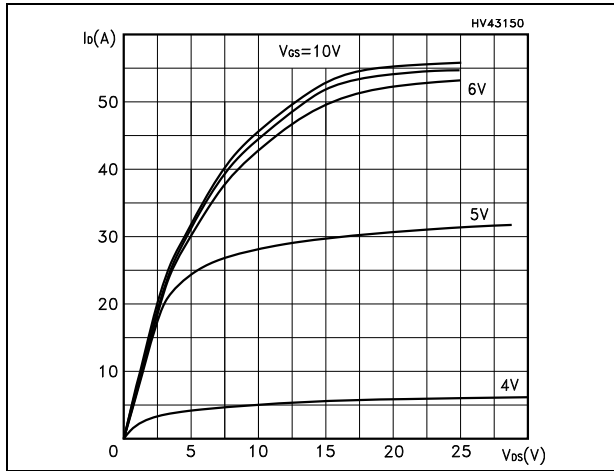


Figure 9. Transfer characteristics

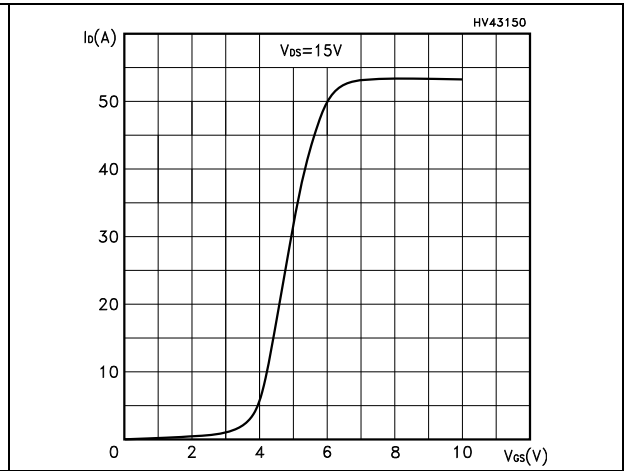


Figure 10. Transconductance

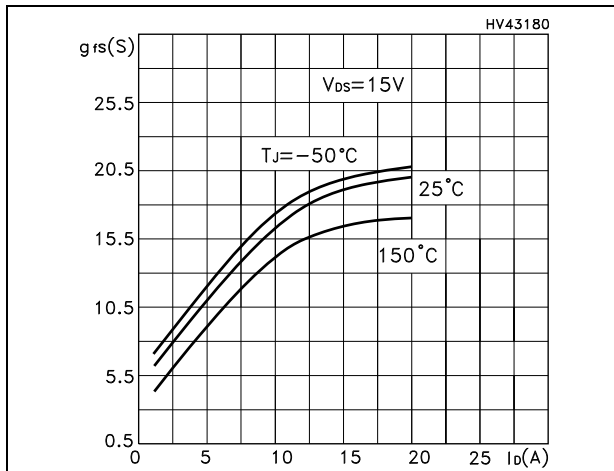


Figure 11. Static drain-source on resistance

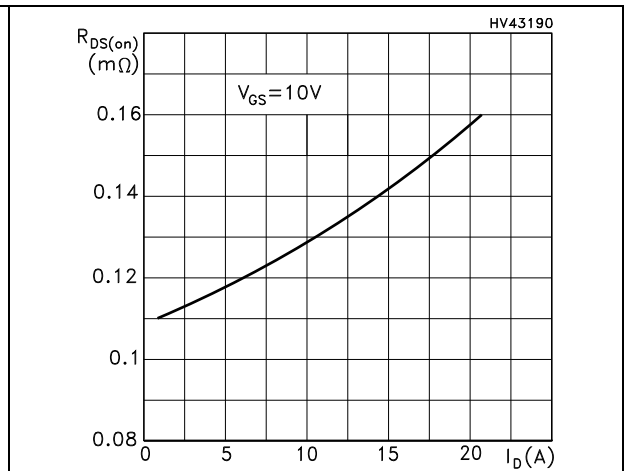


Figure 12. Gate charge vs gate-source voltage Figure 13. Capacitance variations

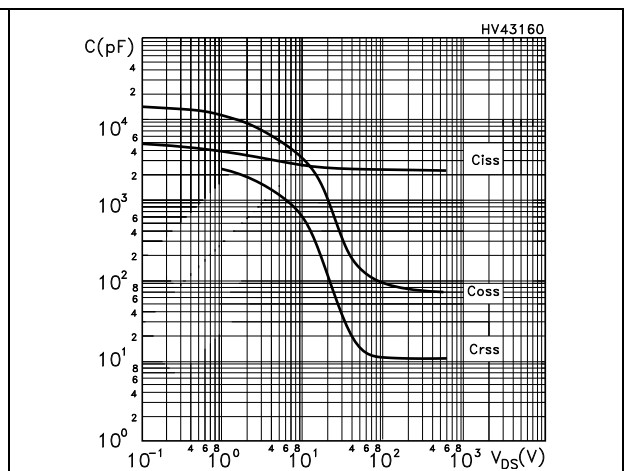
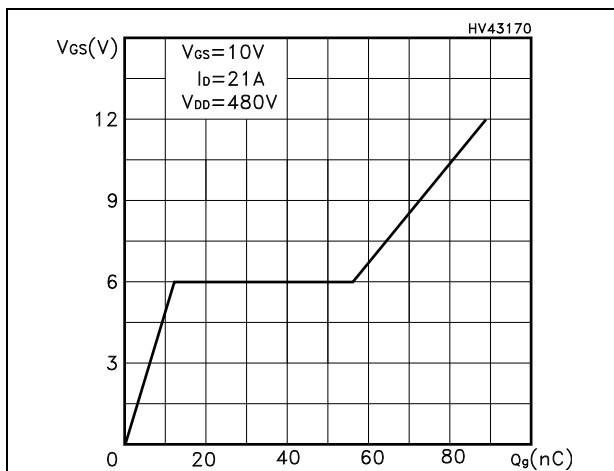


Figure 14. Normalized gate threshold voltage vs temperature

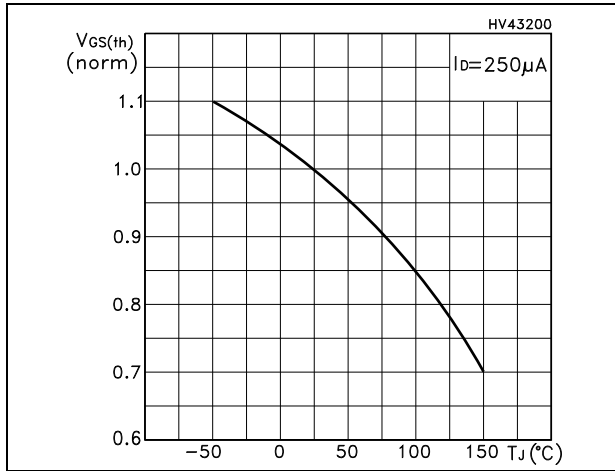


Figure 15. Normalized on resistance vs temperature

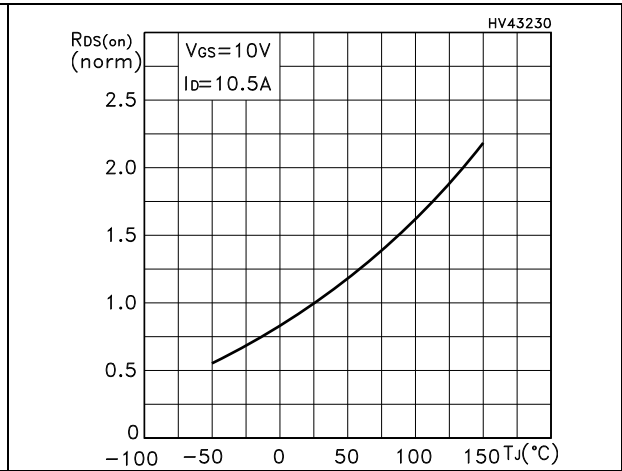


Figure 16. Source-drain diode forward characteristics

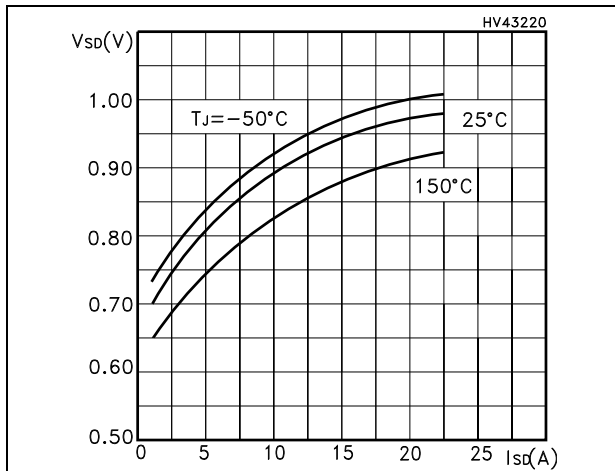
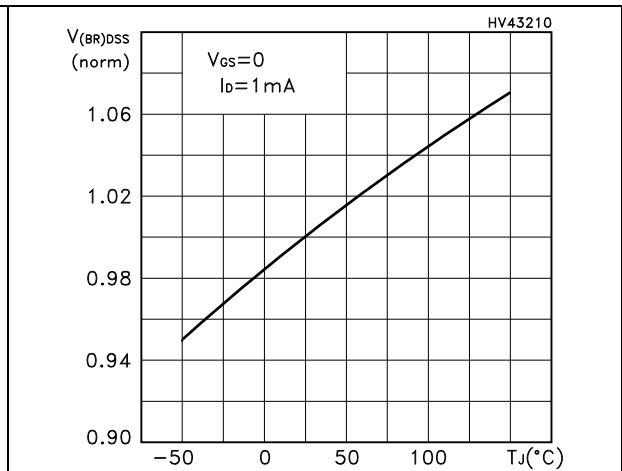


Figure 17. Normalized B_VDSS vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

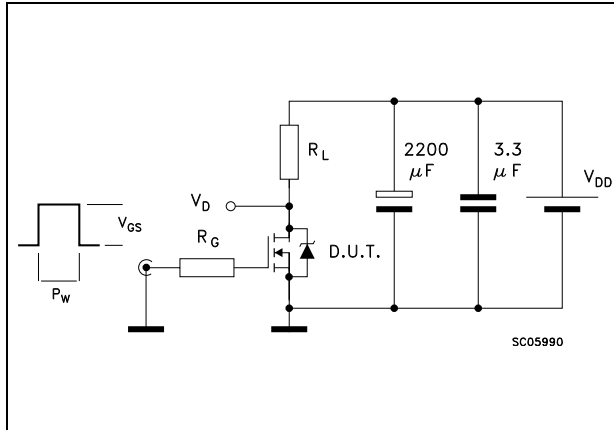


Figure 19. Gate charge test circuit

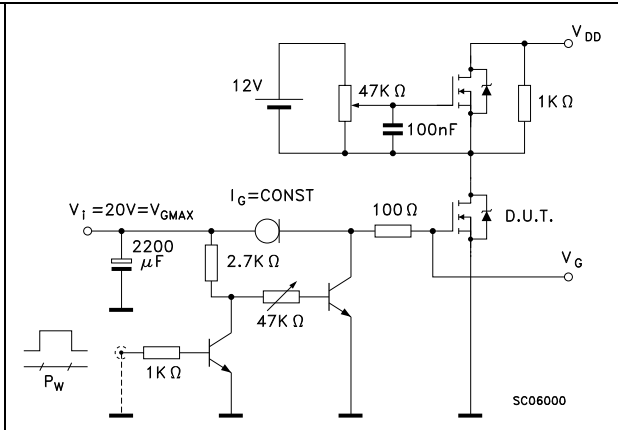


Figure 20. Test circuit for inductive load switching and diode recovery times

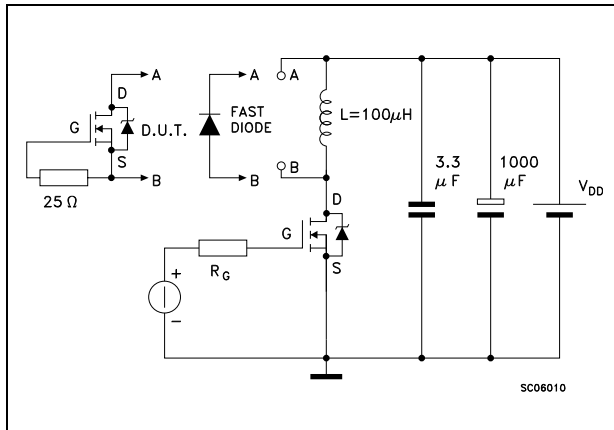


Figure 21. Unclamped inductive load test circuit

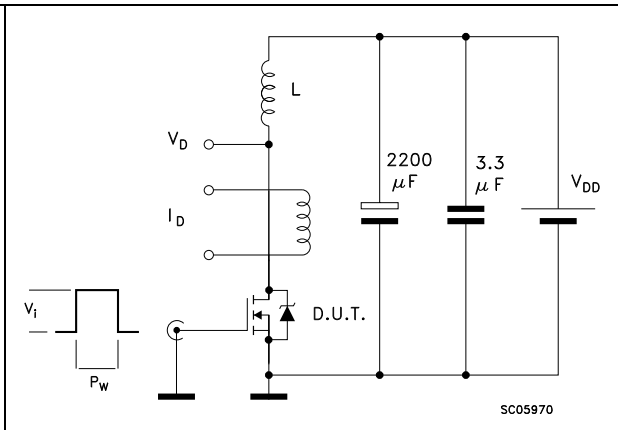


Figure 22. Unclamped inductive waveform

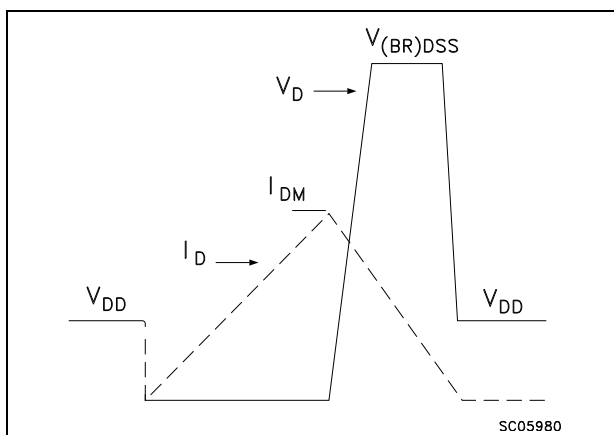
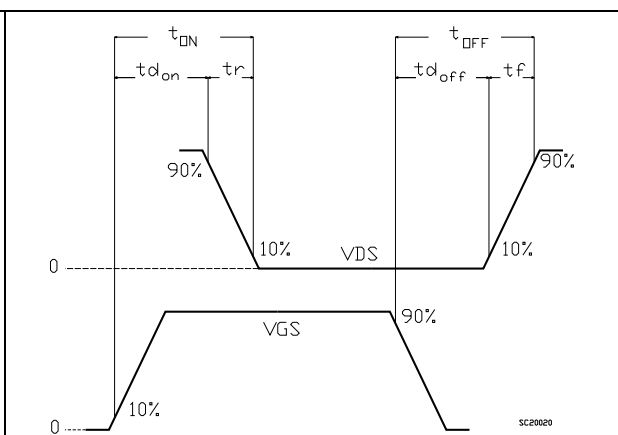


Figure 23. Switching time waveform



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.

Table 8. D²PAK (TO-263) mechanical data

| Dim. | mm | | |
|------|------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| A1 | 0.03 | | 0.23 |
| b | 0.70 | | 0.93 |
| b2 | 1.14 | | 1.70 |
| c | 0.45 | | 0.60 |
| c2 | 1.23 | | 1.36 |
| D | 8.95 | | 9.35 |
| D1 | 7.50 | | |
| E | 10 | | 10.40 |
| E1 | 8.50 | | |
| e | | 2.54 | |
| e1 | 4.88 | | 5.28 |
| H | 15 | | 15.85 |
| J1 | 2.49 | | 2.69 |
| L | 2.29 | | 2.79 |
| L1 | 1.27 | | 1.40 |
| L2 | 1.30 | | 1.75 |
| R | | 0.4 | |
| V2 | 0° | | 8° |

Figure 24. D²PAK (TO-263) drawing



Figure 25. D²PAK footprint^(a)



a. All dimension are in millimeters

Table 9. 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 |
| Dia | 3 | | 3.2 |

TO-220FP drawing

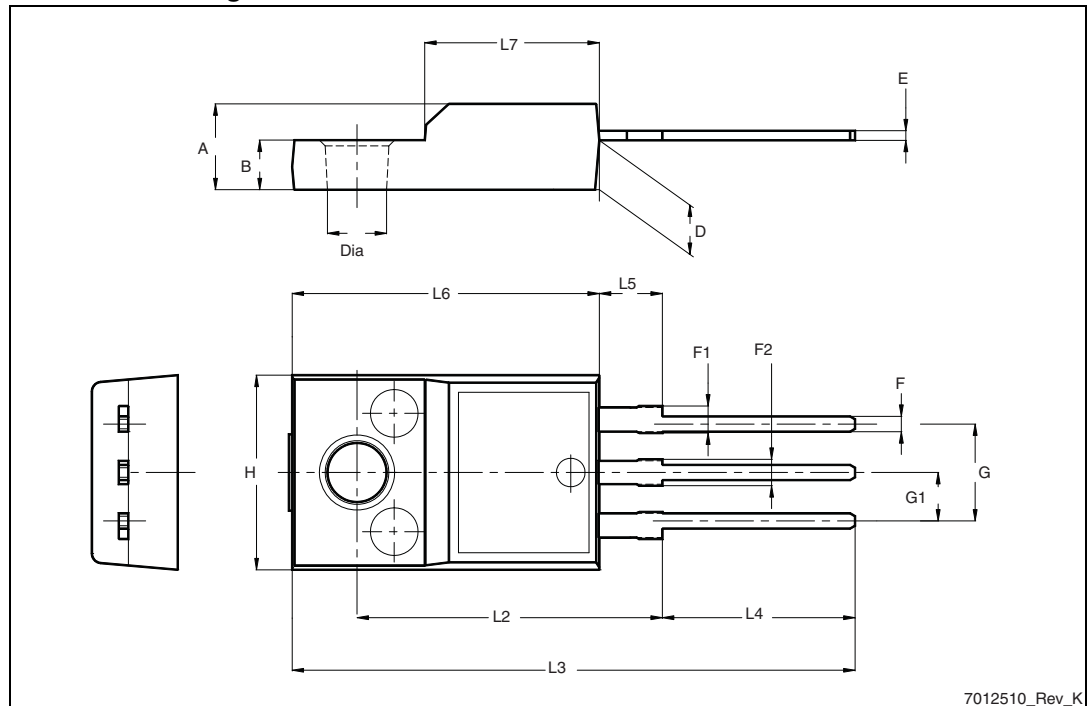


Table 10. TO-220 type A mechanical data

| 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 | |
| ØP | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

Figure 26. TO-220 type A drawing

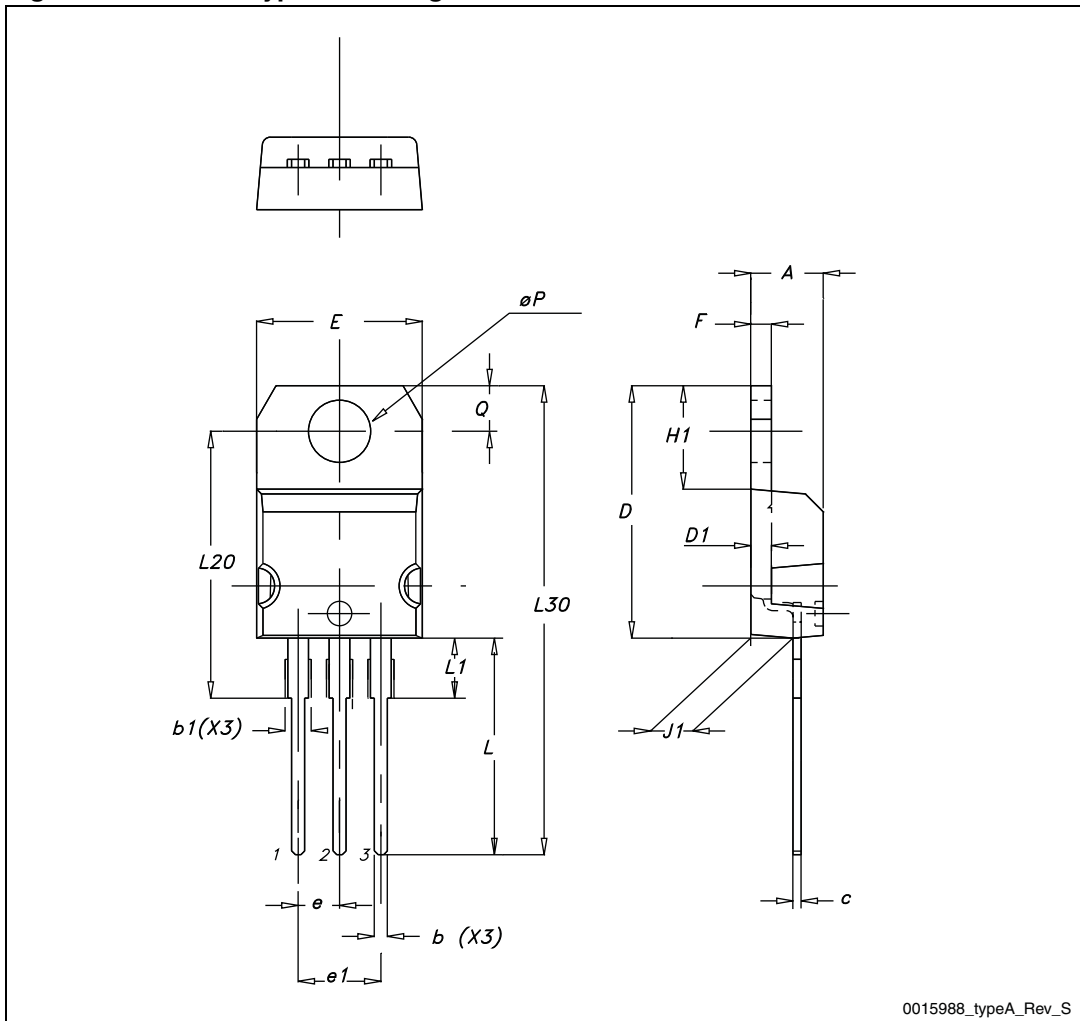
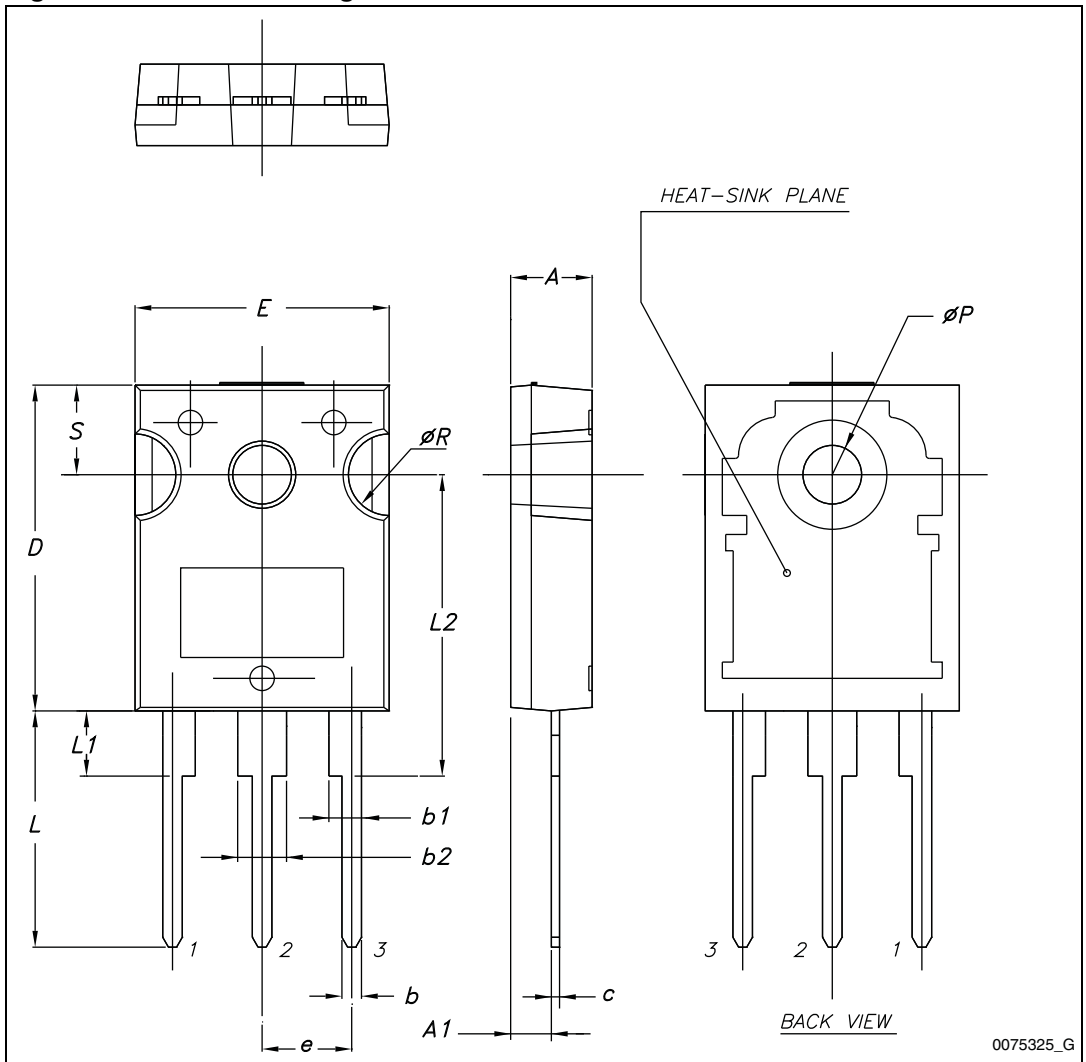


Table 11. TO-247 mechanical data

| 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 |

Figure 27. TO-247 drawing



0075325_G

5 Packing mechanical data

Table 12. D²PAK (TO-263) tape and reel mechanical data

| Tape | | | Reel | | |
|------|------|------|----------|------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 10.5 | 10.7 | A | | 330 |
| B0 | 15.7 | 15.9 | B | 1.5 | |
| D | 1.5 | 1.6 | C | 12.8 | 13.2 |
| D1 | 1.59 | 1.61 | D | 20.2 | |
| E | 1.65 | 1.85 | G | 24.4 | 26.4 |
| F | 11.4 | 11.6 | N | 100 | |
| K0 | 4.8 | 5.0 | T | | 30.4 |
| P0 | 3.9 | 4.1 | | | |
| P1 | 11.9 | 12.1 | Base qty | | 1000 |
| P2 | 1.9 | 2.1 | Bulk qty | | 1000 |
| R | 50 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 23.7 | 24.3 | | | |

Figure 28. Tape

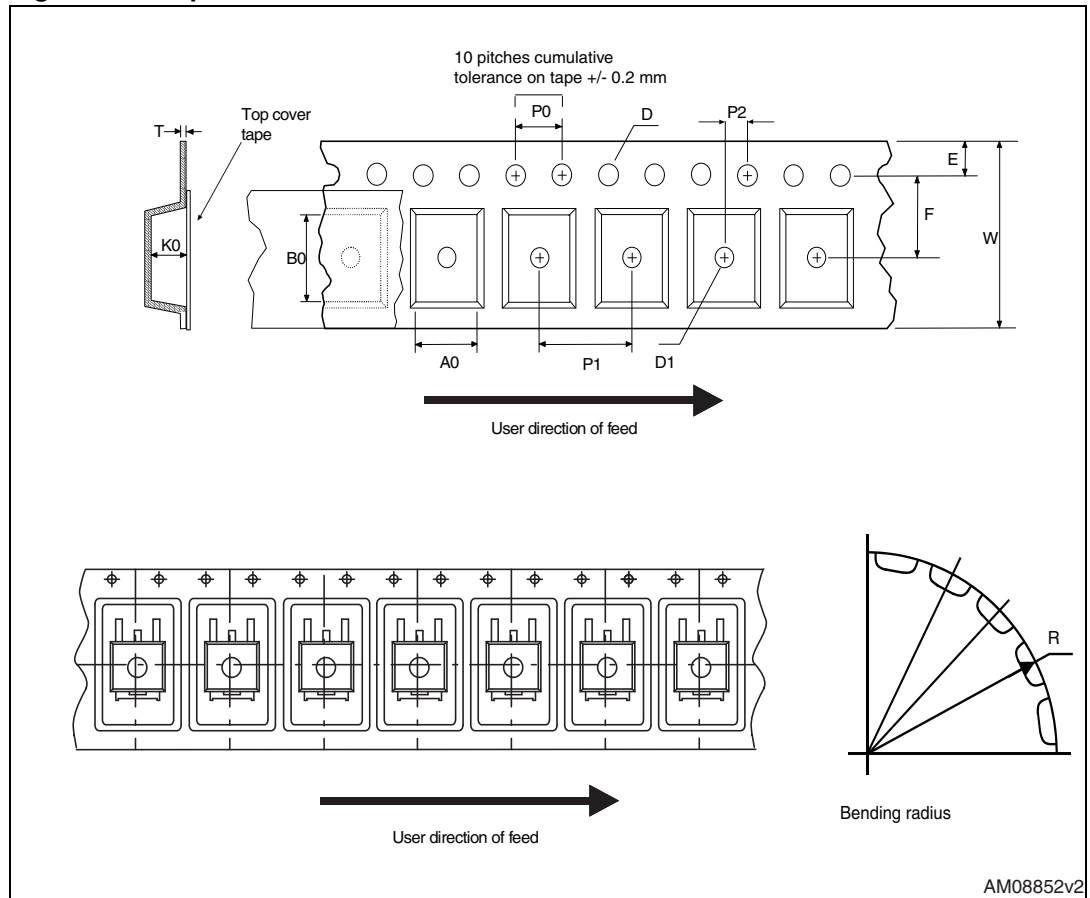
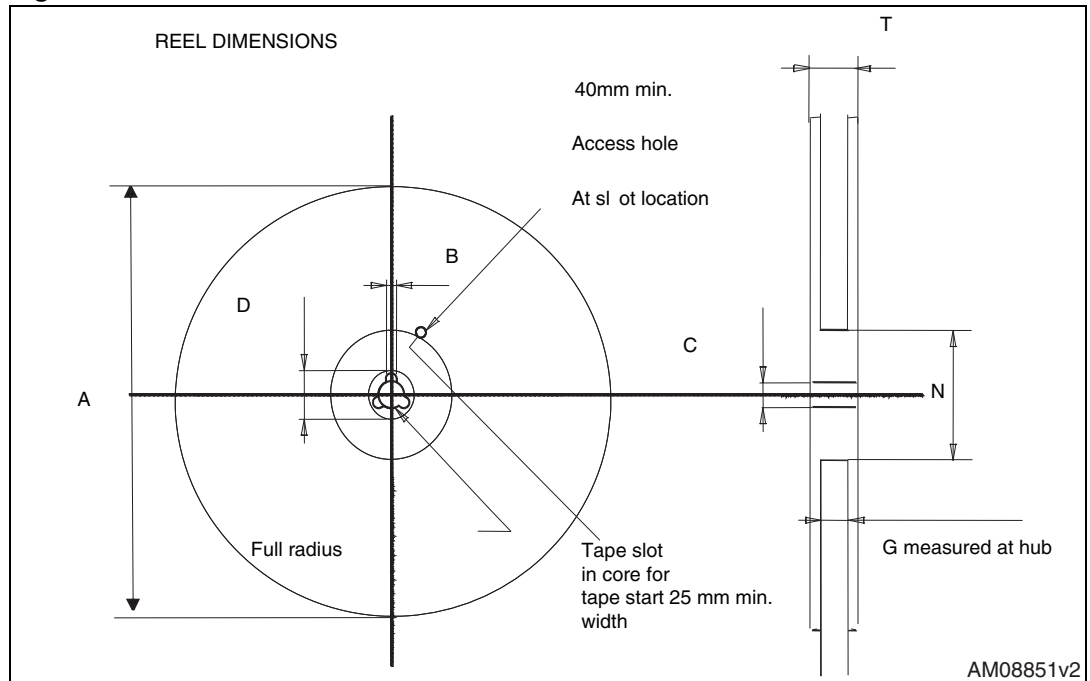


Figure 29. Reel



6 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 15-Nov-2007 | 1 | First release. |
| 22-Jan-2008 | 2 | Document status promoted from target specification to preliminary data. |
| 08-Apr-2008 | 3 | – Updated Table 3: Thermal data on page 3 ; – Document status promoted from preliminary data to datasheet. |
| 03-Mar-2009 | 4 | Q _g value has been updated. |
| 28-Nov-2011 | 5 | Updated Section 4: Package mechanical data and Section 5: Packing mechanical data . Minor text changes. |

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