

STB28N65M2, STF28N65M2, STP28N65M2, STW28N65M2

N-channel 650 V, 0.15 Ω typ., 20 A MDmesh™ M2 Power MOSFETs
in D²PAK, TO-220FP, TO-220 and TO-247 packages

Datasheet - preliminary data

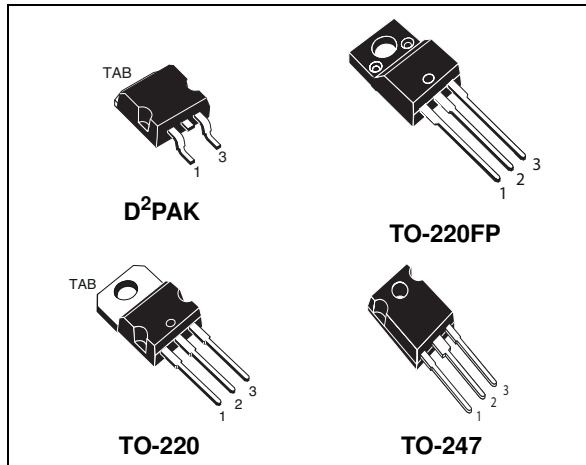
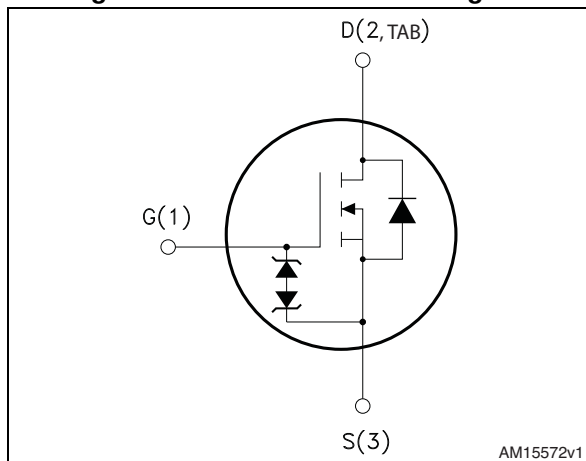


Figure 1. Internal schematic diagram



Features

| Order codes | V _{DS} | R _{DS(on)} max | I _D |
|-------------|-----------------|-------------------------|----------------|
| STB28N65M2 | 650 V | 0.18 Ω | 20 A |
| STF28N65M2 | | | |
| STP28N65M2 | | | |
| STW28N65M2 | | | |

- Extremely low gate charge
- Excellent output capacitance (C_{oss}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, the devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|--------------------|---------------|
| STB28N65M2 | 28N65M2 | D ² PAK | Tape and reel |
| STF28N65M2 | | TO-220FP | Tube |
| STP28N65M2 | | TO-220 | |
| STW28N65M2 | | TO-247 | |

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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 _{GS} | Gate-source voltage | ± 25 | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 20 | 20 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 13 | 13 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 80 | | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 170 | 30 | W |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C) | | 2500 | V |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 15 | | V/ns |
| dv/dt ⁽⁴⁾ | MOSFET dv/dt ruggedness | 50 | | |
| T _{stg} | Storage temperature | - 55 to 150 | | °C |
| T _j | Max. operating junction temperature | 150 | | |

1. Current limited by package.
2. Pulse width limited by safe operating area.
3. I_{SD} ≤ 20 A, di/dt ≤ 400 A/μs; V_{DS peak} < V_{(BR)DSS}; V_{DD}=520 V
4. V_{DS} ≤ 520 V

Table 3. Thermal data

| Symbol | Parameter | Value | | | | Unit |
|-------------------------------------|---|--------------------|----------|--------|--------|------|
| | | D ² PAK | TO-220FP | TO-220 | TO-247 | |
| R _{thj-case} | Thermal resistance junction-case max | 0.74 | 4.17 | 0.74 | | °C/W |
| R _{thj-pcb} ⁽¹⁾ | Thermal resistance junction-pcb max | 30 | | | | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient max | | 62.5 | | 50 | °C/W |

1. When mounted on 1 inch² FR-4, 2 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}) | 2.4 | A |
| E _{AS} | Single pulse avalanche energy (starting T _j = 25°C, I _D = I _{AR} ; V _{DD} = 50 V) | 760 | 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 | $V_{GS} = 0, I_D = 1\text{ mA}$ | 650 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0, V_{DS} = 650\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0, V_{DS} = 650\text{ V}$ $T_C = 125\text{ °C}$ | | | 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 | $V_{GS} = 10\text{ V}, I_D = 10\text{ A}$ | | 0.15 | 0.18 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------------------|-------------------------------|---|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}, f = 1\text{ MHz},$ $V_{GS} = 0$ | - | 1440 | - | pF |
| C_{oss} | Output capacitance | | - | 60 | - | pF |
| C_{rss} | Reverse transfer capacitance | | - | 2 | - | pF |
| $C_{oss\text{ eq}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0\text{ to }520\text{ V}$ | - | 307 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz open drain}$ | - | 4.9 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 520\text{ V}, I_D = 20\text{ A},$ $V_{GS} = 10\text{ V}$ (see Figure 19) | - | 35 | - | nC |
| Q_{gs} | Gate-source charge | | - | 6 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 15 | - | 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

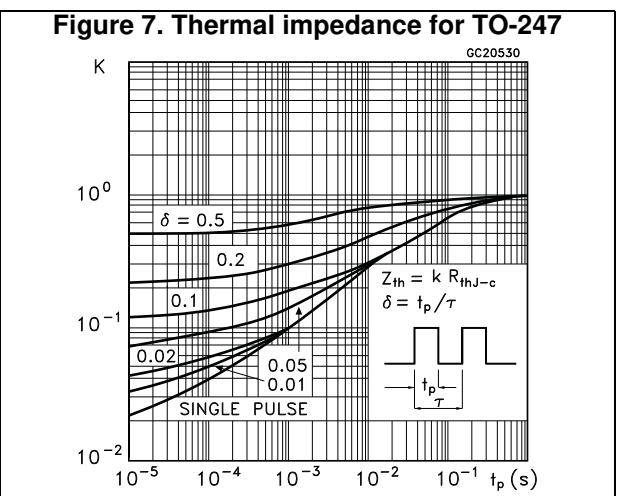
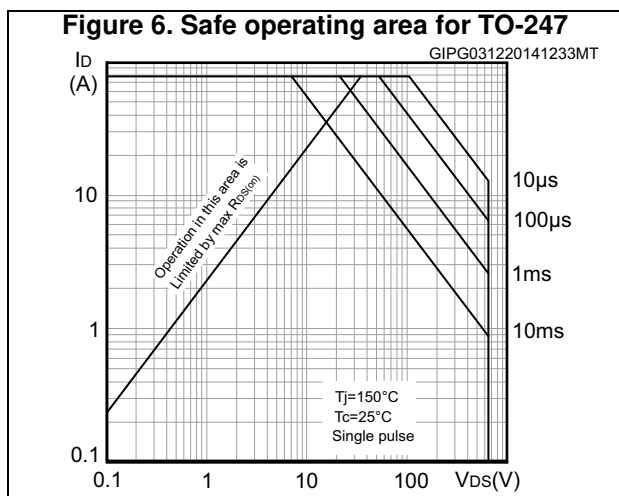
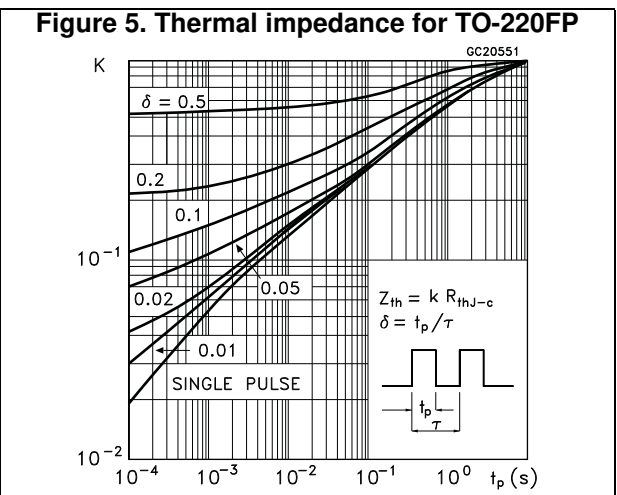
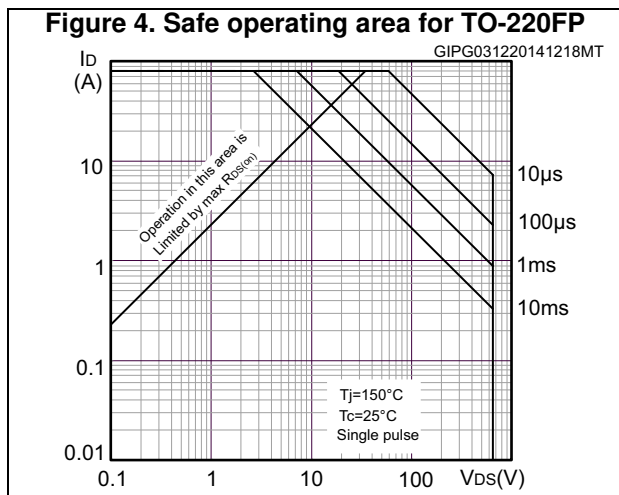
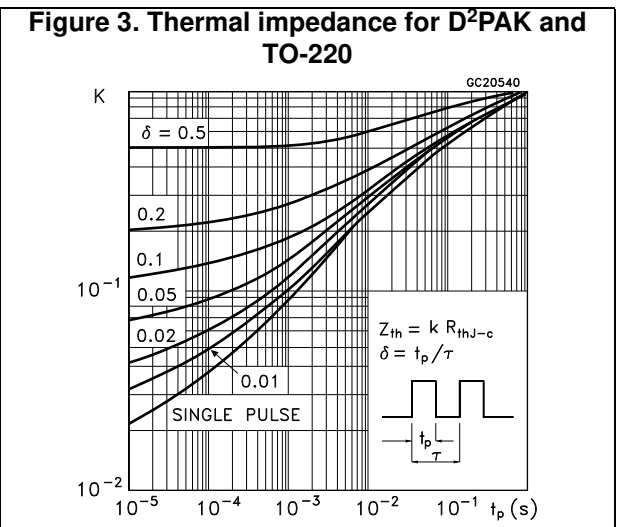
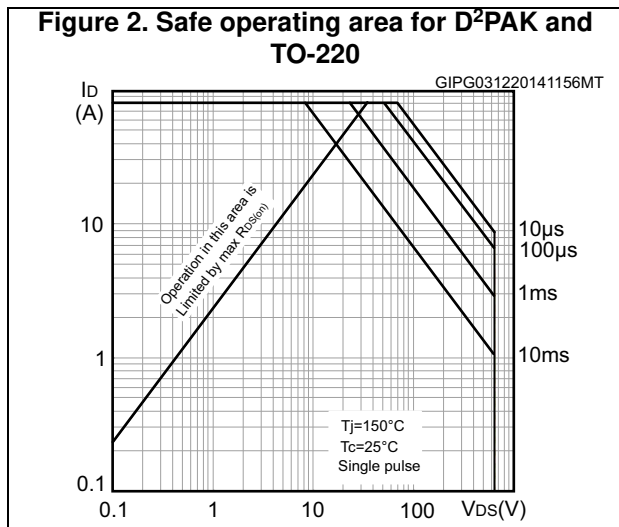
| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 325\text{ V}, I_D = 10\text{ A},$ $R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see Figure 18 and Figure 23) | - | 13.4 | - | ns |
| t_r | Rise time | | - | 10 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 59 | - | ns |
| t_f | Fall time | | - | 8.8 | - | ns |

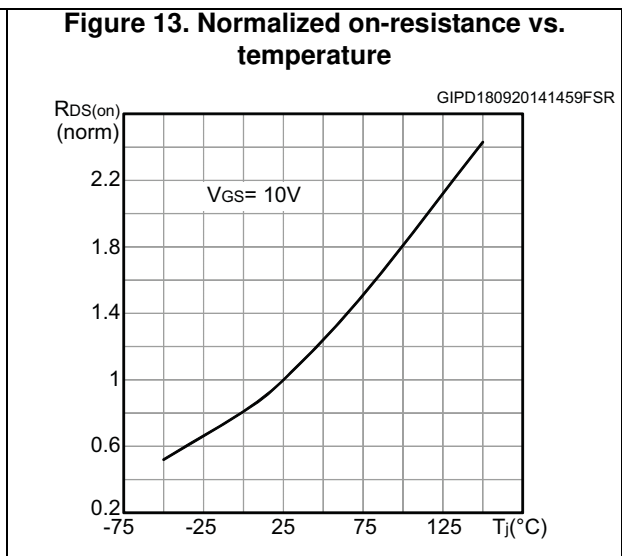
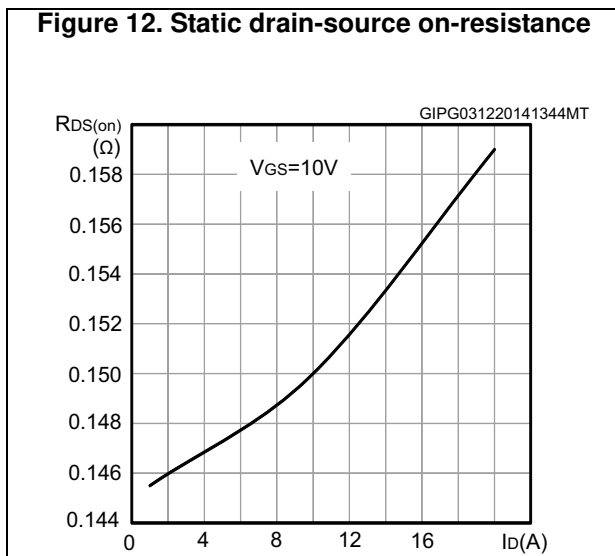
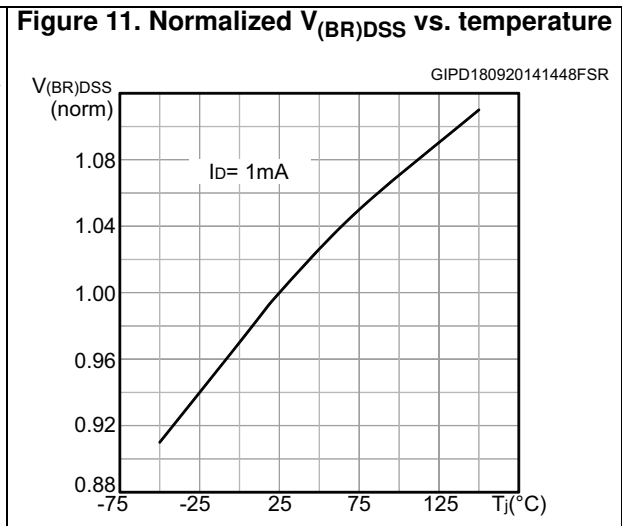
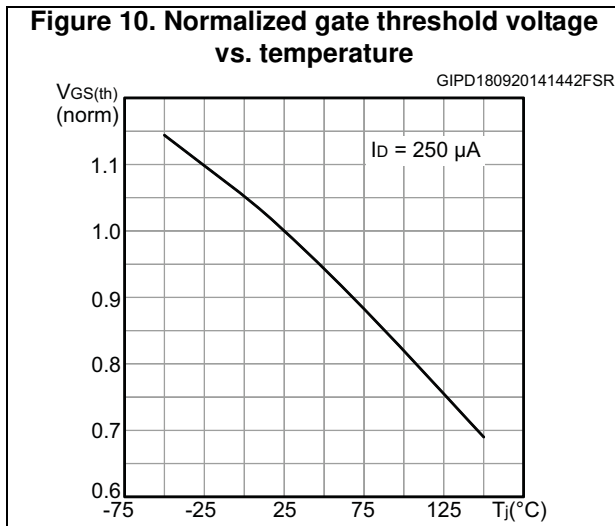
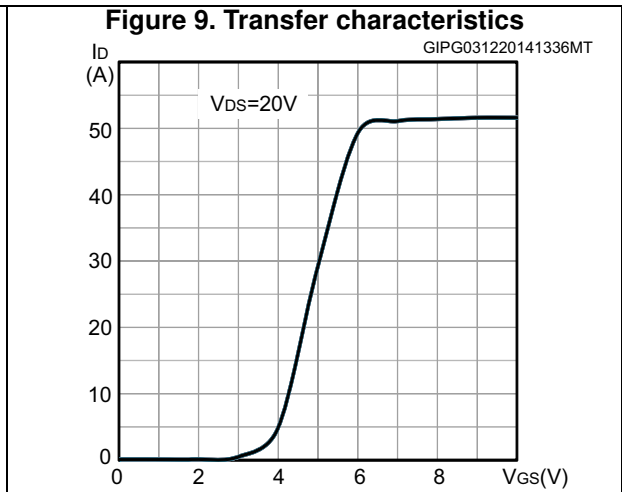
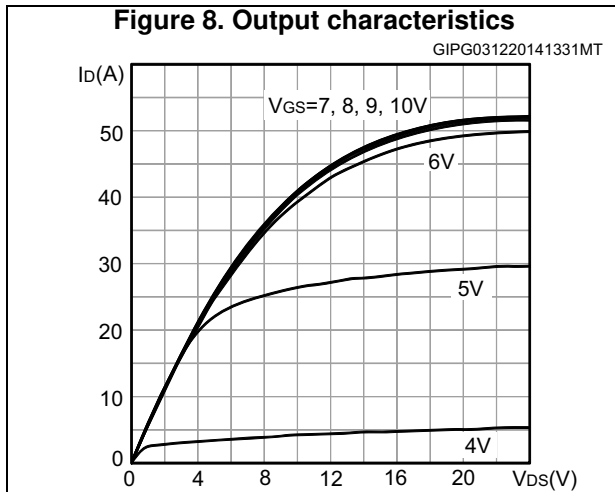
Table 8. Source drain diode

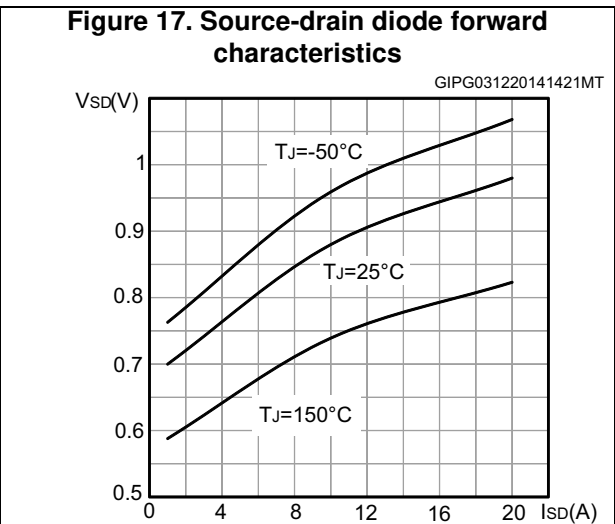
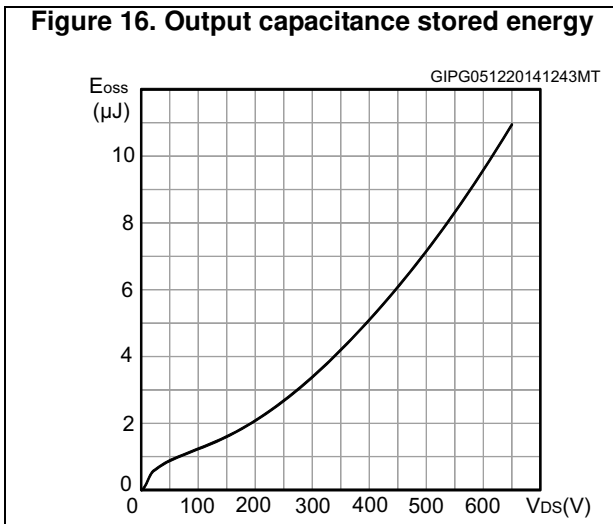
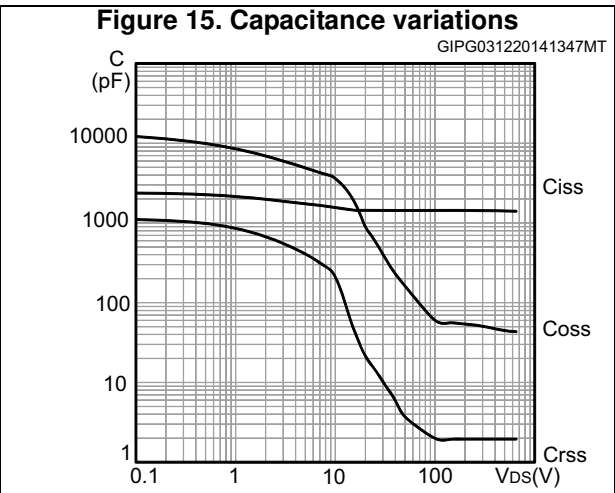
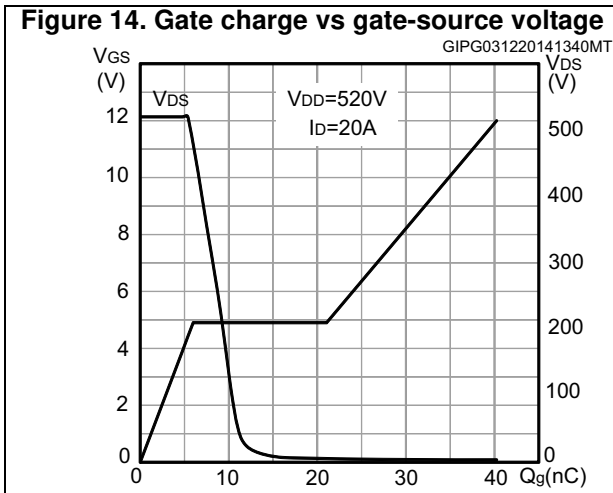
| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 20 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 80 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $V_{GS} = 0, I_{SD} = 20 \text{ A}$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 20 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see Figure 20) | - | 384 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 5.7 | | μC |
| I_{RRM} | Reverse recovery current | | - | 30 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 20 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}, T_j = 150 \text{ }^\circ\text{C}$ (see Figure 20) | - | 544 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 8.2 | | μC |
| I_{RRM} | Reverse recovery current | | - | 30.5 | | A |

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

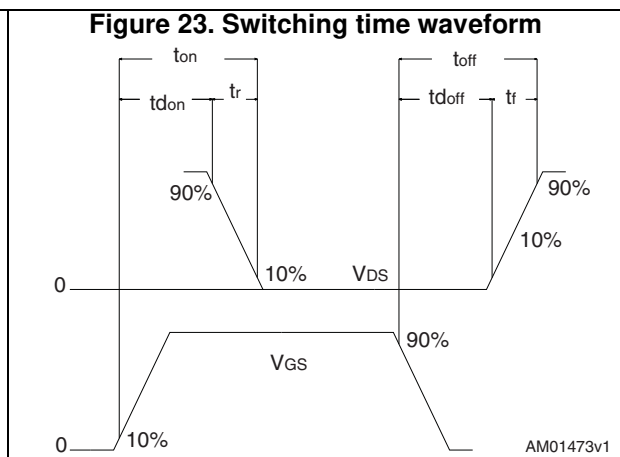
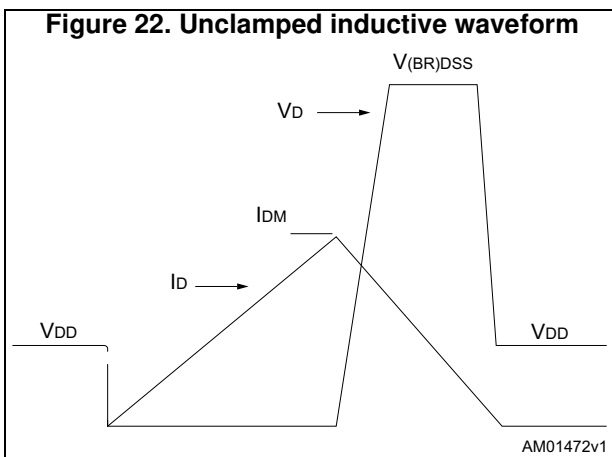
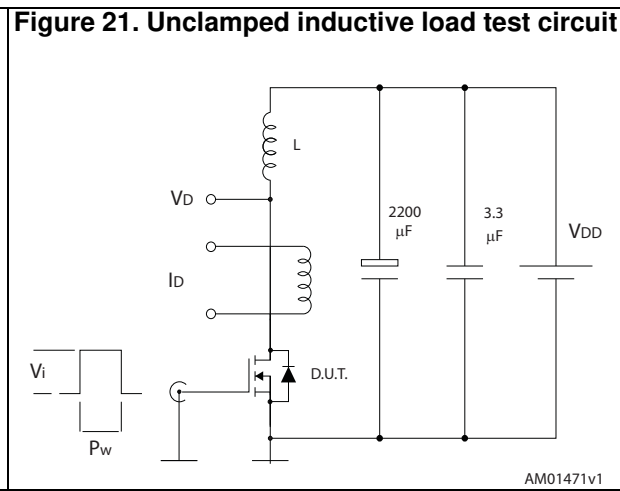
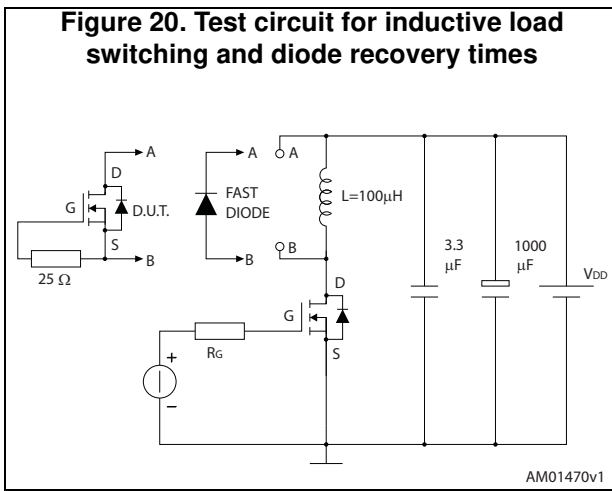
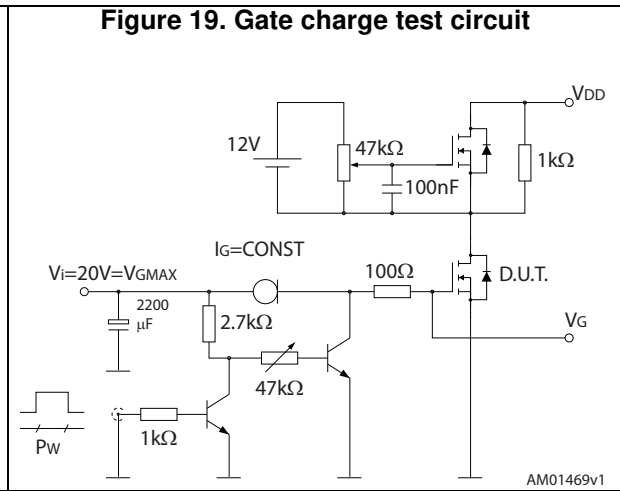
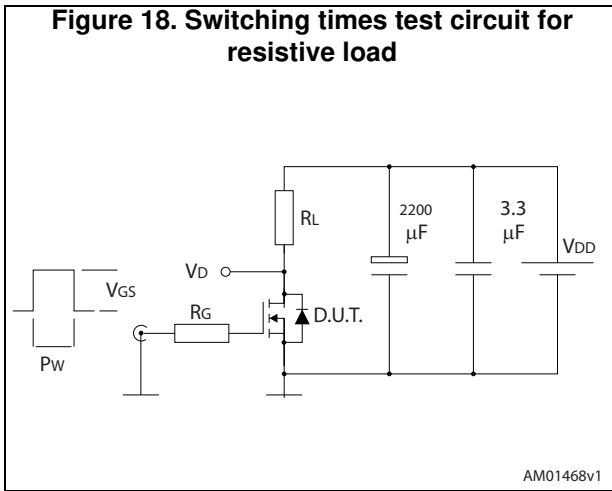
2.1 Electrical characteristics (curves)







3 Test circuits



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 D²PAK, STB28N65M2

Figure 24. D²PAK drawing

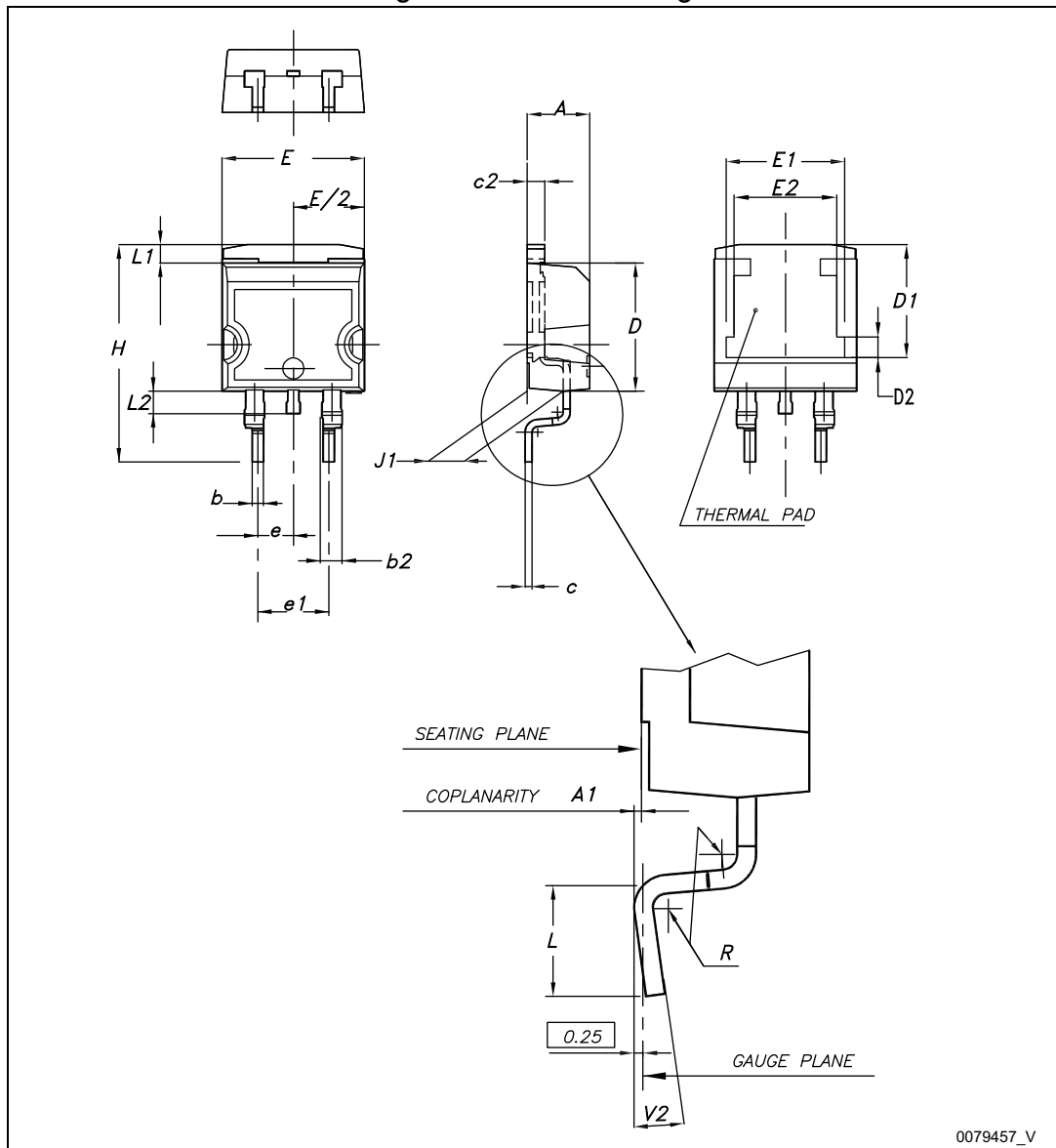
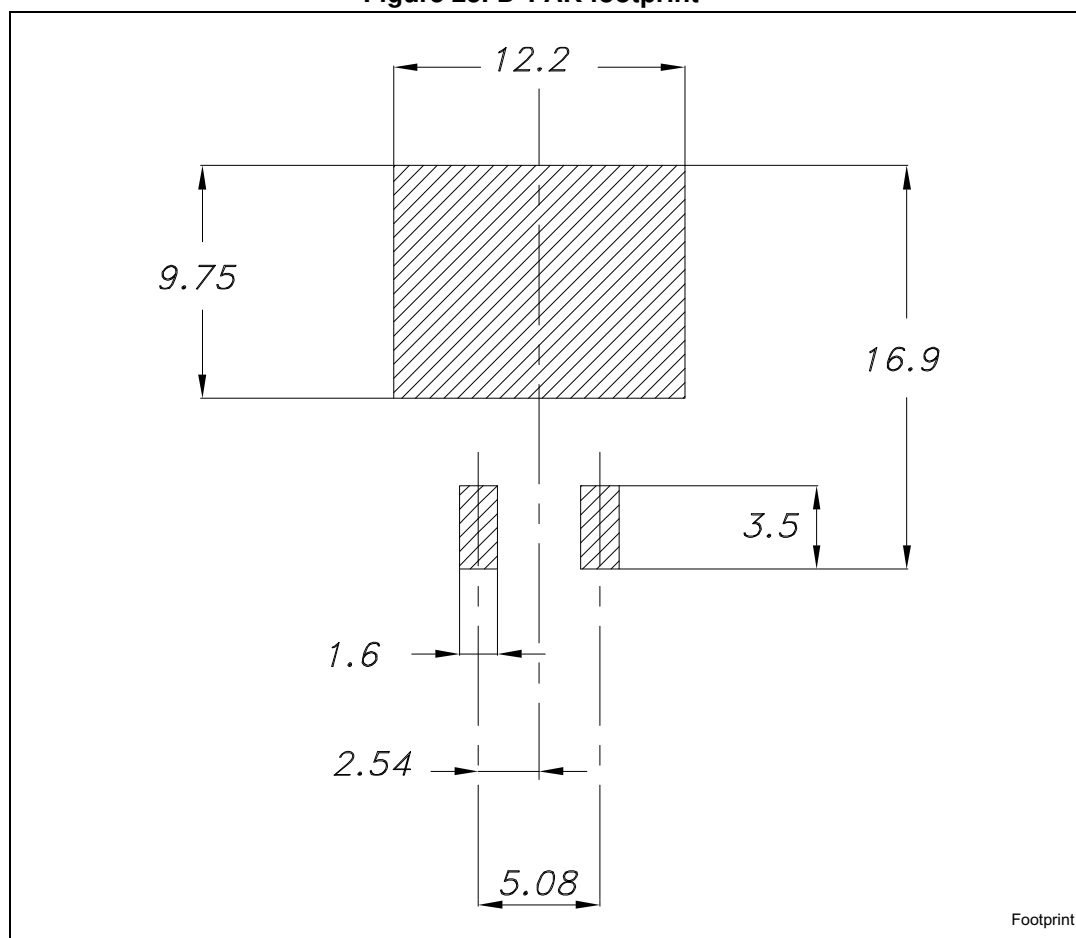


Table 9. D²PAK mechanical data

| 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 | 7.75 | 8.00 |
| D2 | 1.10 | 1.30 | 1.50 |
| E | 10 | | 10.40 |
| E1 | 8.50 | 8.70 | 8.90 |
| E2 | 6.85 | 7.05 | 7.25 |
| 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° |

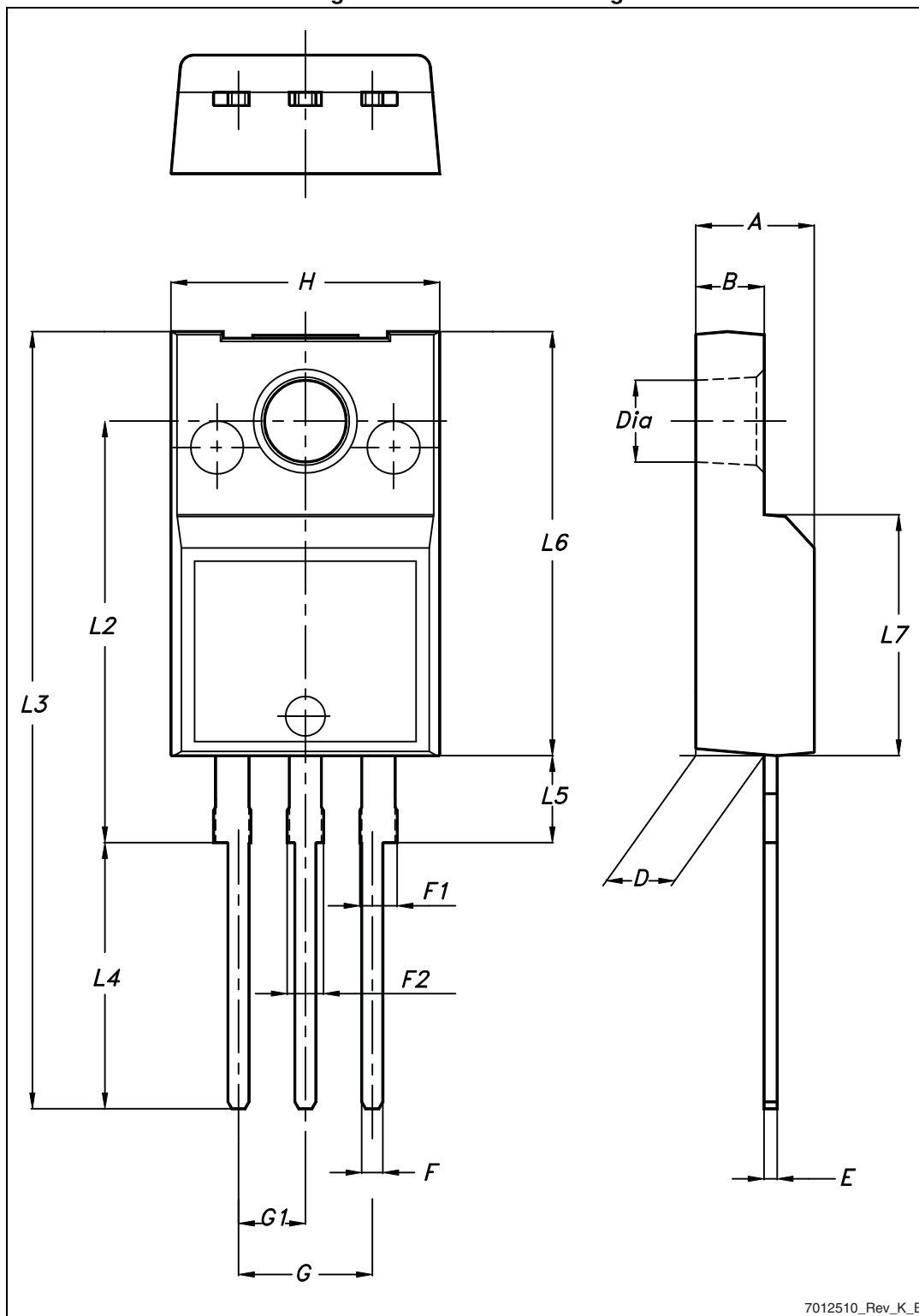
Figure 25. D²PAK footprint (a)



a. All dimensions are in millimeters

4.2 TO-220FP, STF28N65M2

Figure 26. 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 |

4.3 TO-220, STP28N65M2

Figure 27. TO-220 type A drawing

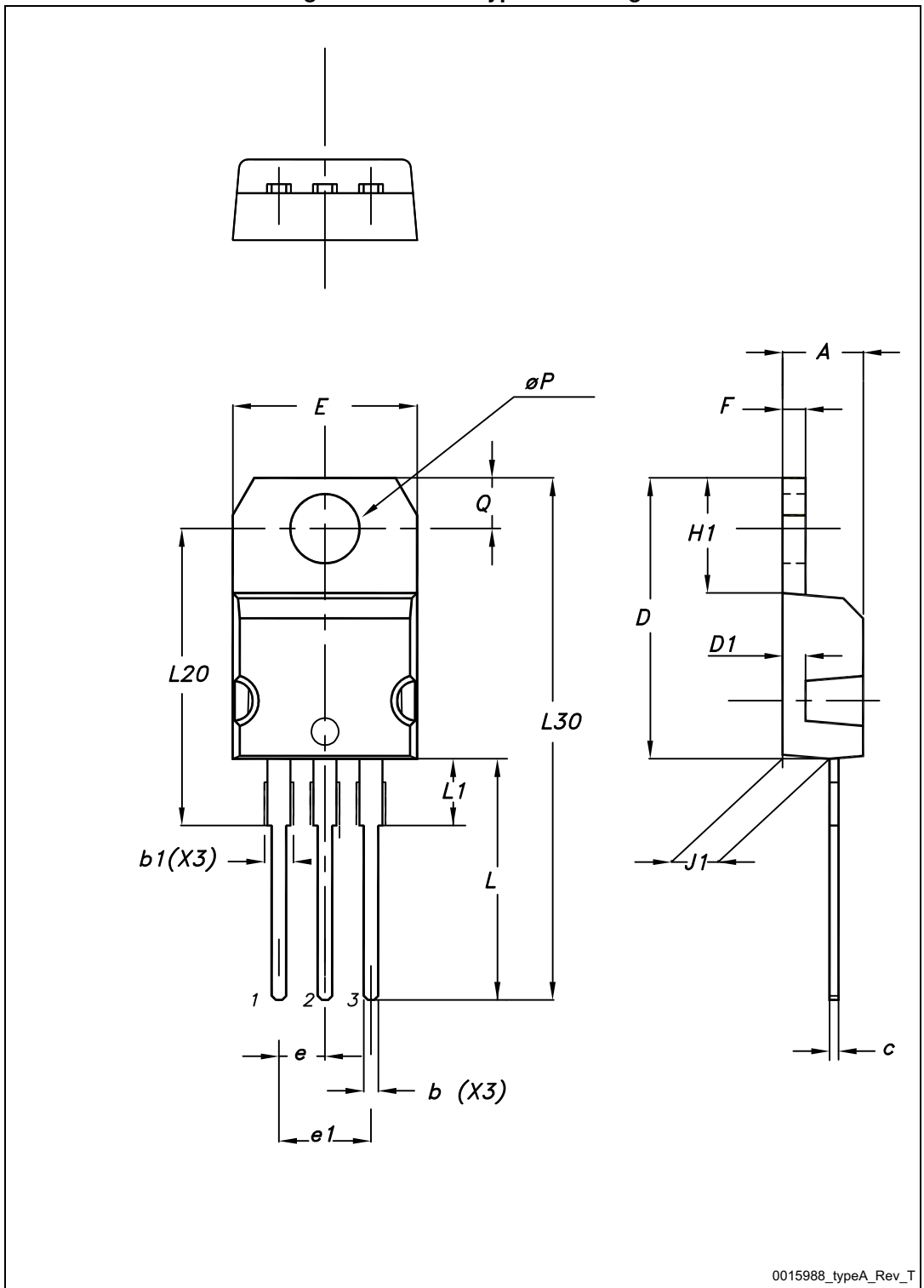


Table 11. TO-220 type A mechanical data

| 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 |

4.4 TO-247, STW28N65M2

Figure 28. TO-247 drawing

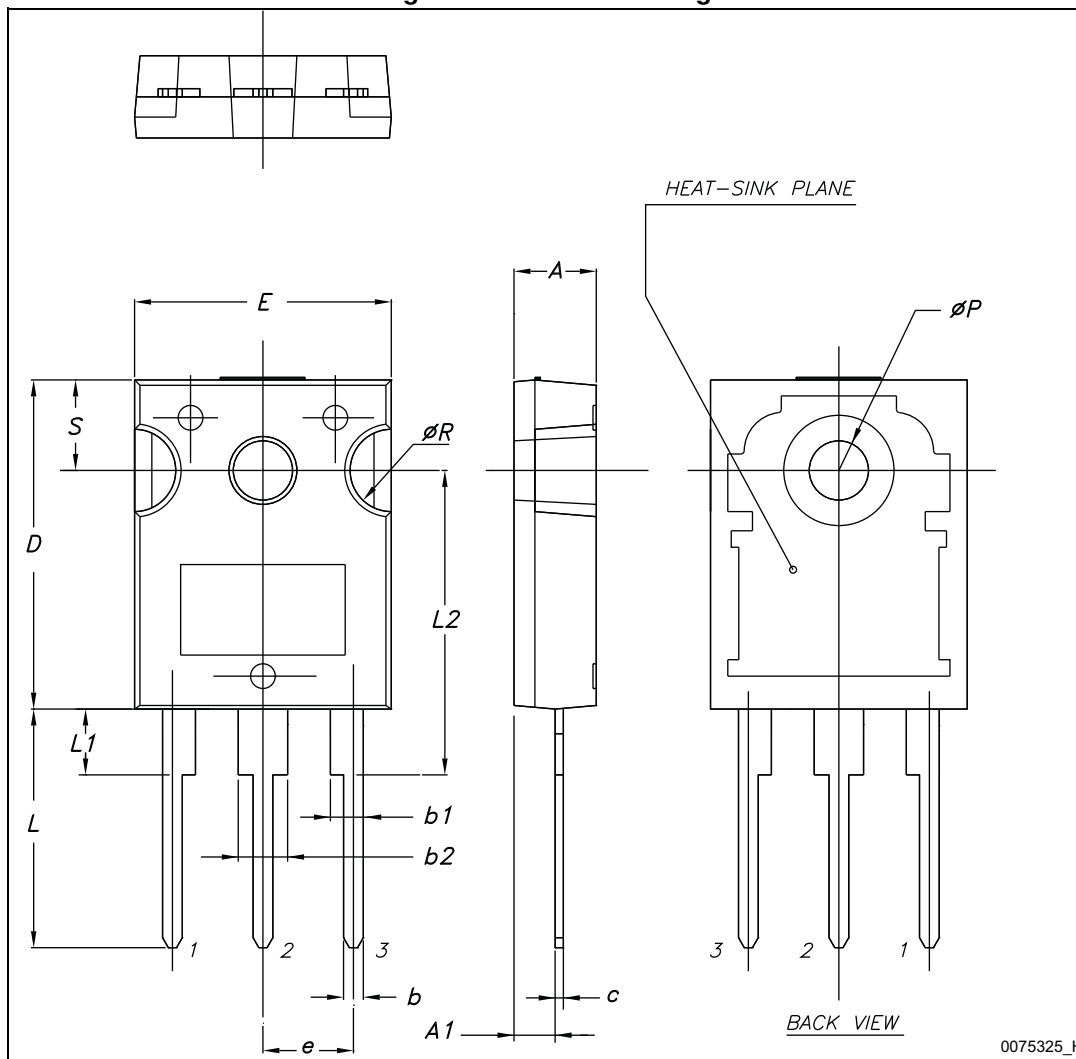


Table 12. TO-247 mechanical data

| 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 |

5 Packing mechanical data

Figure 29. Tape for D²PAK

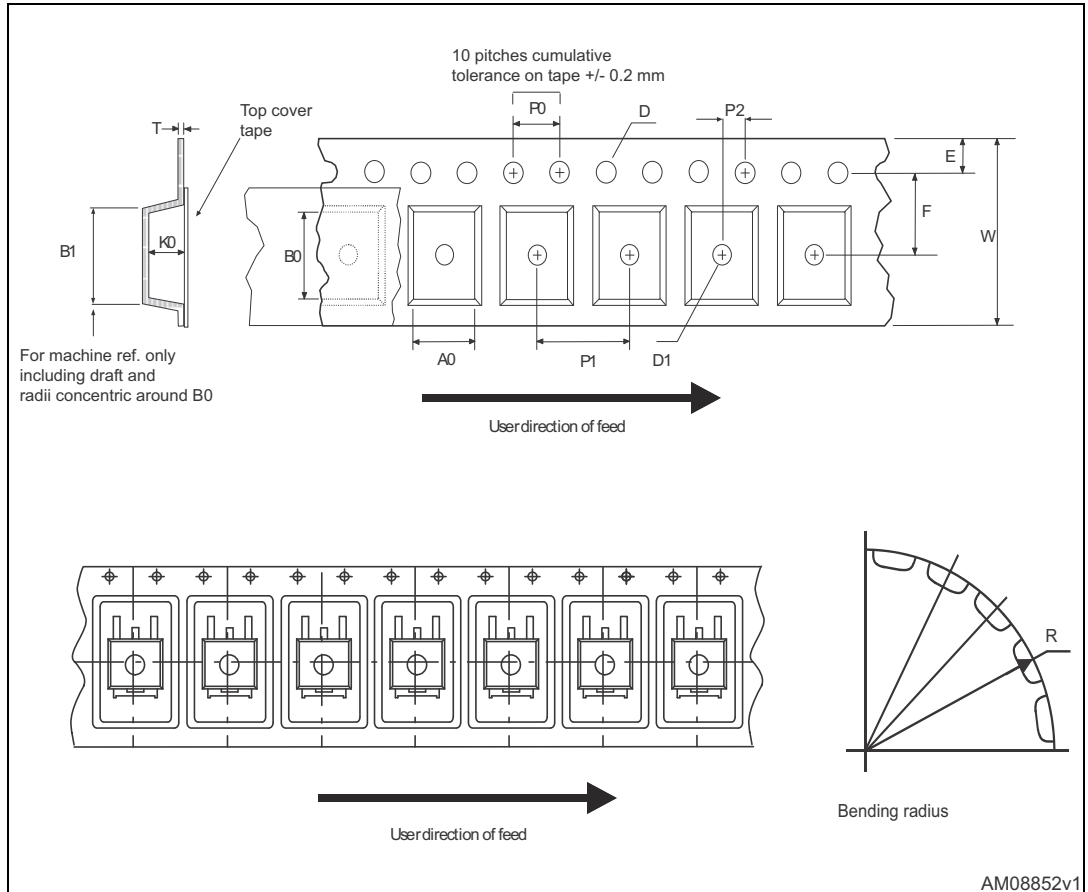


Figure 30. Reel for D²PAK

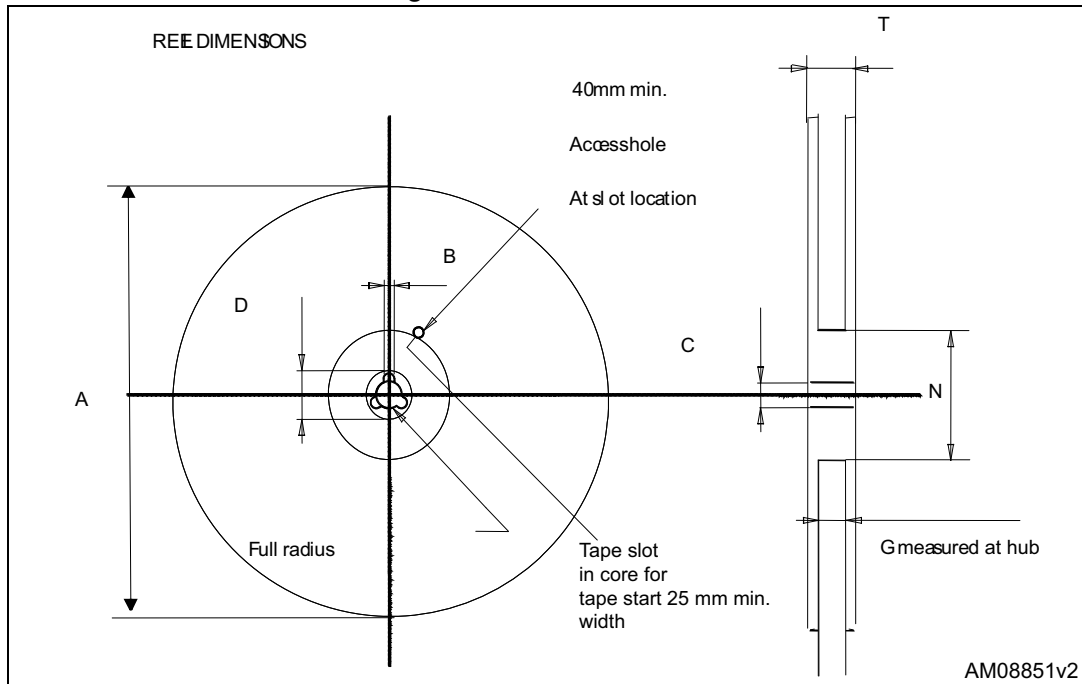


Table 13. D²PAK tape and reel mechanical data

| 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 | | | |

6 Revision history

Table 14. Document revision history

| Date | Revision | Changes |
|-------------|----------|----------------|
| 09-Dec-2014 | 1 | First release. |

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