



STB20N65M5, STI20N65M5, STP20N65M5, STW20N65M5

N-channel 650 V, 0.160 Ω typ., 18 A MDmesh™ V Power MOSFET
in D²PAK, I²PAK, TO-220 and TO-247 packages

Datasheet — production data

Features

| Order codes | V _{DS} @ T _{Jmax} | R _{DS(on)} max | I _D |
|-------------|--|----------------------------|----------------|
| STB20N65M5 | 710 V | 0.19 Ω | 18 A |
| STI20N65M5 | | | |
| STP20N65M5 | | | |
| STW20N65M5 | | | |

- Worldwide best R_{DS(on)} * area
- Higher V_{DSS} rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

Applications

- Switching applications

Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

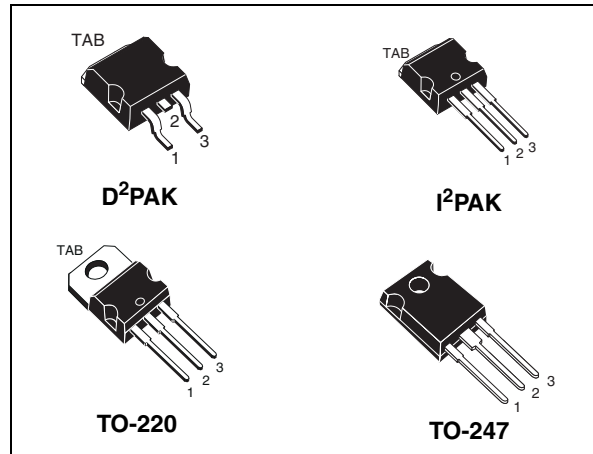


Figure 1. Internal schematic diagram

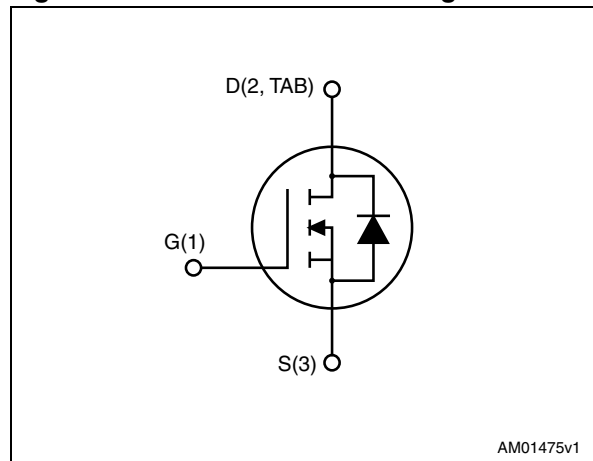


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|--------------------|---------------|
| STB20N65M5 | 20N65M5 | D ² PAK | Tape and reel |
| STI20N65M5 | | I ² PAK | Tube |
| STP20N65M5 | | TO-220 | |
| STW20N65M5 | | TO-247 | |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|---|-------------|------------------|
| V_{GS} | Gate-source voltage | ± 25 | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$ | 18 | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 11.3 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 72 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 130 | W |
| $dv/dt^{(1)}$ | Peak diode recovery voltage slope | 15 | V/ns |
| T_{stg} | Storage temperature | - 55 to 150 | $^\circ\text{C}$ |
| T_j | Max. operating junction temperature | 150 | $^\circ\text{C}$ |

1. $I_{SD} \leq 18\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$; $V_{DS\text{ peak}} < V_{(BR)DSS}$, $V_{DD}=400\text{ V}$

Table 3. Thermal data

| Symbol | Parameter | Value | | | Unit |
|---------------------|---|--------------------|-------------------------------|--------|---------------------------|
| | | D ² PAK | I ² PAK, TO-220 | TO-247 | |
| $R_{thj-case}$ | Thermal resistance junction-case max | 0.96 | | | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | | 62.5 | 50 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb max | 30 | | | $^\circ\text{C}/\text{W}$ |

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

Table 4. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------|--|-------|------|
| I_{AR} | Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax}) | 4 | A |
| E_{AS} | Single pulse avalanche energy (starting $t_j=25\text{ }^\circ\text{C}$, $I_d=I_{AR}$; $V_{dd}=50\text{ V}$) | 270 | 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 | $I_D = 1\text{ mA}$, $V_{GS} = 0$ | 650 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}$, $T_C = 125\text{ °C}$ | | | 1 100 | μA μA |
| I_{GSS} | Gate-body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 25\text{ V}$ | | | ± 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 | $V_{GS} = 10\text{ V}$, $I_D = 9\text{ A}$ | | 0.160 | 0.19 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-------------------|---------------------------------------|--|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 1434 | - | pF |
| C_{oss} | Output capacitance | | | 38 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 3.7 | | pF |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related | $V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0$ | - | 118 | - | pF |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related | | | 35 | | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$ open drain | - | 3.5 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 520\text{ V}$, $I_D = 9\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 18) | - | 36 | - | nC |
| Q_{gs} | Gate-source charge | | | 7.5 | | nC |
| Q_{gd} | Gate-drain charge | | | 18 | | nC |

1. 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}
2. Energy related is defined as a constant equivalent capacitance giving the same stored energy 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 |
|--------------|--------------------|---|------|------|-----|------|
| $t_{d(v)}$ | Voltage delay time | $V_{DD} = 400\text{ V}$, $I_D = 12\text{ A}$, | | 43 | | ns |
| $t_{r(v)}$ | Voltage rise time | $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ | - | 7.5 | - | ns |
| $t_{f(i)}$ | Current fall time | (see Figure 19 and | | 7.5 | | ns |
| $t_{c(off)}$ | Crossing time | Figure 22) | | 11.5 | | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 18 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 72 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 18\text{ A}$, $V_{GS} = 0$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 18\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | - | 288 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$ (see Figure 22) | | 4 | | μC |
| I_{RRM} | Reverse recovery current | | | 27 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 18\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ | - | 342 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ | | 4.7 | | μC |
| I_{RRM} | Reverse recovery current | (see Figure 22) | | 28 | | 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, I²PAK, TO-220

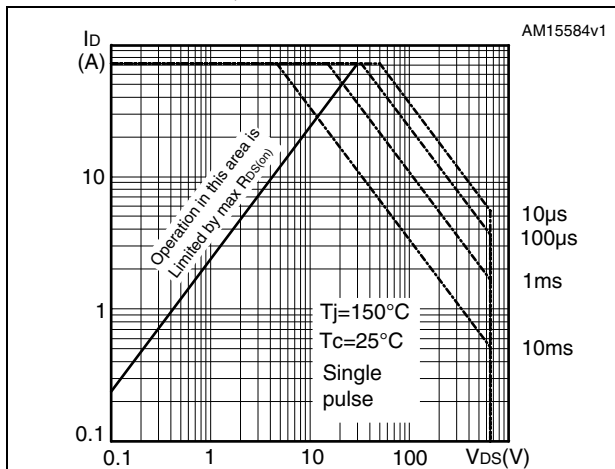


Figure 3. Thermal impedance for D²PAK, I²PAK, TO-220

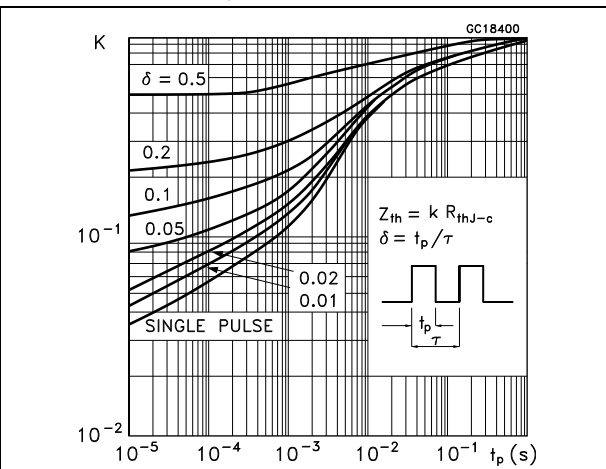


Figure 4. Safe operating area for TO-247

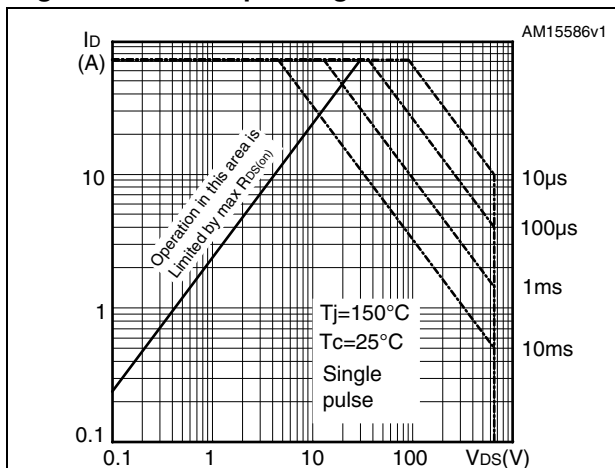


Figure 5. Thermal impedance for TO-247

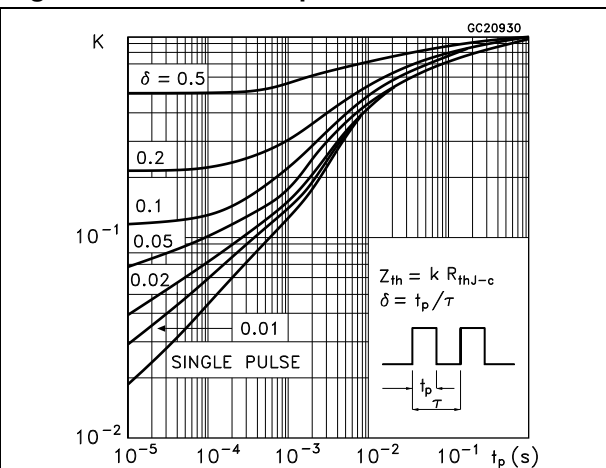


Figure 6. Output characteristics

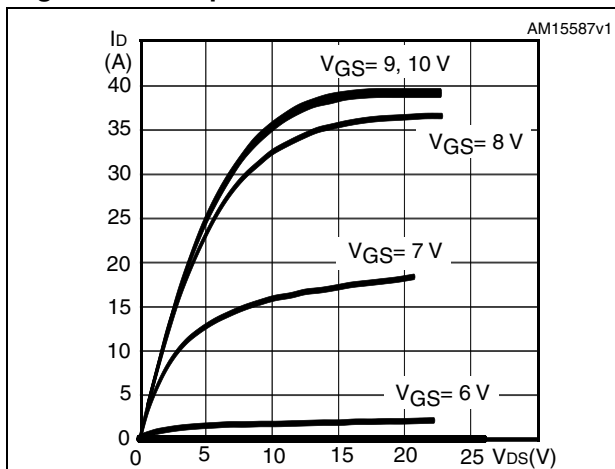


Figure 7. Transfer characteristics

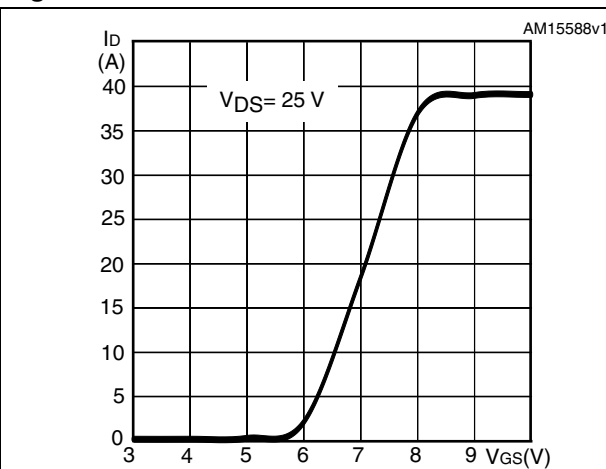


Figure 8. Gate charge vs gate-source voltage Figure 9. Static drain-source on-resistance

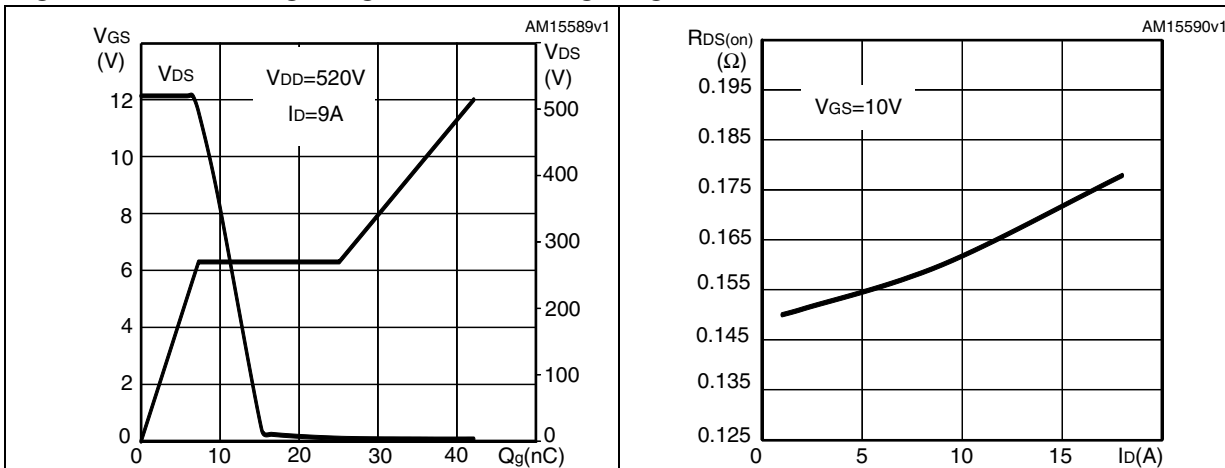


Figure 10. Capacitance variations Figure 11. Output capacitance stored energy

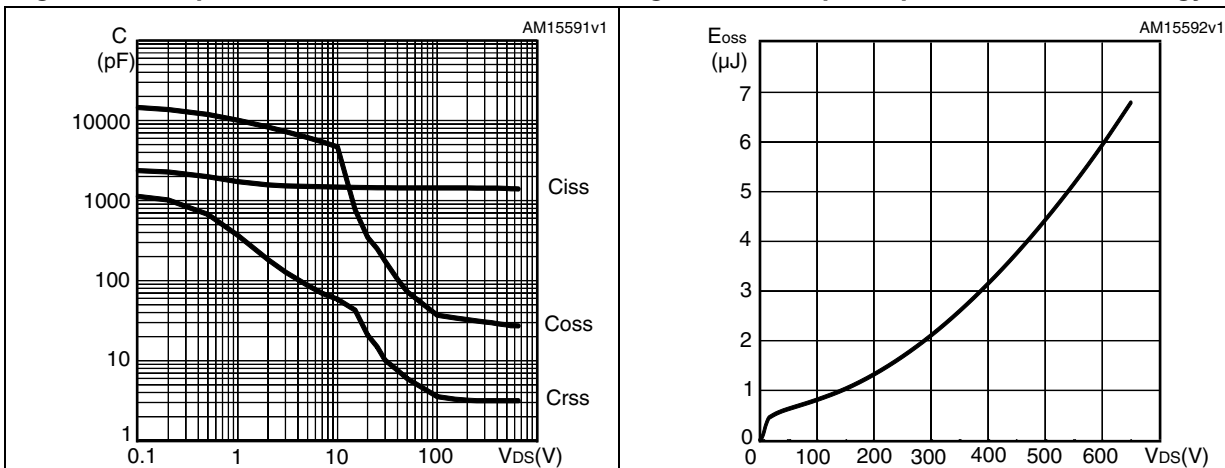


Figure 12. Normalized gate threshold voltage vs temperature Figure 13. Normalized on-resistance vs temperature

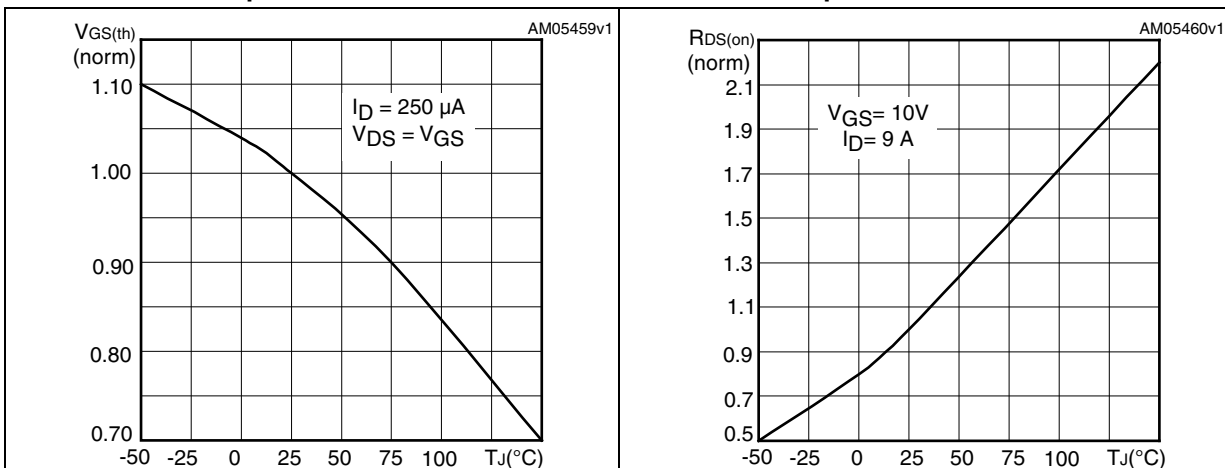


Figure 14. Normalized $B_{V_{DSS}}$ vs temperature

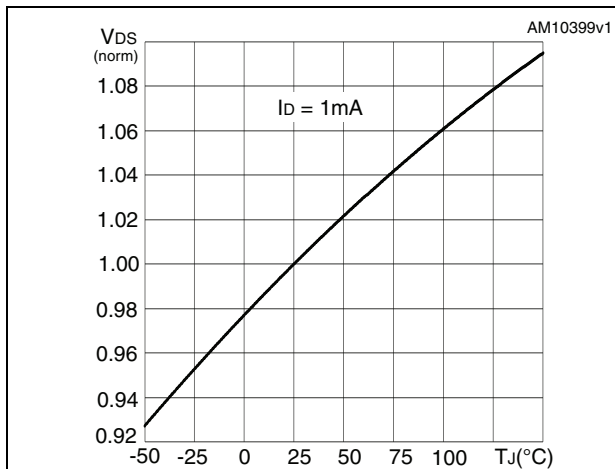


Figure 15. Drain-source diode forward characteristics

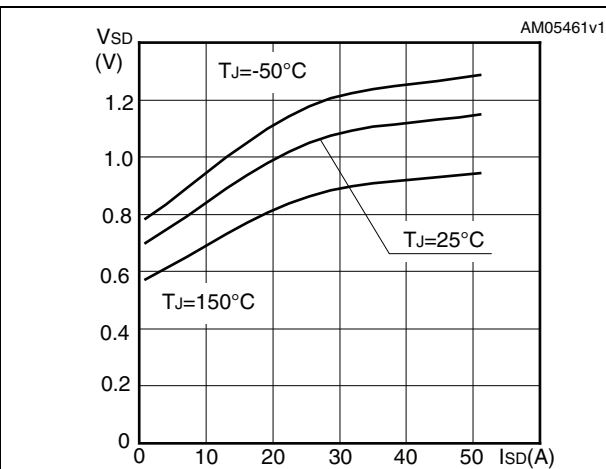
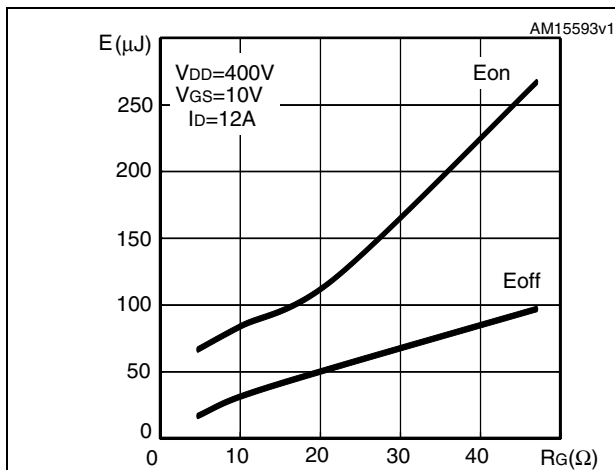


Figure 16. Switching losses vs gate resistance (1)



1. E_{on} including reverse recovery of a SiC diode

3 Test circuits

Figure 17. Switching times test circuit for resistive load

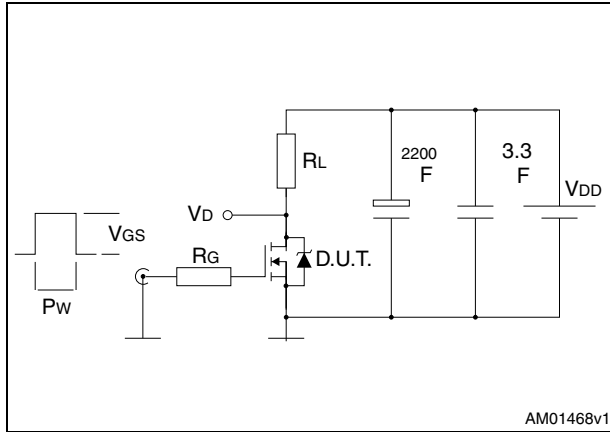


Figure 18. Gate charge test circuit

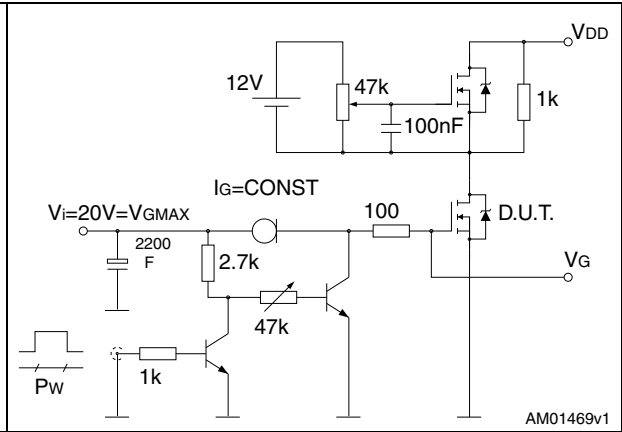


Figure 19. Test circuit for inductive load switching and diode recovery times

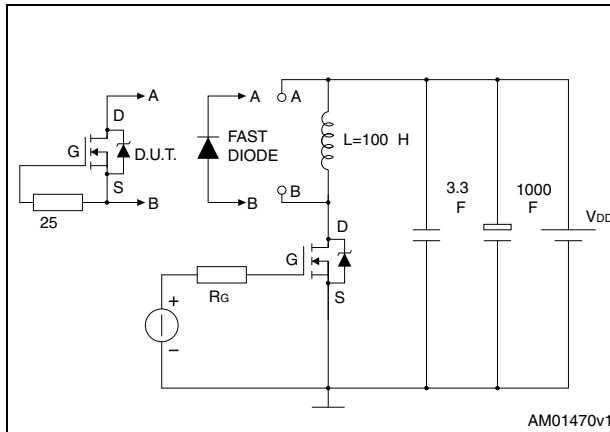


Figure 20. Unclamped inductive load test circuit

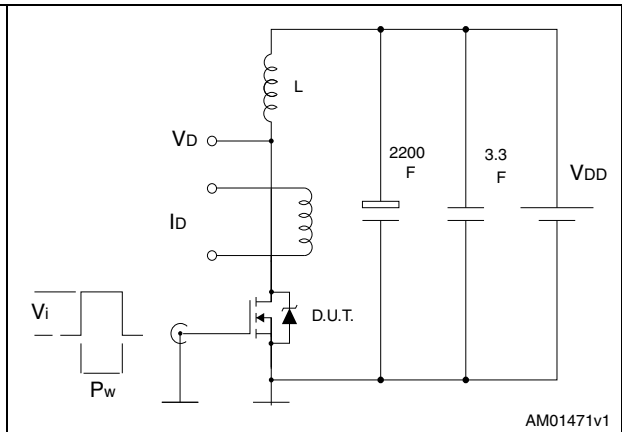


Figure 21. Unclamped inductive waveform

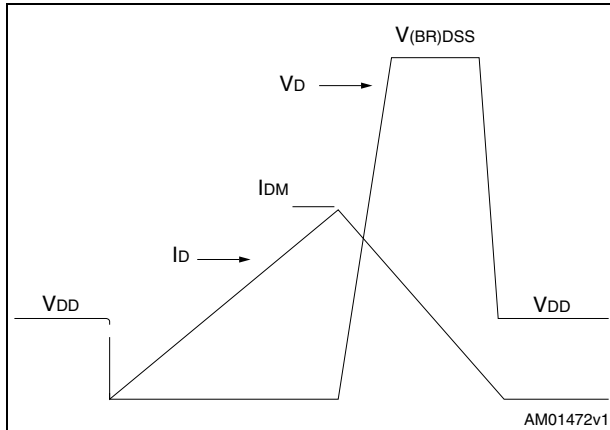
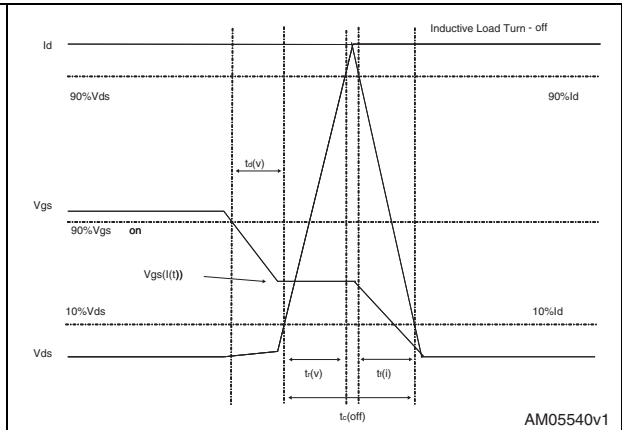


Figure 22. Switching time waveform



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 9. 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 23. D²PAK (TO-263) drawing

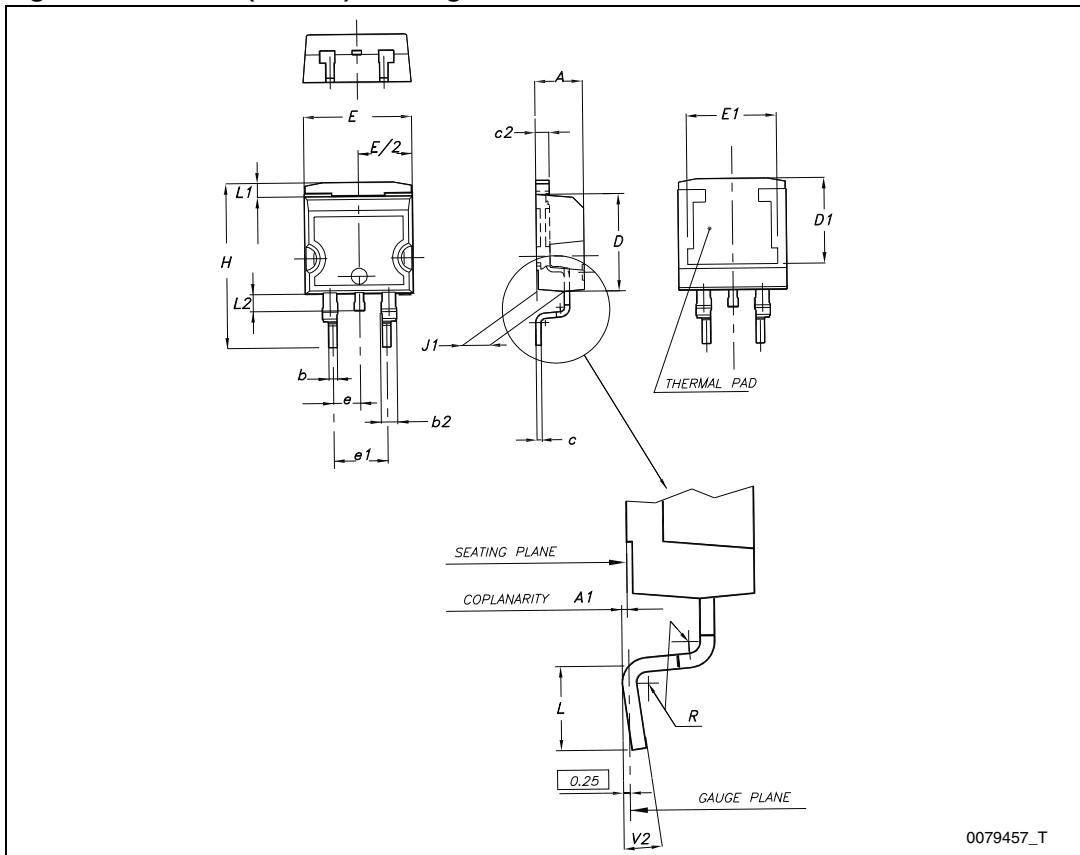
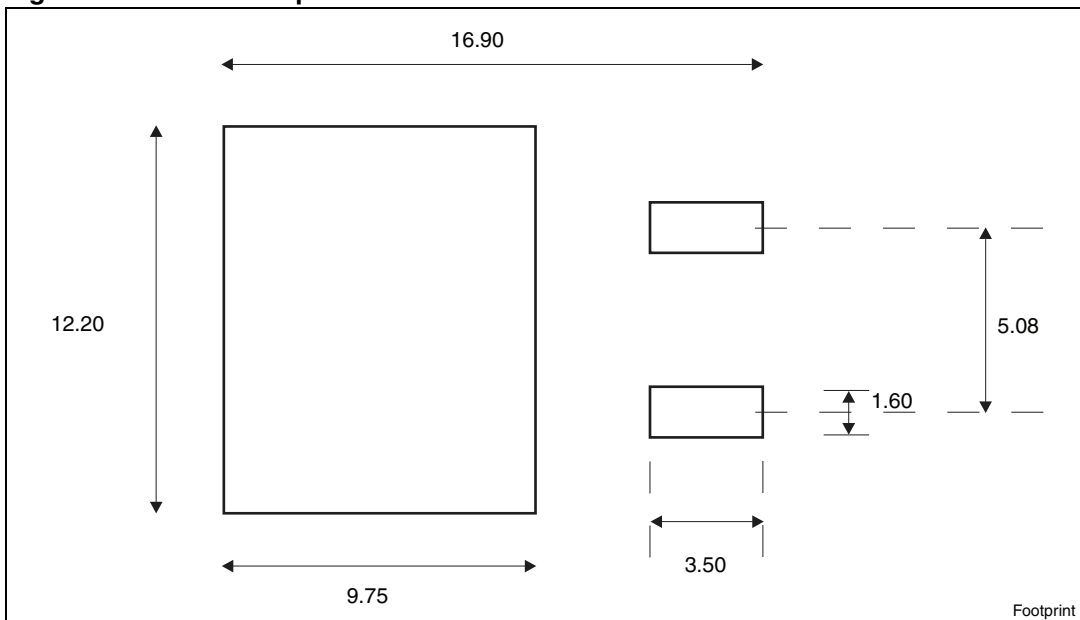


Figure 24. D²PAK footprint^(a)

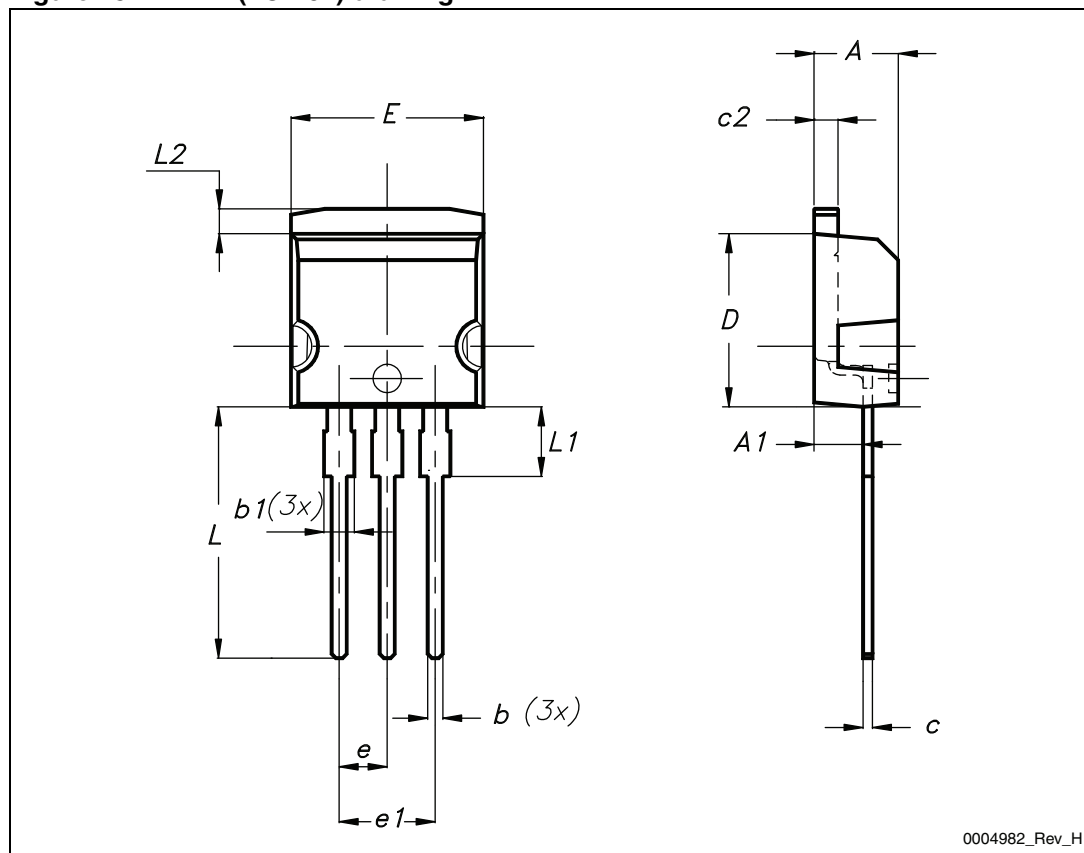


a. All dimension are in millimeters

Table 10. I²PAK (TO-262) mechanical data

| DIM. | mm. | | |
|------|------|-----|-------|
| | min. | typ | max. |
| A | 4.40 | | 4.60 |
| A1 | 2.40 | | 2.72 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.70 |
| c | 0.49 | | 0.70 |
| c2 | 1.23 | | 1.32 |
| D | 8.95 | | 9.35 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| E | 10 | | 10.40 |
| L | 13 | | 14 |
| L1 | 3.50 | | 3.93 |
| L2 | 1.27 | | 1.40 |

Figure 25. I²PAK (TO-262) drawing

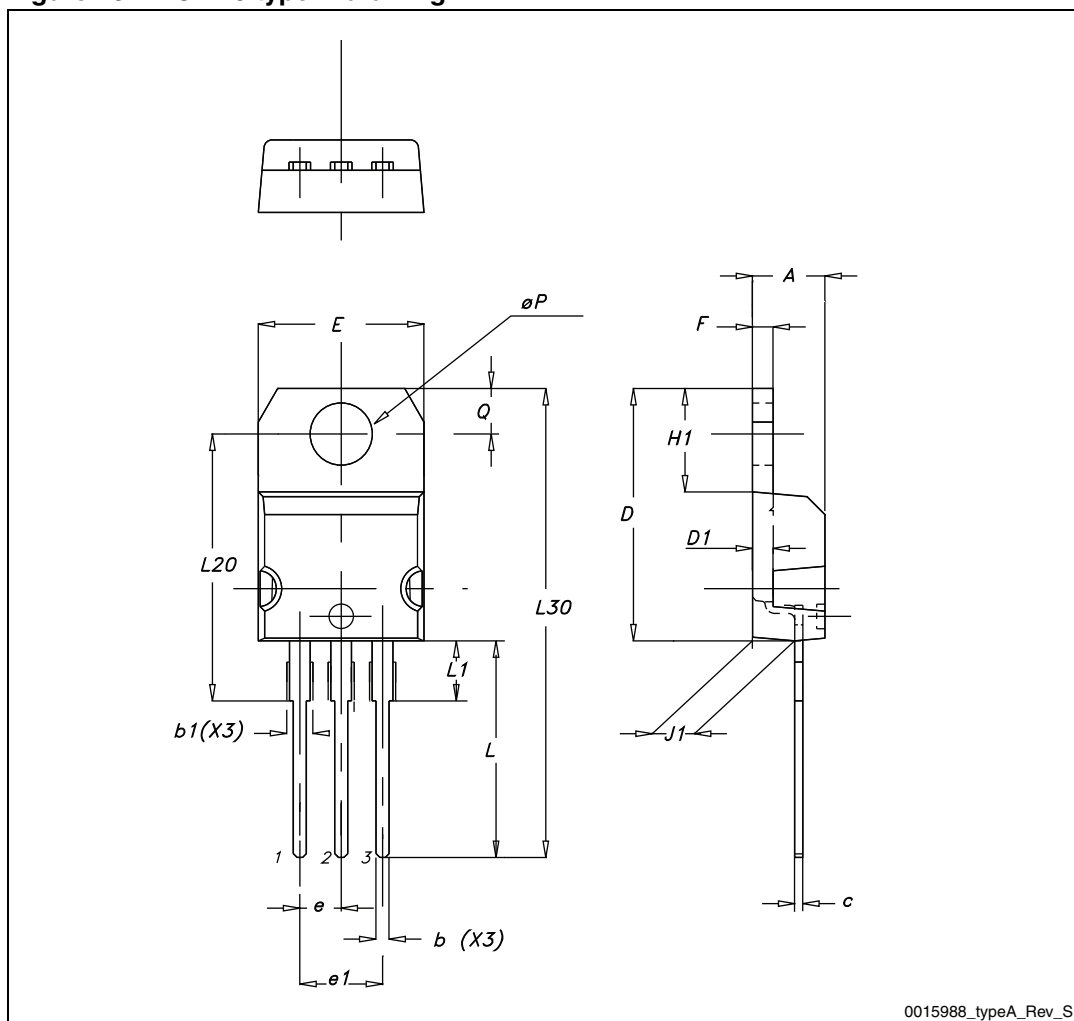


0004982_Rev_H

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

Figure 26. TO-220 type A drawing

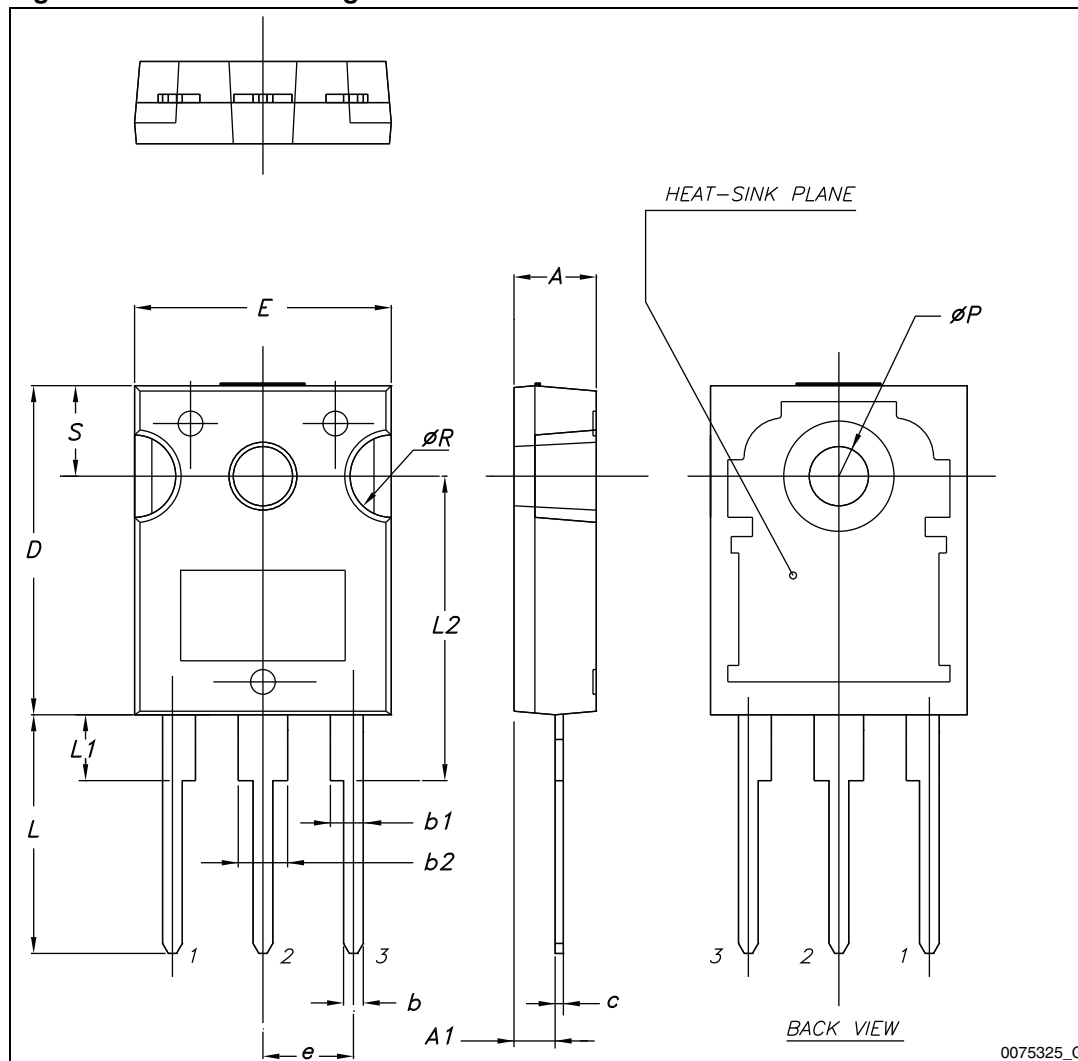


0015988_typeA_Rev_S

Table 12. 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

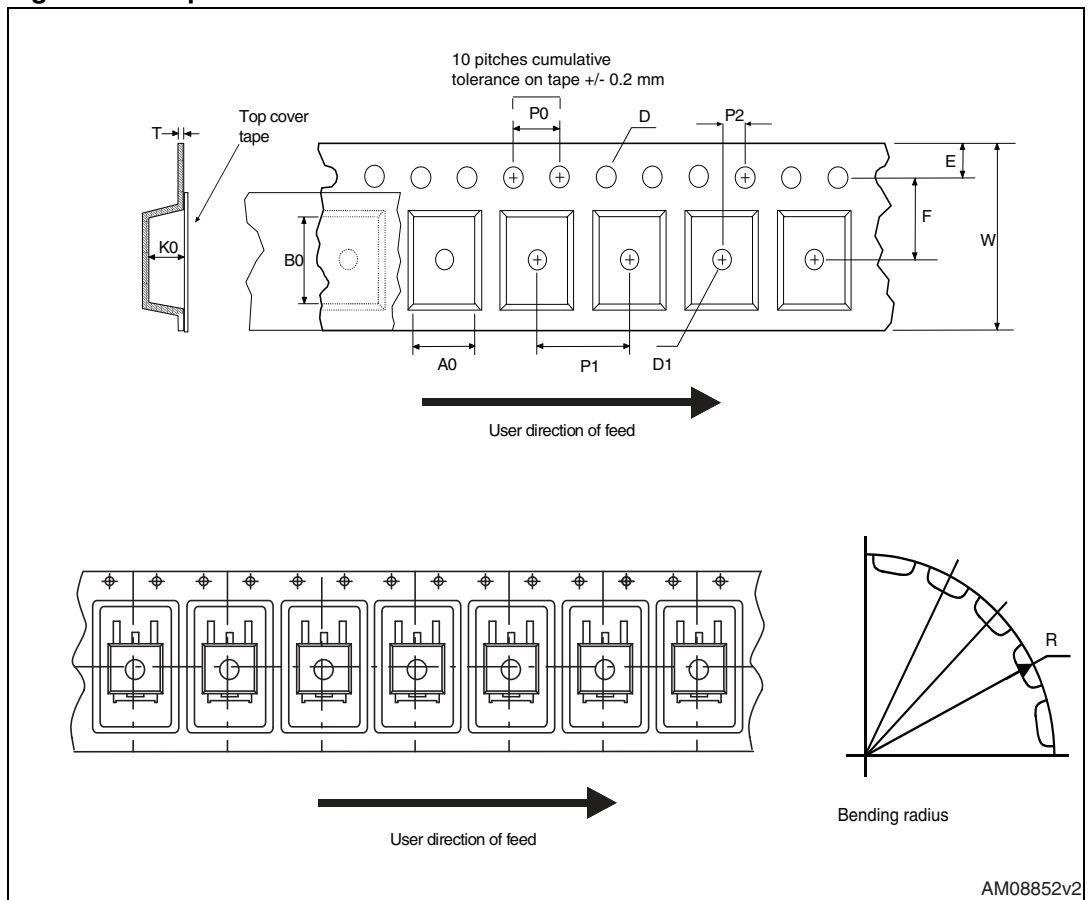


5 Packaging mechanical data

Table 13. D²PAK (TO-263) tape and reel mechanical data

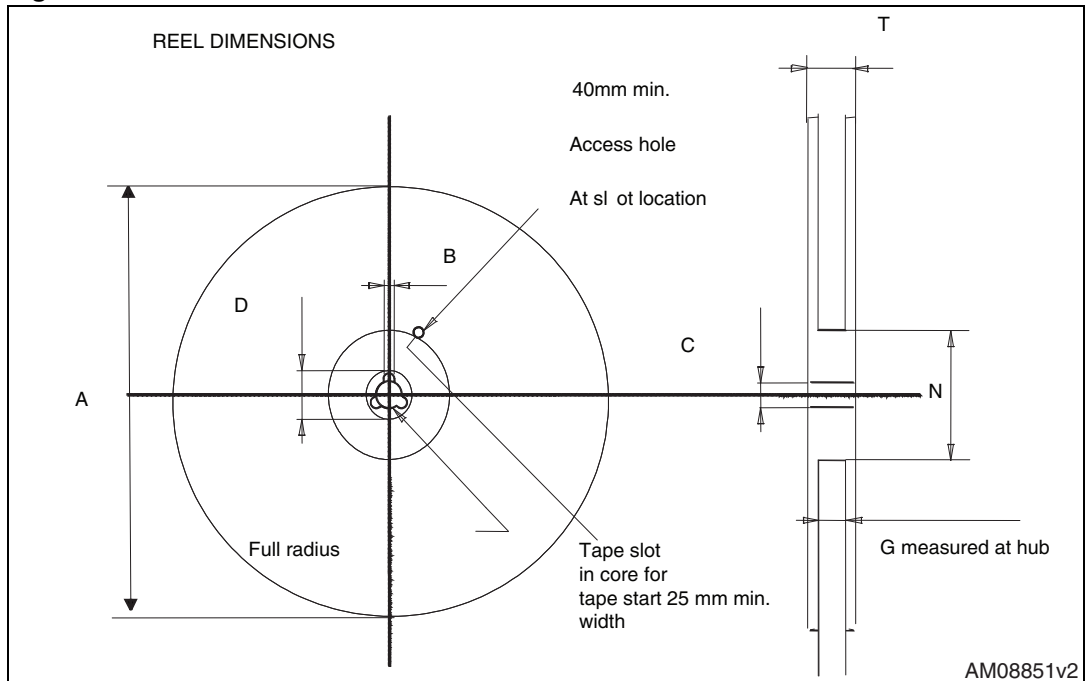
| Tape | | | Reel | | |
|------|------|------|------|----------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 10.5 | 10.7 | A | | 330 |
| B0 | 15.7 | 15.9 | B | 1.5 | |
| D | 1.5 | 1.6 | C | 12.8 | 13.2 |
| D1 | 1.59 | 1.61 | D | 20.2 | |
| E | 1.65 | 1.85 | G | 24.4 | 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



AM08852v2

Figure 29. Reel



AM08851v2

6 Revision history

Table 14. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 06-Mar-2012 | 1 | First release. |
| 01-Feb-2013 | 2 | <ul style="list-style-type: none">– The part numbers STF20N65M5 and STFI20N65M5 have been moved to a separate datasheet.– Added: part numbers STB20N65M5 and STI20N65M5– Modified: note 1 on Table 2, Table 4 values and typical values of Table 5, 6, 7, 8– Added: $R_{thj-pcb}$ and note 1 on Table 3– Updated: Section 4: Package mechanical data– Added: Section 2.1: Electrical characteristics (curves) |

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