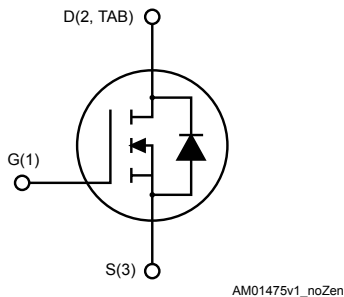
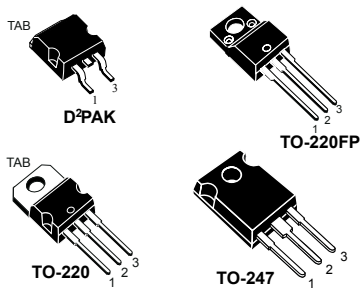




THE DATASHEET OF STF31N65M5



N-channel 650 V, 0.124 Ω , 22 A, MDmesh M5 Power MOSFETs in D²PAK, TO-220FP, TO-220 and TO-247 packages



Features

| Order code | $V_{DS} @ T_{JMAX}$ | $R_{DS(on)}$ max. | I_D | Package |
|------------|---------------------|-------------------|-------|--------------------|
| STB31N65M5 | 710 V | 0.148 Ω | 22 A | D ² PAK |
| STF31N65M5 | | | | TO-220FP |
| STP31N65M5 | | | | TO-220 |
| STW31N65M5 | | | | TO-247 |

- Extremely low $R_{DS(on)}$
- Low gate charge and input capacitance
- Excellent switching performance
- 100% avalanche tested

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs based on the MDmesh M5 innovative vertical process technology combined with the well-known PowerMESH horizontal layout. The resulting products offer extremely low on-resistance, making them particularly suitable for applications requiring high power and superior efficiency.



Product status link

[STB31N65M5](#)

[STF31N65M5](#)

[STP31N65M5](#)

[STW31N65M5](#)

1 Electrical ratings

Table 1. 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 | 22 | 22 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 13.9 | 13.9 ⁽¹⁾ | A |
| I _{DM} ⁽²⁾ | Drain current (pulsed) | 88 | 88 ⁽¹⁾ | A |
| P _{TOT} | Total power dissipation at T _C = 25 °C | 150 | 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 _J | Operating junction temperature range | -55 to 150 | | °C |
| T _{stg} | Storage temperature range | | | |

1. Limited by package.
2. Limited by maximum junction temperature.
3. I_{SD} ≤ 22 A, di/dt ≤ 400 A/μs; V_{DS} (peak) < V_{(BR)DSS}; V_{DD} = 400 V.
4. V_{DS} ≤ 480 V.

Table 2. Thermal data

| Symbol | Parameter | Value | | | | Unit |
|-------------------------------------|-------------------------------------|--------------------|--------|----------|--------|------|
| | | D ² PAK | TO-220 | TO-220FP | TO-247 | |
| R _{thj-case} | Thermal resistance junction-case | 0.83 | | 4.17 | 0.83 | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient | | 62.5 | | 50 | °C/W |
| R _{thj-pcb} ⁽¹⁾ | Thermal resistance junction-pcb | 30 | | | | °C/W |

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

Table 3. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------|--|-------|------|
| I_{AR} | Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax}) | 5 | A |
| E_{AS} | Single pulse avalanche energy (starting $T_j = 25\text{ °C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$) | 410 | mJ |

2 Electrical characteristics

$T_C = 25\text{ }^\circ\text{C}$ unless otherwise specified

Table 4. On/off-state

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------------------|---|------|-------|-----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$ | 650 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}, V_{DS} = 650\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0\text{ V}, V_{DS} = 650\text{ V},$ $T_C = 125\text{ }^\circ\text{C}$ ⁽¹⁾ | | | 100 | μA |
| I_{GSS} | Gate body leakage current | $V_{DS} = 0\text{ V}, V_{GS} = \pm 25\text{ V}$ | | | ± 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 | $V_{GS} = 10\text{ V}, I_D = 11\text{ A}$ | | 0.124 | 0.148 | Ω |

1. Defined by design, not subject to production test.

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|---------------------------------------|---|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}, f = 1\text{ MHz},$ $V_{GS} = 0\text{ V}$ | - | 1865 | - | pF |
| C_{oss} | Output capacitance | | - | 45 | - | pF |
| C_{rss} | Reverse transfer capacitance | | - | 4.2 | - | pF |
| $C_{o(tr)}$ ⁽¹⁾ | Equivalent capacitance time related | $V_{GS} = 0\text{ V},$ | - | 146 | - | pF |
| $C_{o(er)}$ ⁽²⁾ | Equivalent capacitance energy related | $V_{DS} = 0\text{ to }520\text{ V}$ | - | 43 | - | pF |
| R_g | Intrinsic gate resistance | $f = 1\text{ MHz}$ | - | 2.8 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 520\text{ V}, I_D = 11\text{ A}$ | - | 45 | - | nC |
| Q_{gs} | Gate-source charge | $V_{GS} = 0\text{ to }10\text{ V}$ | - | 11.5 | - | nC |
| Q_{gd} | Gate-drain charge | (see Figure 18. Test circuit for gate charge behavior) | - | 20 | - | nC |

- $C_{o(tr)}$ 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} .
- $C_{o(er)}$ 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 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|--------------------|--|------|------|------|------|
| $t_{d(v)}$ | Voltage delay time | $V_{DD} = 400\text{ V}$, $I_D = 14\text{ A}$, | - | 46 | - | ns |
| $t_{r(v)}$ | Voltage rise time | $R_G = 4.7\ \Omega$ | - | 8 | - | ns |
| $t_{f(i)}$ | Current fall time | $V_{GS} = 10\text{ V}$ | - | 8.5 | - | ns |
| $t_{c(off)}$ | Crossing time | (see Figure 19. Test circuit for inductive load switching and diode recovery times and Figure 22. Switching time waveform) | - | 11 | - | ns |

Table 7. Source-drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 22 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 88 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 22\text{ A}$, $V_{GS} = 0\text{ V}$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 22\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times) | - | 336 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 5 | | μC |
| I_{RRM} | Reverse recovery current | | - | 30 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 22\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, | - | 406 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 100\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times) | - | 6 | | μC |
| I_{RRM} | Reverse recovery current | | - | 31 | | A |

1. Pulse width limited by safe operating area

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

2.1 Electrical characteristics (curves)

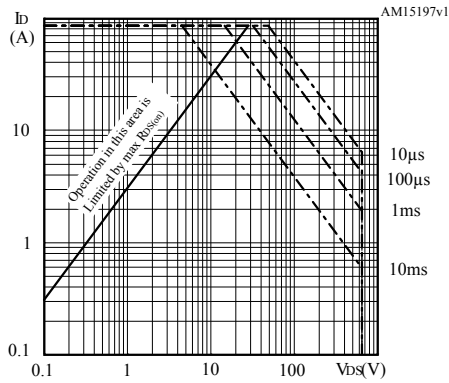
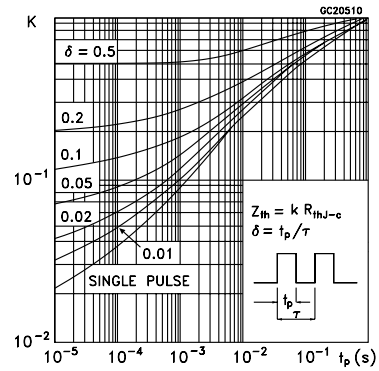
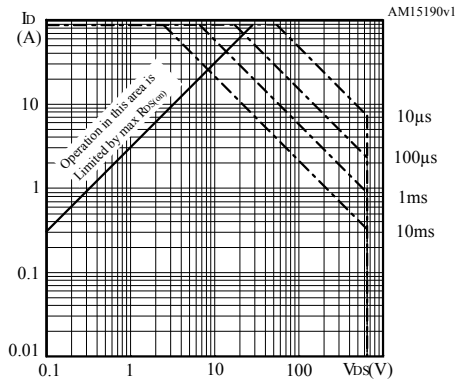
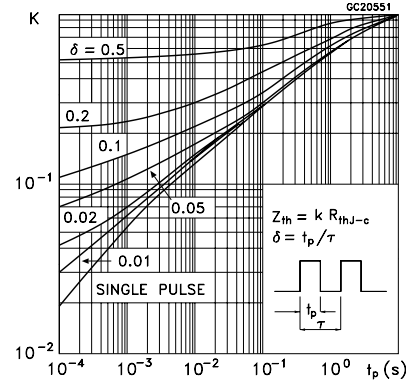
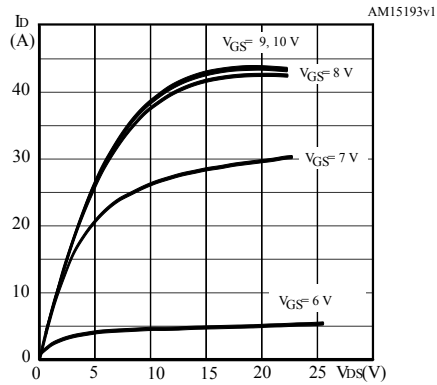
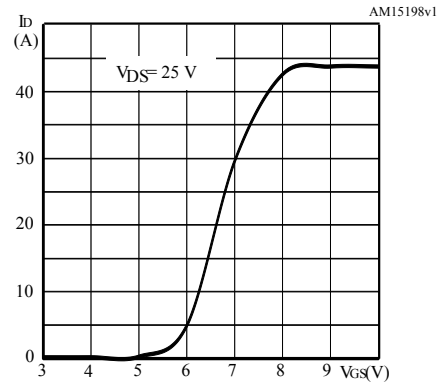
Figure 1. Safe operating area for D²PAK, TO-220 and TO-247

Figure 2. Thermal impedance for D²PAK, TO-220 and TO-247

Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

Figure 5. Output characteristics

Figure 6. Transfer characteristics


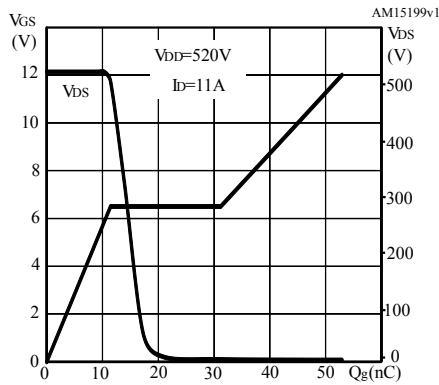
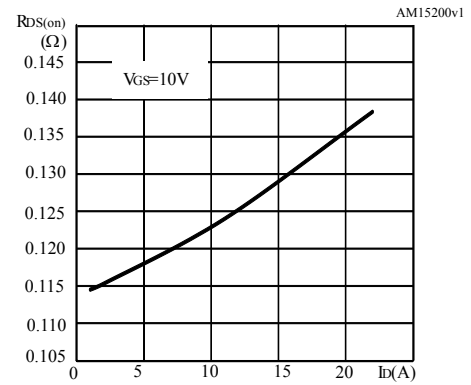
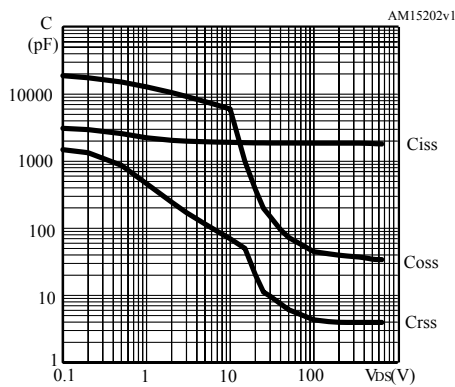
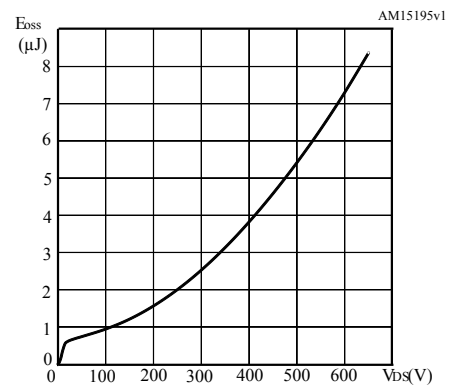
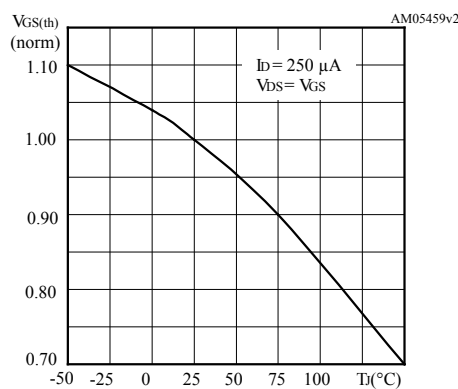
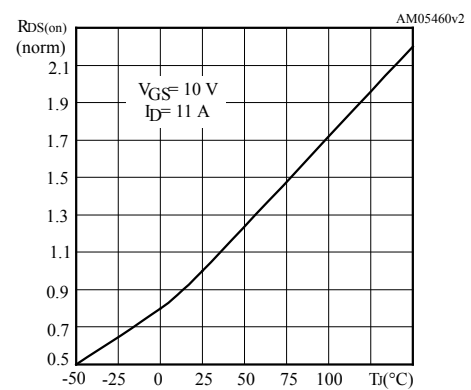
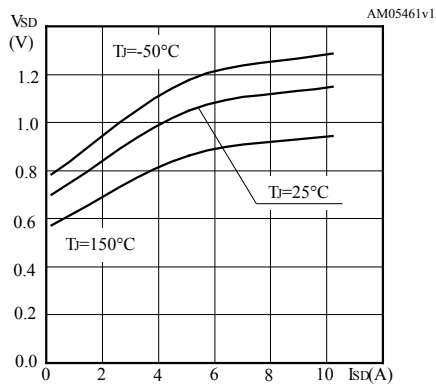
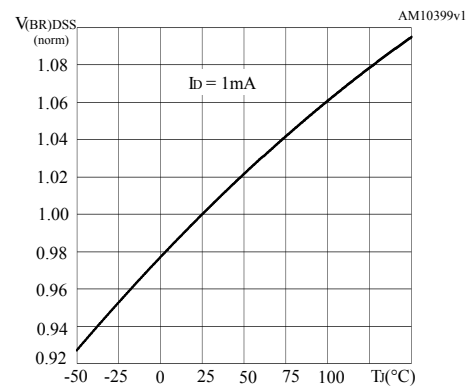
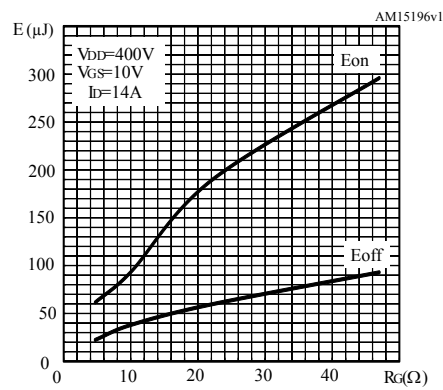
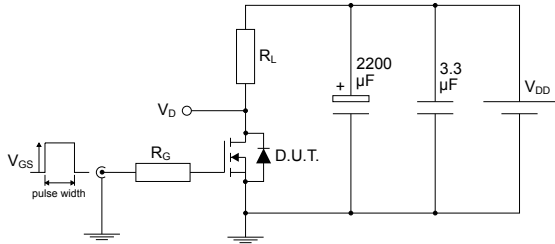
Figure 7. Gate charge vs gate-source voltage

Figure 8. Static drain-source on-resistance

Figure 9. Capacitance variations

Figure 10. Output capacitance stored energy

Figure 11. Normalized gate threshold voltage vs temperature

Figure 12. Normalized on-resistance vs temperature


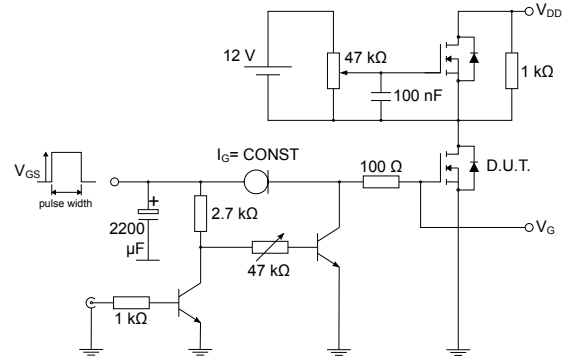
Figure 13. Source-drain diode forward characteristics

Figure 14. Normalized $V_{(BR)DSS}$ vs temperature

Figure 15. Switching energy vs gate resistance


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

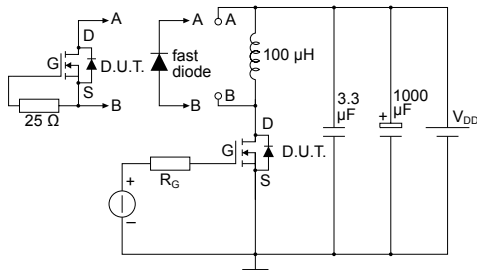
3 Test circuits

Figure 17. Test circuit for resistive load switching times


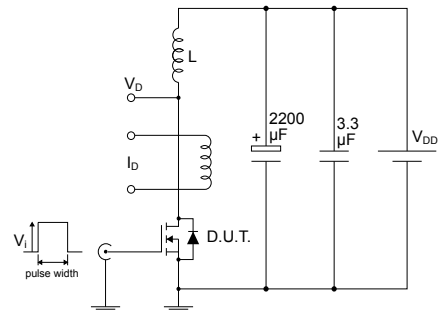
AM01468v1

Figure 18. Test circuit for gate charge behavior


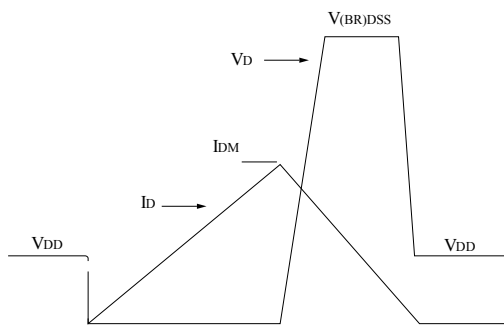
AM01469v1

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


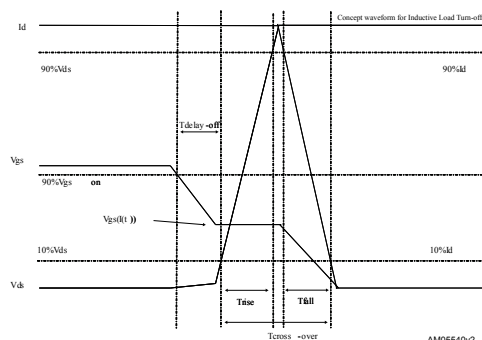
AM01470v1

Figure 20. Unclamped inductive load test circuit


AM01471v1

Figure 21. Unclamped inductive waveform


AM01472v1

Figure 22. Switching time waveform


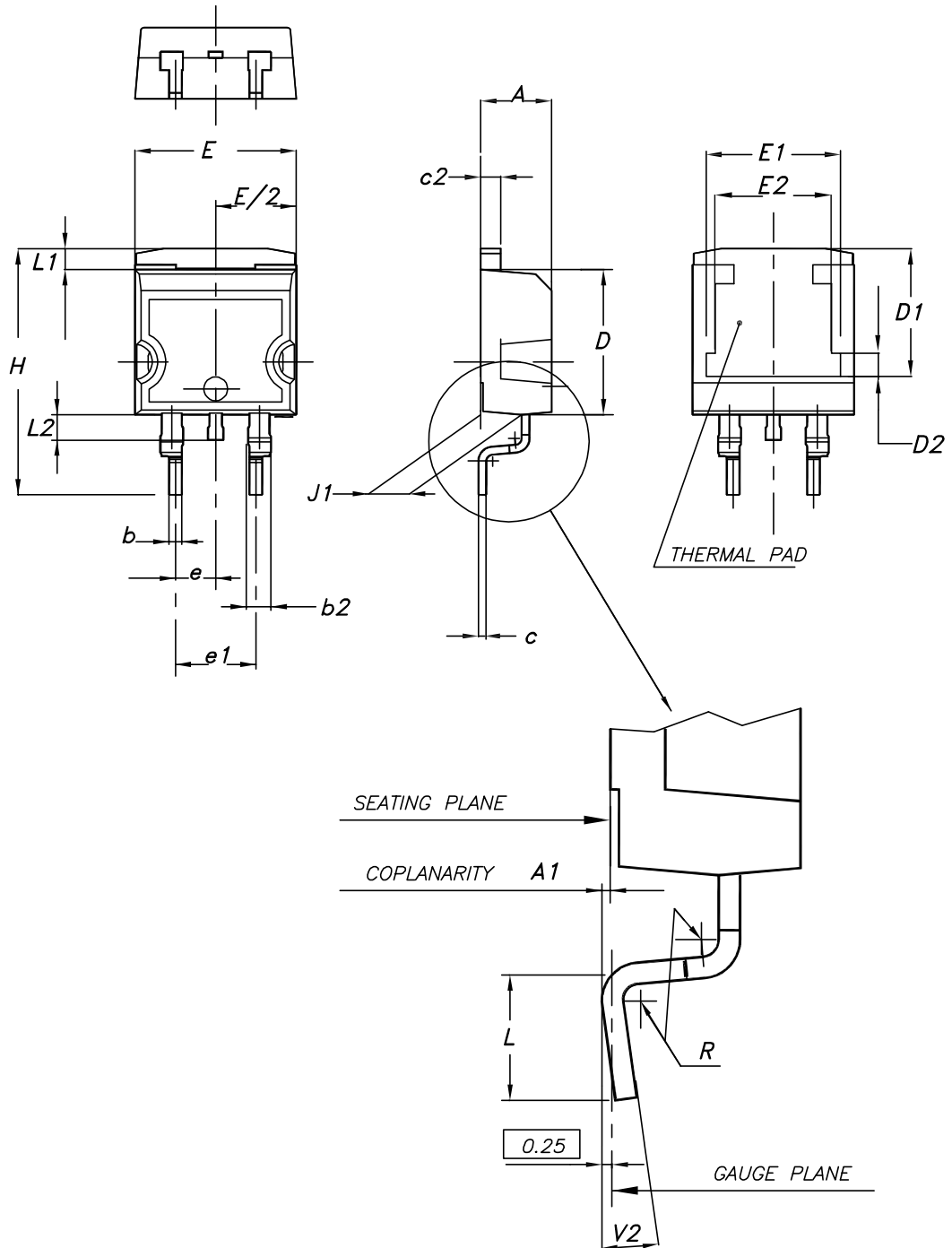
AM05540v2

4 Package information

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 (TO-263) package information

Figure 23. D²PAK (TO-263) type A package outline

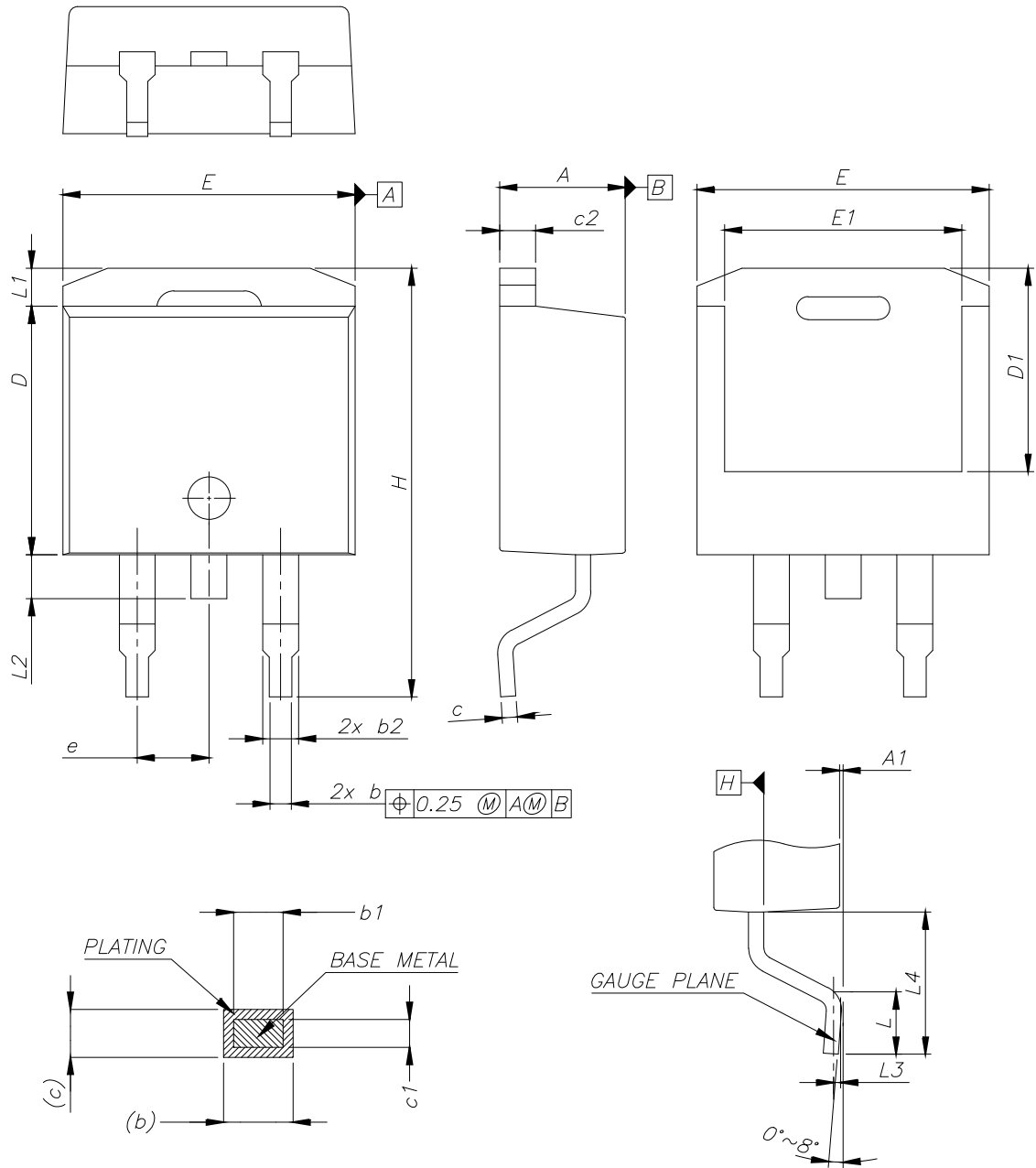


0079457_25

Table 8. D²PAK (TO-263) type A package 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 | 10.00 | | 10.40 |
| E1 | 8.30 | 8.50 | 8.70 |
| E2 | 6.85 | 7.05 | 7.25 |
| e | | 2.54 | |
| e1 | 4.88 | | 5.28 |
| H | 15.00 | | 15.85 |
| J1 | 2.49 | | 2.69 |
| L | 2.29 | | 2.79 |
| L1 | 1.27 | | 1.40 |
| L2 | 1.30 | | 1.75 |
| R | | 0.40 | |
| V2 | 0° | | 8° |

Figure 24. D²PAK (TO-263) type B package outline

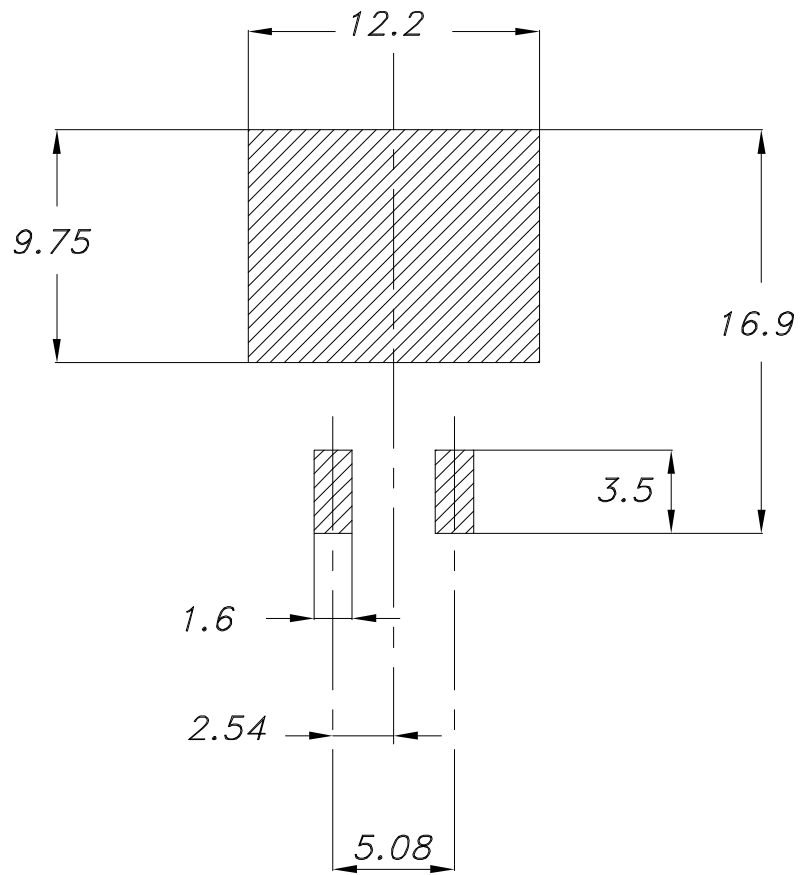


0079457_26_B

Table 9. D²PAK (TO-263) type B mechanical data

| Dim. | mm | | |
|------|----------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.36 | | 4.56 |
| A1 | 0 | | 0.25 |
| b | 0.70 | | 0.90 |
| b1 | 0.51 | | 0.89 |
| b2 | 1.17 | | 1.37 |
| c | 0.38 | | 0.694 |
| c1 | 0.38 | | 0.534 |
| c2 | 1.19 | | 1.34 |
| D | 8.60 | | 9.00 |
| D1 | 6.90 | | 7.50 |
| E | 10.15 | | 10.55 |
| E1 | 8.10 | | 8.70 |
| e | 2.54 BSC | | |
| H | 15.00 | | 15.60 |
| L | 1.90 | | 2.50 |
| L1 | | | 1.65 |
| L2 | | | 1.78 |
| L3 | | 0.25 | |
| L4 | 4.78 | | 5.28 |

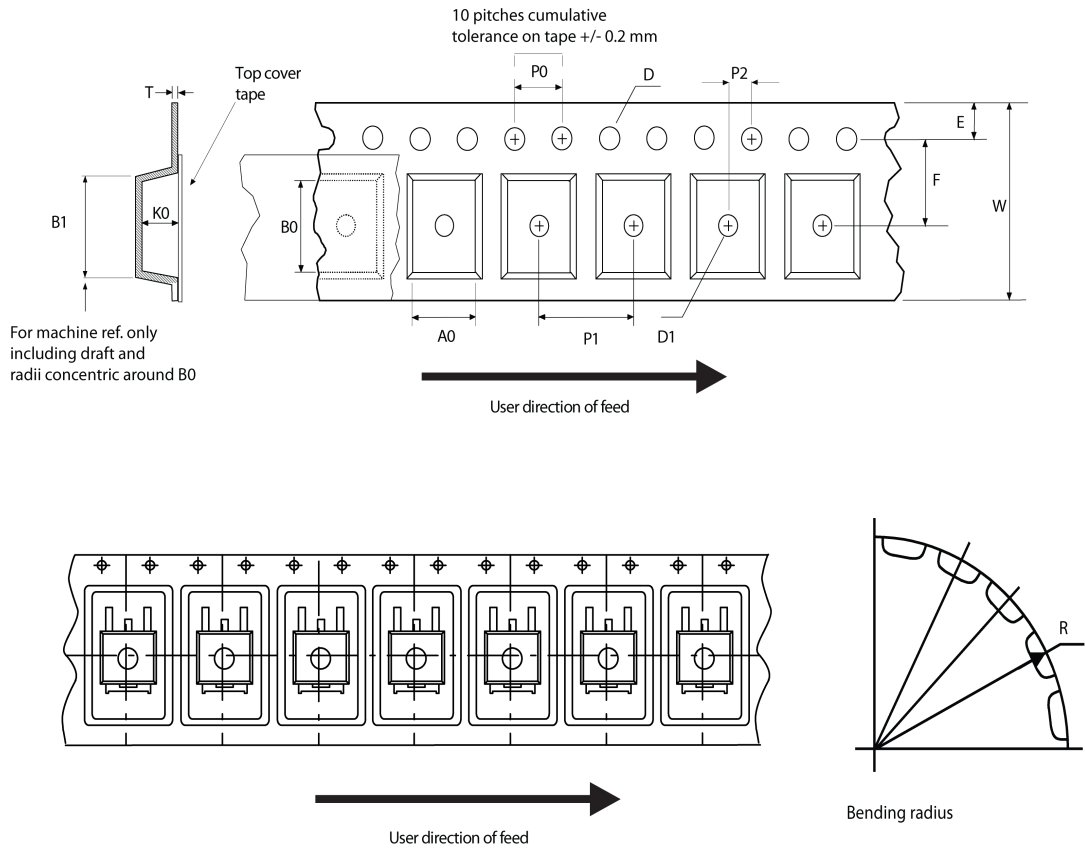
Figure 25. D²PAK (TO-263) recommended footprint (dimensions are in mm)



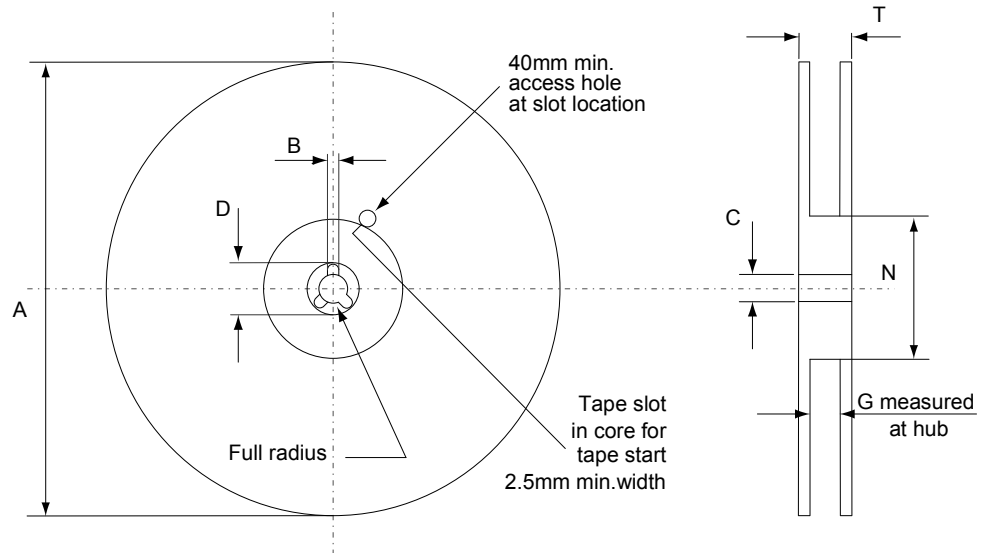
Footprint

4.2 D²PAK packing information

Figure 26. D²PAK tape outline



AM08852v1

Figure 27. D²PAK reel outline


AM06038v1

Table 10. 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 | Base quantity Bulk quantity | | | |
| P1 | 11.9 | 12.1 | | | | 1000 |
| P2 | 1.9 | 2.1 | | | | 1000 |
| R | 50 | | | | | |
| T | 0.25 | 0.35 | | | | |
| W | 23.7 | 24.3 | | | | |

4.3 D²PAK type B packing information

Figure 28. D²PAK type B tape outline

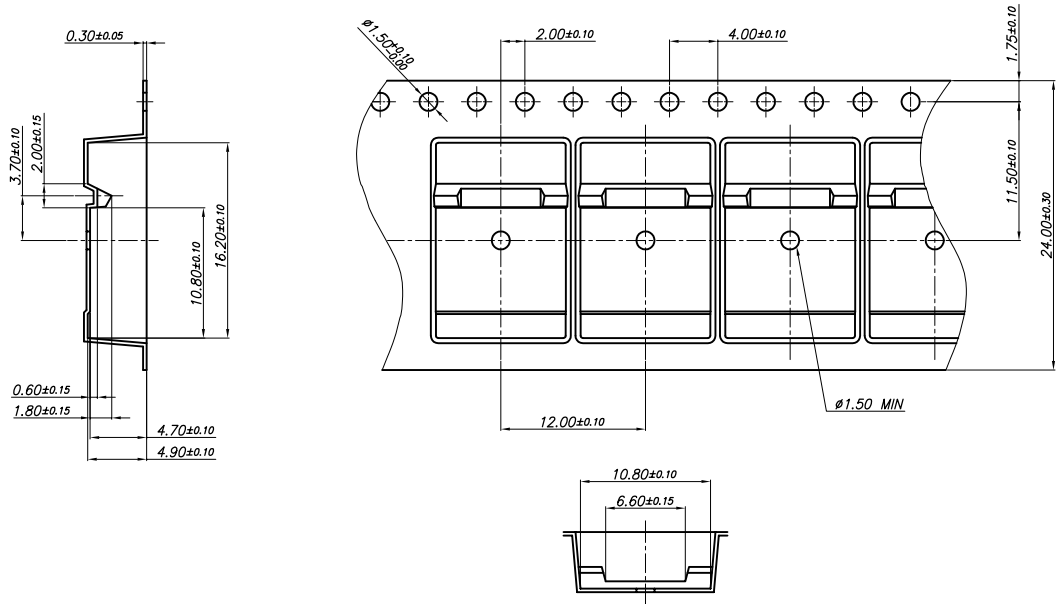
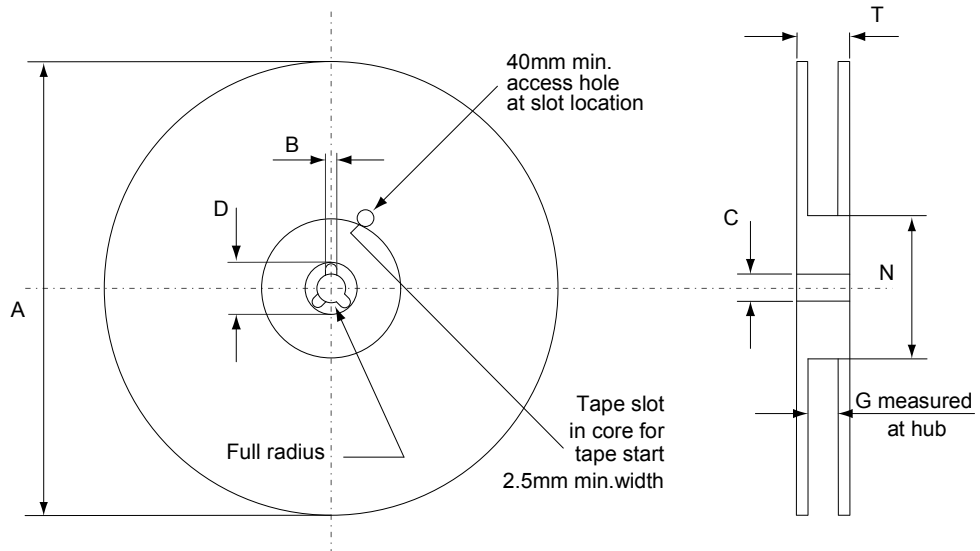


Figure 29. D²PAK type B reel outline



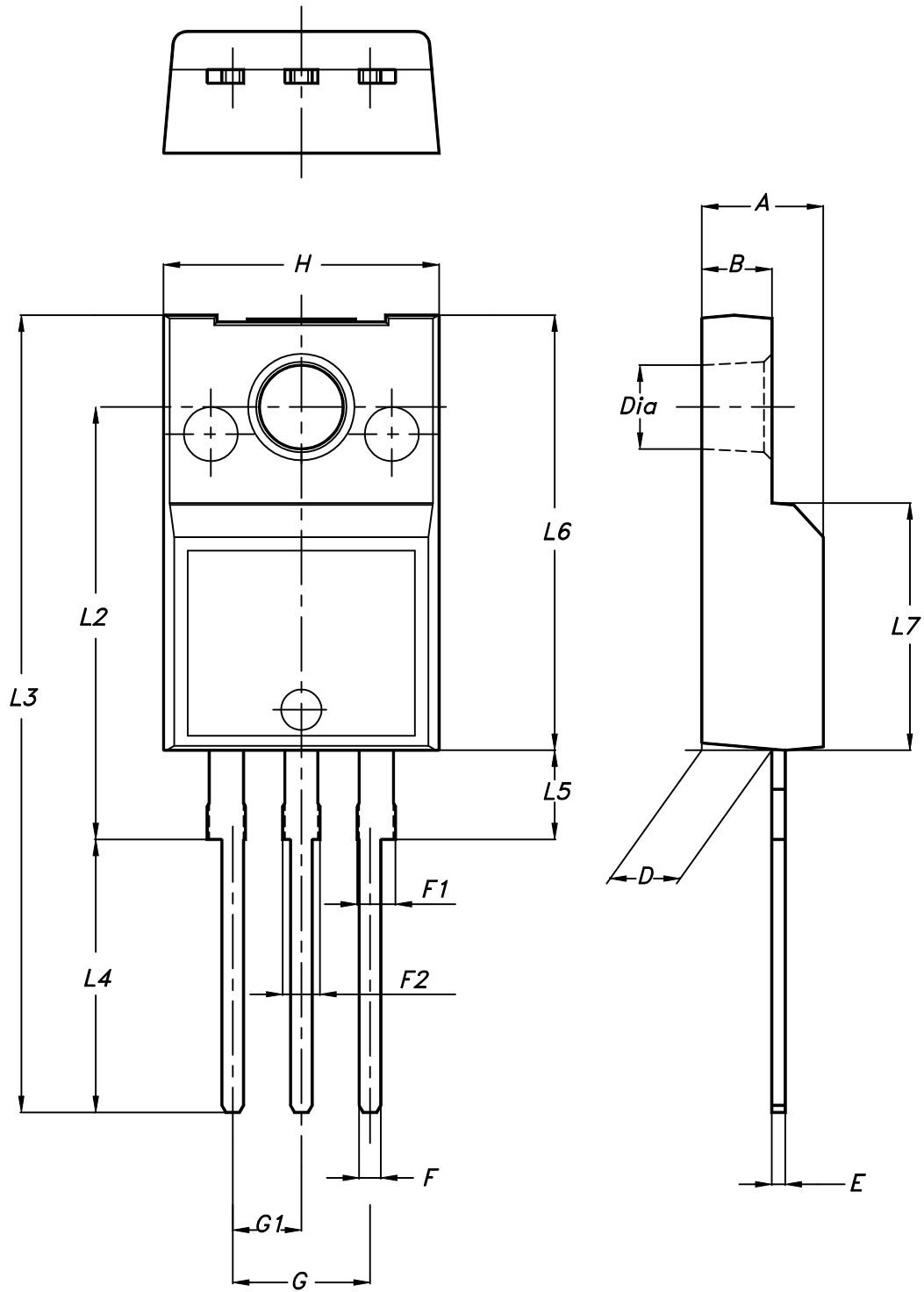
AM06038v1

Table 11. D²PAK type B reel mechanical data

| Dim. | mm | |
|------|------|------|
| | Min. | Max. |
| A | | 330 |
| B | 1.5 | |
| C | 12.8 | 13.2 |
| D | 20.2 | |
| G | 24.4 | 26.4 |
| N | 100 | |
| T | | 30.4 |

4.4 TO-220FP package information

Figure 30. TO-220FP package outline



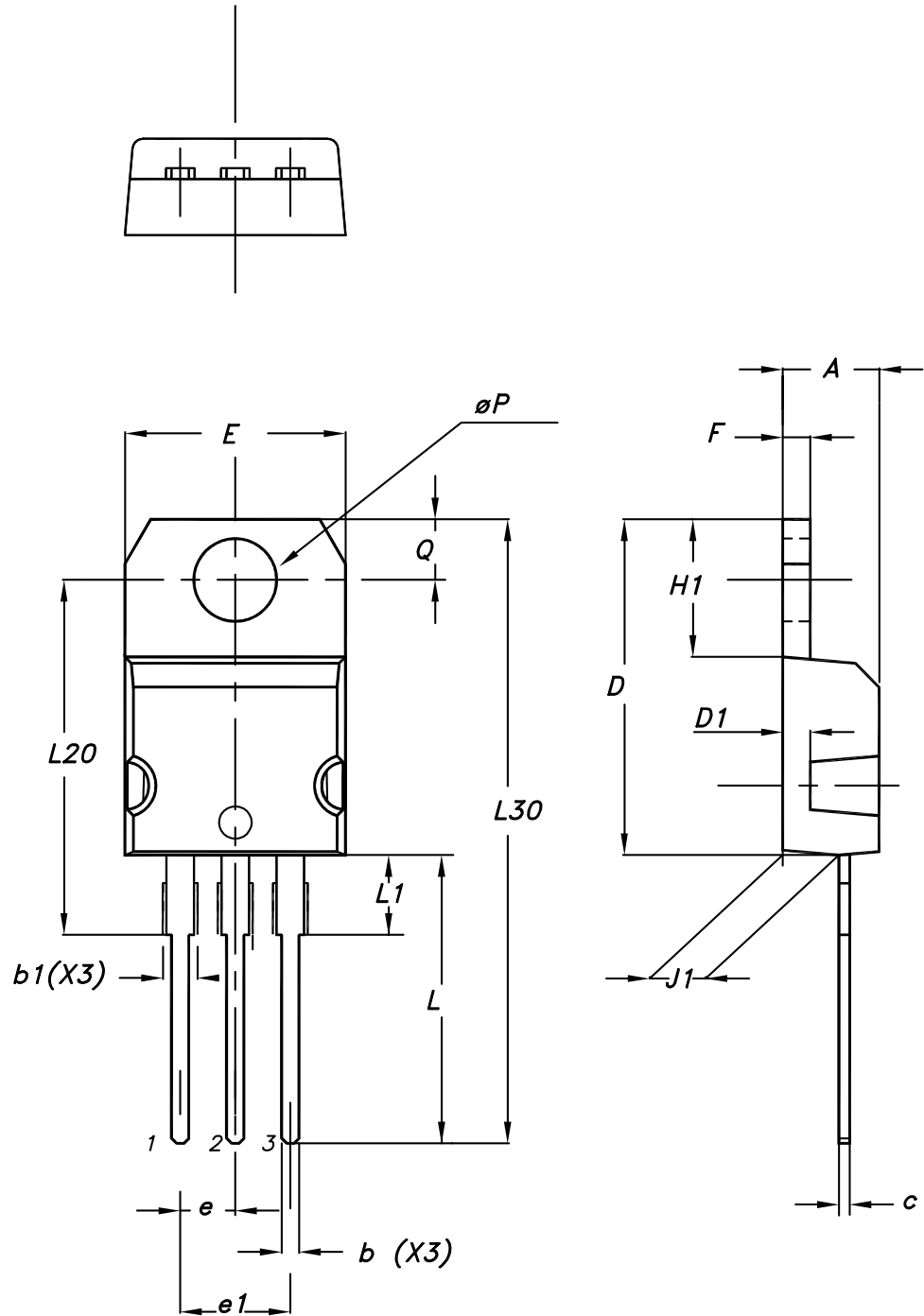
7012510_Rev_12_B

Table 12. TO-220FP package 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 |

4.5 TO-220 type A package information

Figure 31. TO-220 type A package outline



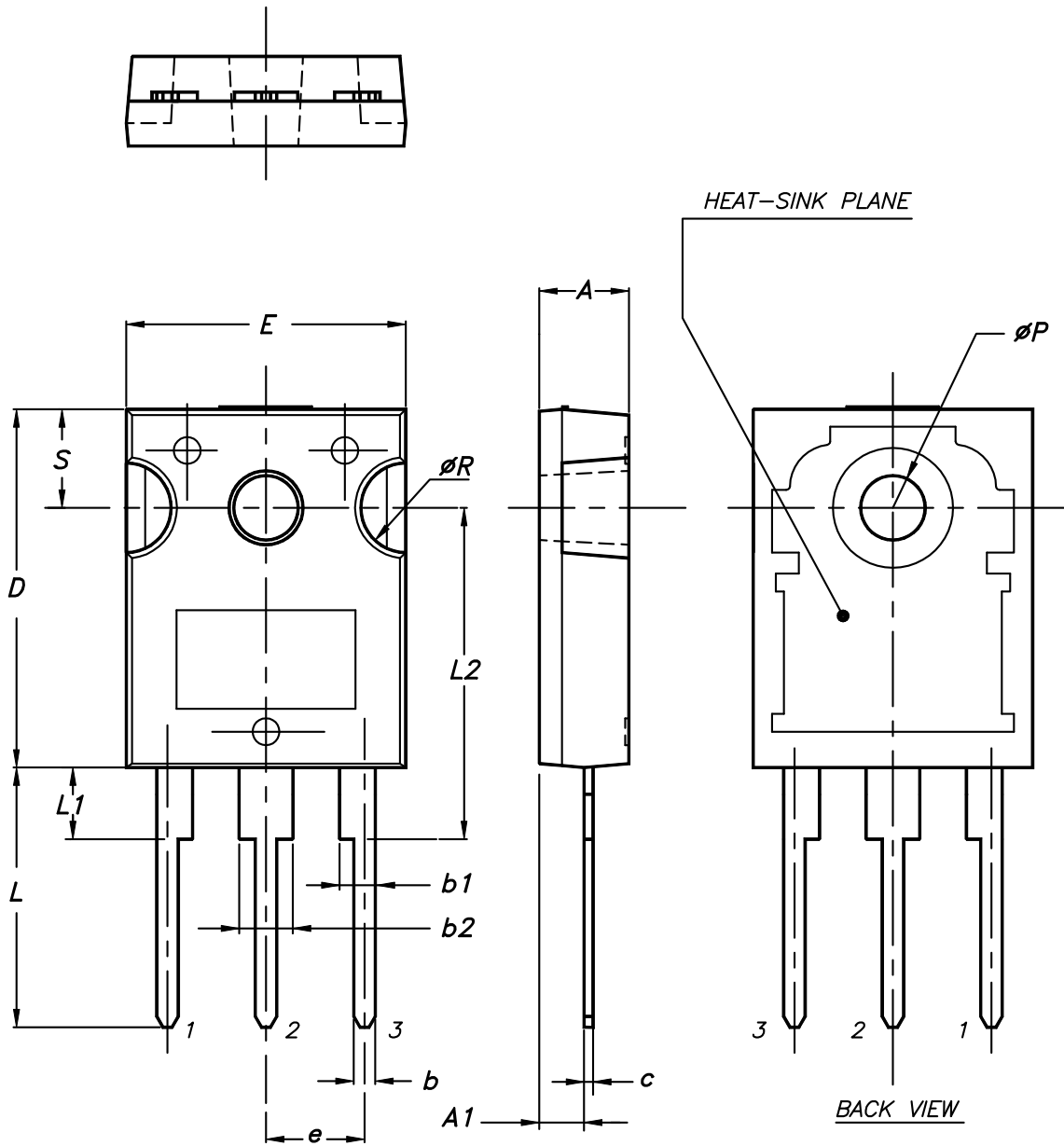
0015988_typeA_Rev_22

Table 13. TO-220 type A package mechanical data

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.55 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10.00 | | 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 | 13.00 | | 14.00 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| øP | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

4.6 TO-247 package information

Figure 32. TO-247 package outline



0075325_9

Table 14. TO-247 package 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 Ordering information

Table 15. Order codes

| Order code | Marking | Package | Packing |
|------------|---------|--------------------|-------------|
| STB31N65M5 | 31N65M5 | D ² PAK | Tape e reel |
| STF31N65M5 | | TO-220FP | Tube |
| STP31N65M5 | | TO-220 | |
| STW31N65M5 | | TO-247 | |

Revision history

Table 16. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 23-Feb-2012 | 1 | First release. |
| 10-Sep-2012 | 2 | <ul style="list-style-type: none"> – Modified <i>note 2</i> under the <i>Table 2</i>. – Updated typical values in <i>Table 4, 5 and 6</i>. – Added <i>Section 2.1</i>. – Minor text changes on the cover page. |
| 05-Mar-2013 | 3 | Added <i>dv/dt</i> value on <i>Table 2: Absolute maximum ratings</i> . |
| 15-Apr-2019 | 4 | <p>The part number STFI31N65M5 has been moved to a separate datasheet.</p> <p>Removed maturity status indication from cover page. The document status is production data.</p> <p>Updated features and description in cover page.</p> <p>Updated Section 4 Package information.</p> <p>Added Section 5 Ordering information.</p> <p>Minor text changes.</p> |

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