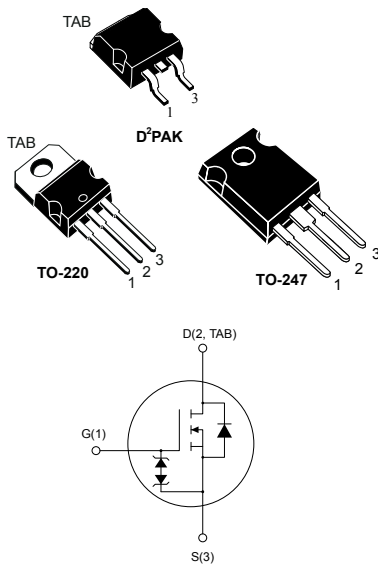


N-channel 600 V, 110 mΩ typ., 24 A MDmesh DM2 Power MOSFET in D²PAK, TO-220 and TO-247 packages



AM01476v1_lab

Features

| Order code | $V_{DS} @ T_{Jmax.}$ | $R_{DS(on)}$ max. | I_D |
|-------------|----------------------|-------------------|-------|
| STB33N60DM2 | 650 V | 130 mΩ | 24 A |
| STP33N60DM2 | | | |
| STW33N60DM2 | | | |

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

Applications

- Switching applications

Description

These high voltage N-channel Power MOSFETs are part of the MDmesh DM2 fast recovery diode series. They offer very low recovery charge (Q_{rr}) and time (t_{rr}) combined with low $R_{DS(on)}$, rendering them suitable for the most demanding high efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.



Product status link

[STB33N60DM2](#)
[STP33N60DM2](#)
[STW33N60DM2](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|--------------------------------|--|------------|------|
| V _{GS} | Gate-source voltage (static) | ±25 | V |
| | Gate-source voltage (dynamic AC, f > 1 Hz) | ±30 | |
| I _D | Drain current (continuous) at T _{case} = 25 °C | 24 | A |
| | Drain current (continuous) at T _{case} = 100 °C | 15.5 | |
| I _{DM} ⁽¹⁾ | Drain current (pulsed) | 96 | A |
| P _{TOT} | Total power dissipation at T _{case} = 25 °C | 190 | W |
| dv/dt ⁽²⁾ | Peak diode recovery voltage slope | 100 | V/ns |
| di/dt ⁽²⁾ | Peak diode recovery current slope | 1000 | A/μs |
| dv/dt ⁽³⁾ | MOSFET dv/dt ruggedness | 100 | V/ns |
| T _{stg} | Storage temperature range | -55 to 150 | °C |
| T _j | Operating junction temperature range | | |

1. Pulse width is limited by safe operating area.
2. I_{SD} ≤ 24 A, V_{DS peak} < V_{(BR)DSS}, V_{DD} = 400 V.
3. V_{DS} ≤ 480 V.

Table 2. Thermal data

| Symbol | Parameter | Value | | | Unit |
|-------------------------------------|-------------------------------------|--------------------|--------|--------|------|
| | | D ² PAK | TO-220 | TO-247 | |
| R _{thj-case} | Thermal resistance junction-case | 0.66 | | | °C/W |
| R _{thj-pcb} ⁽¹⁾ | Thermal resistance junction-pcb | 30 | | | |
| R _{thj-amb} | Thermal resistance junction-ambient | | 62.5 | 50 | |

1. When mounted on 1 inch² FR-4, 2 Oz copper board.

Table 3. Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|-----------------|--|-------|------|
| I _{AR} | Avalanche current, repetitive or not repetitive (Pulse width limited by T _{jmax}) | 5.5 | A |
| E _{AS} | Single pulse avalanche energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V) | 570 | mJ |

2 Electrical characteristics

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

Table 4. Static

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------------------|---|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$ | 600 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}, V_{DS} = 600\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0\text{ V}, V_{DS} = 600\text{ V}, T_{case} = 125\text{ °C}$ ⁽¹⁾ | | | 100 | |
| I_{GSS} | Gate-body leakage current | $V_{DS} = 0\text{ V}, V_{GS} = \pm 25\text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}, I_D = 12\text{ A}$ | | 110 | 130 | m 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 | $V_{DS} = 100\text{ V}, f = 1\text{ MHz}, V_{GS} = 0\text{ V}$ | - | 1870 | - | pF |
| C_{oss} | Output capacitance | | - | 87 | - | |
| C_{riss} | Reverse transfer capacitance | | - | 2 | - | |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DD} = 480\text{ V}, V_{GS} = 0\text{ V}$ | - | 157 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}, I_D = 0\text{ A}$ | - | 4.5 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 480\text{ V}, I_D = 24\text{ A}, V_{GS} = 10\text{ V}$ (see Figure 18. Test circuit for gate charge behavior) | - | 43 | - | nC |
| Q_{gs} | Gate-source charge | | - | 9.8 | - | |
| Q_{gd} | Gate-drain charge | | - | 21 | - | |

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 6. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 300\text{ V}, I_D = 12\text{ A}, R_G = 4.7\text{ }\Omega,$ $V_{GS} = 10\text{ V}$ (see Figure 17. Test circuit for resistive load switching times and Figure 22. Switching time waveform) | - | 17 | - | ns |
| t_r | Rise time | | - | 8 | - | |
| $t_{d(off)}$ | Turn-off delay time | | - | 62 | - | |
| t_f | Fall time | | - | 9 | - | |

Table 7. Source-drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 24 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 96 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $V_{GS} = 0\text{ V}$, $I_{SD} = 24\text{ A}$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 24\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times) | - | 150 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 0.5 | | μC |
| I_{RRM} | Reverse recovery current | | - | 8.8 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 24\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times) | - | 316 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 2.85 | | μC |
| I_{RRM} | Reverse recovery current | | - | 18 | | A |

1. Pulse width is limited by safe operating area.

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

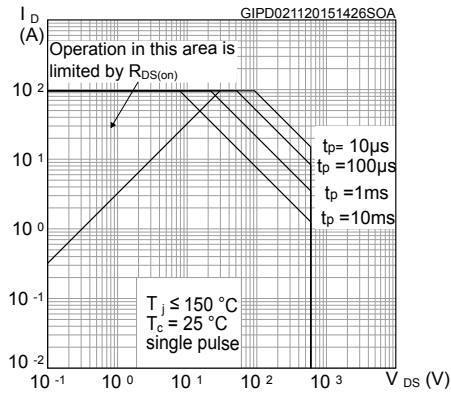
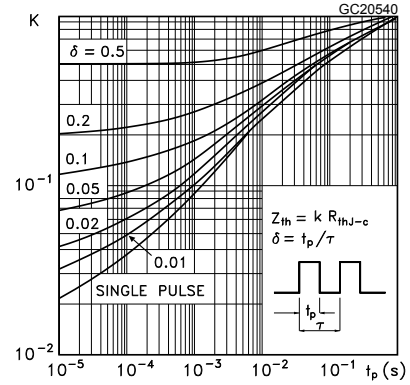
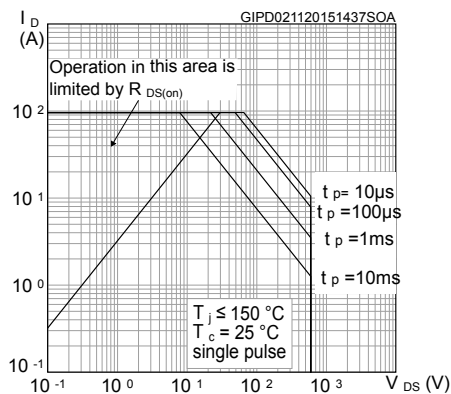
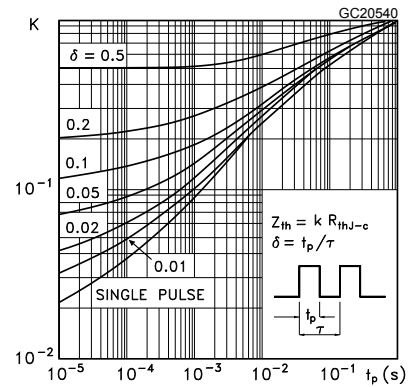
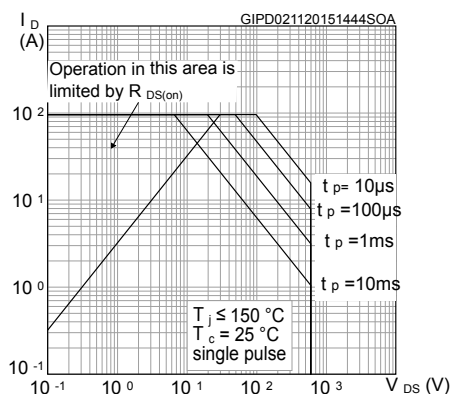
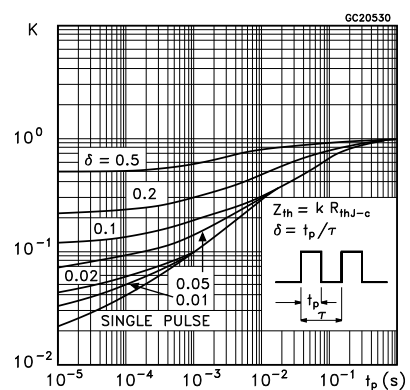
2.1 Electrical characteristics curves
Figure 1. Safe operating area for D²PAK

Figure 2. Thermal impedance for D²PAK

Figure 3. Safe operating area for TO-220

Figure 4. Thermal impedance for TO-220

Figure 5. Safe operating area for TO-247

Figure 6. Thermal impedance for TO-247


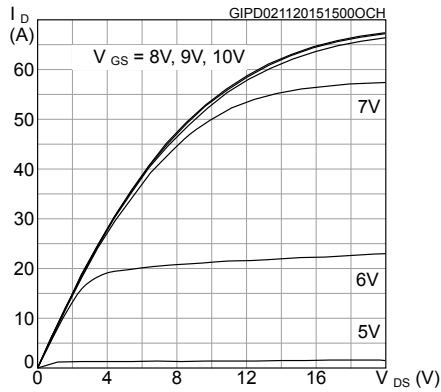
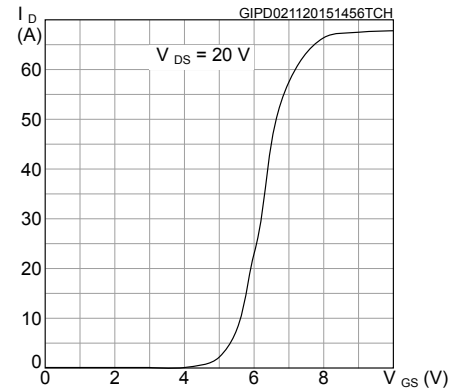
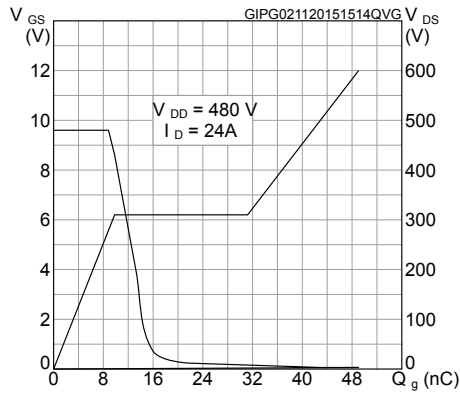
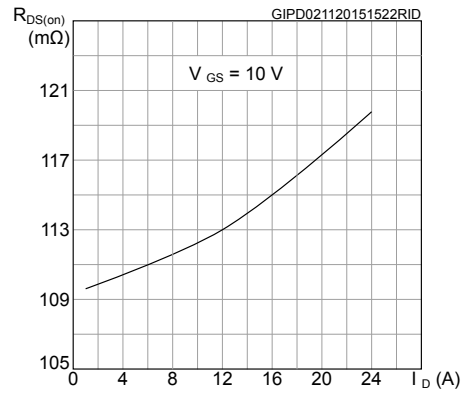
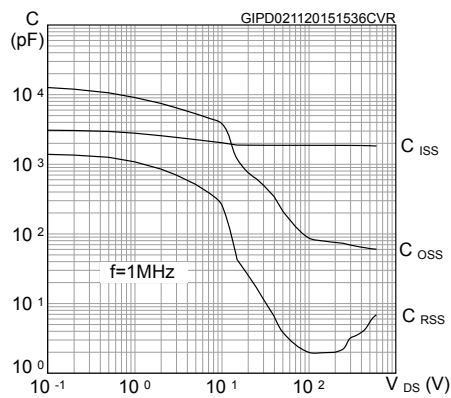
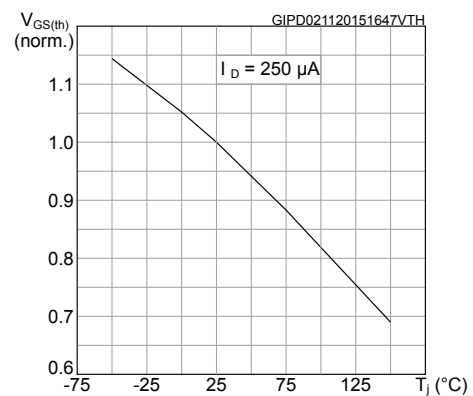
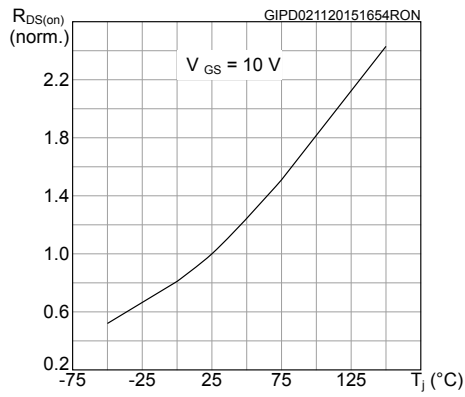
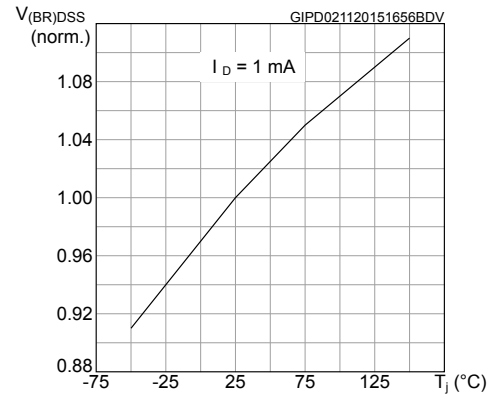
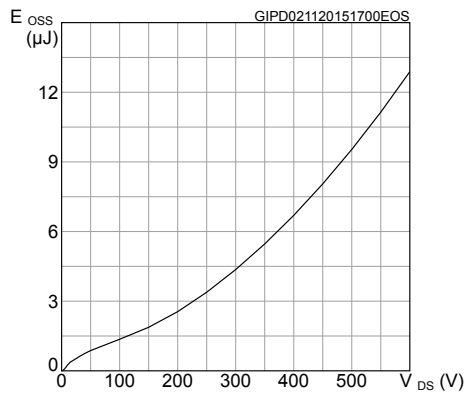
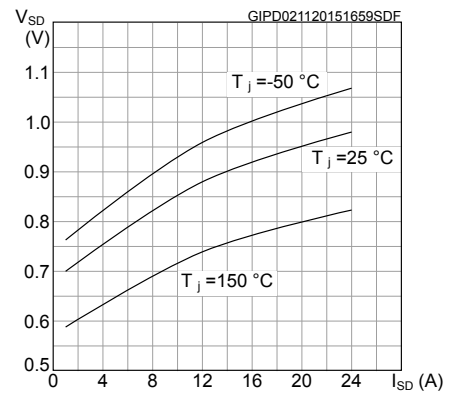
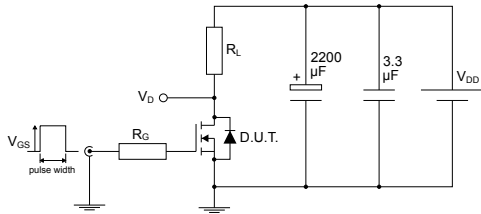
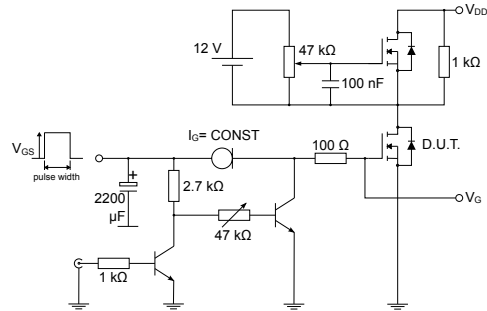
Figure 7. Output characteristics

Figure 8. Transfer characteristics

Figure 9. Gate charge vs gate-source voltage

Figure 10. Static drain-source on-resistance

Figure 11. Capacitance variations

Figure 12. Normalized gate threshold voltage vs temperature


Figure 13. Normalized on-resistance vs temperature

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

Figure 15. Output capacitance stored energy

Figure 16. Source-drain diode forward characteristics


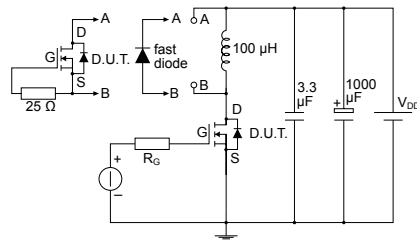
3 Test circuits

Figure 17. Test circuit for resistive load switching times


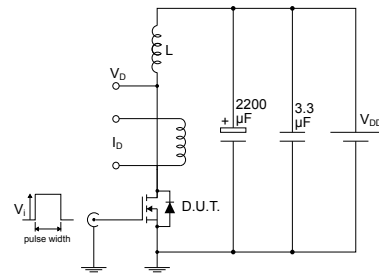
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Figure 18. Test circuit for gate charge behavior


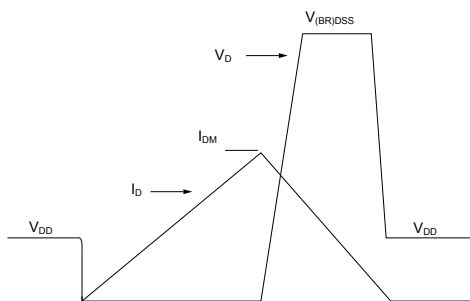
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Figure 19. Test circuit for inductive load switching and diode recovery times


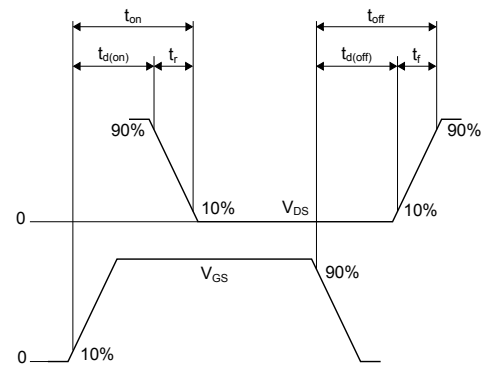
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Figure 20. Unclamped inductive load test circuit


AM01471v1

Figure 21. Unclamped inductive waveform


AM01472v1

Figure 22. Switching time waveform


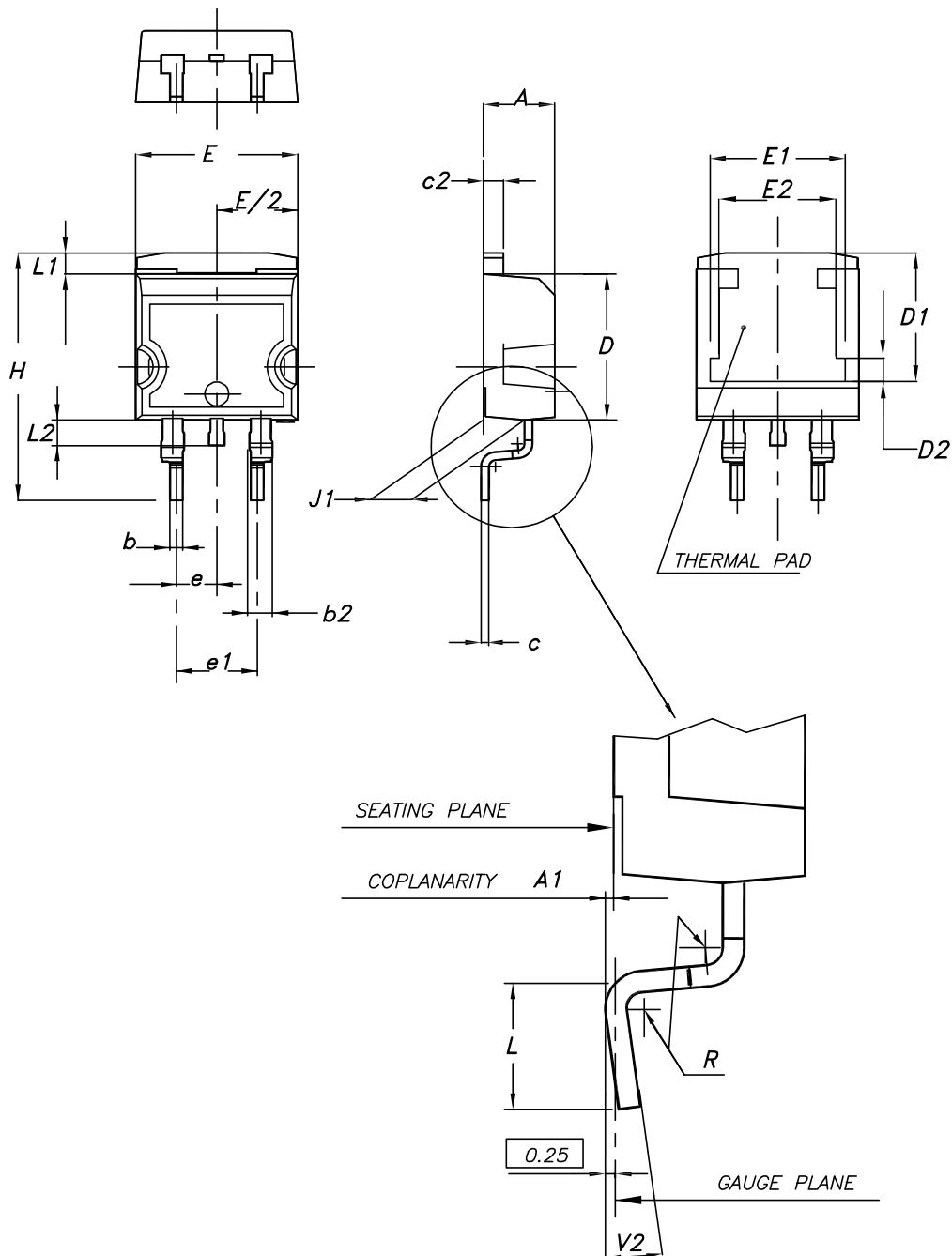
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4 Package information

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) type A package information

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

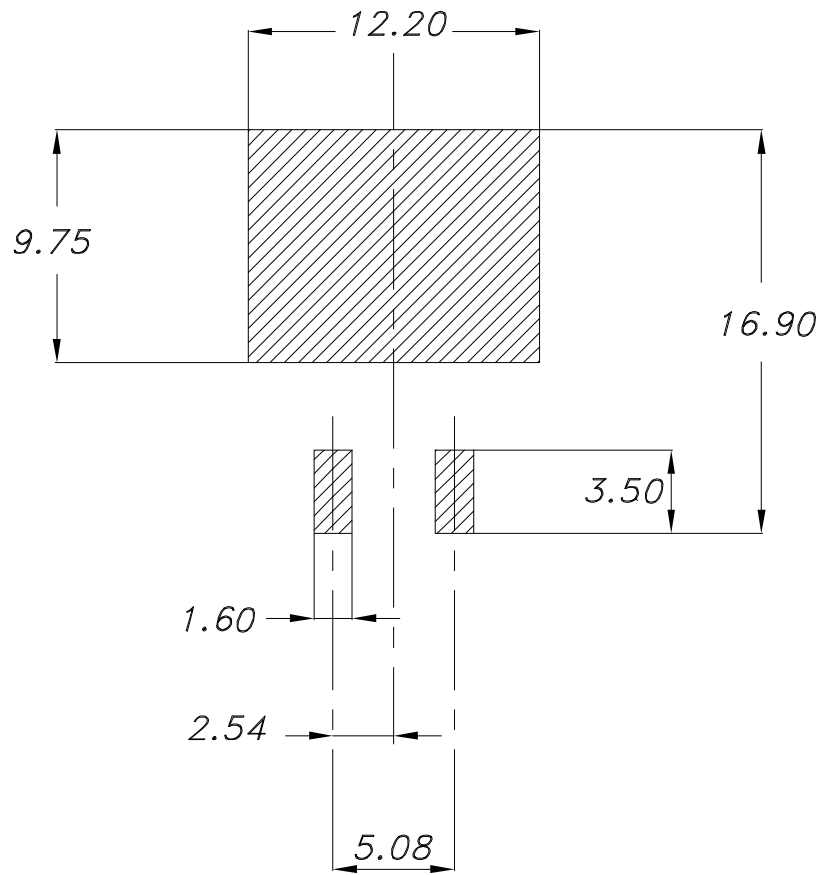


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Table 8. D²PAK (TO-263) type A package mechanical data

| 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° |

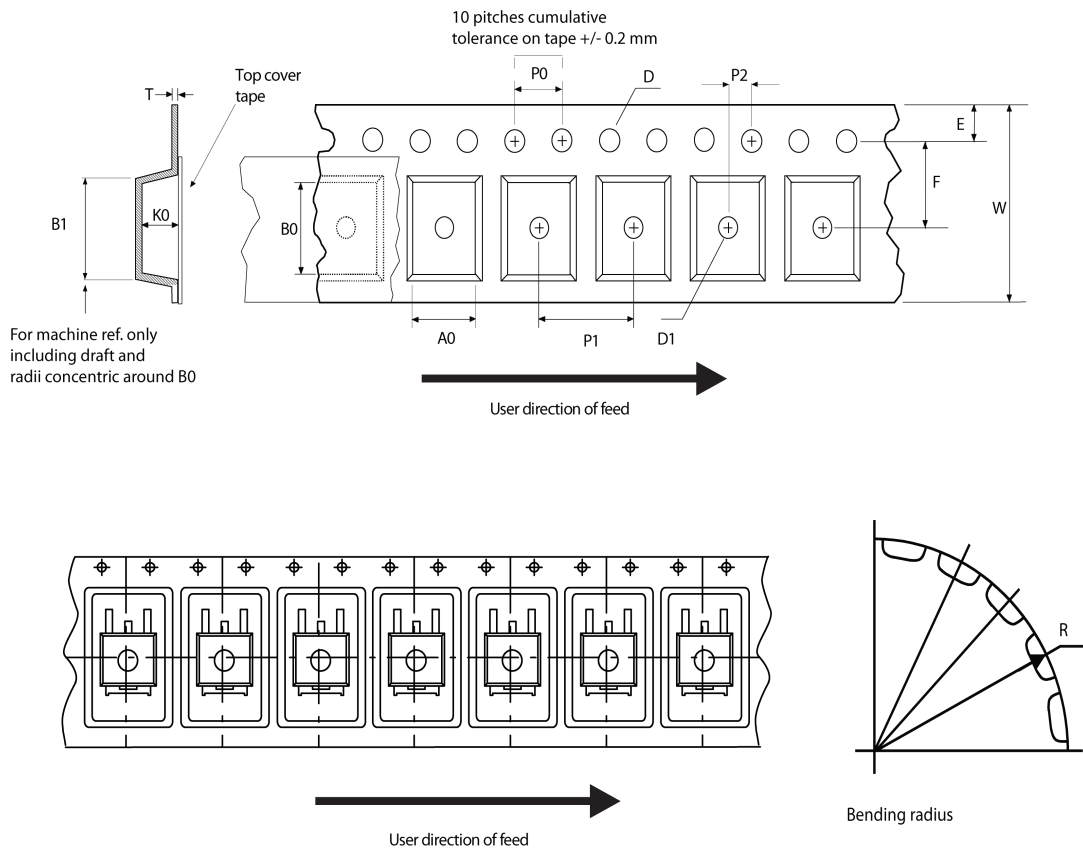
Figure 24. D²PAK (TO-263) recommended footprint (dimensions are in mm)



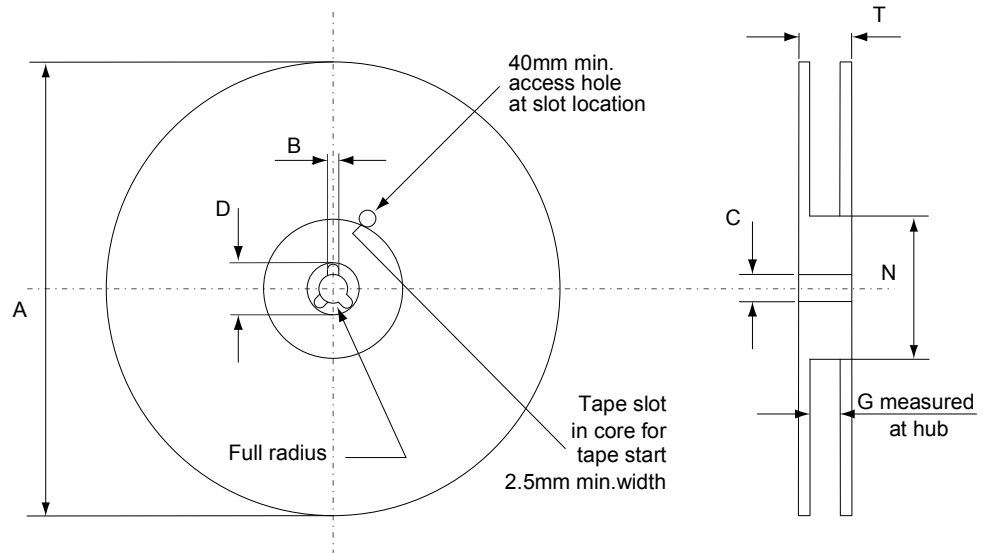
Footprint_26

4.2 D²PAK packing information

Figure 25. D²PAK tape outline



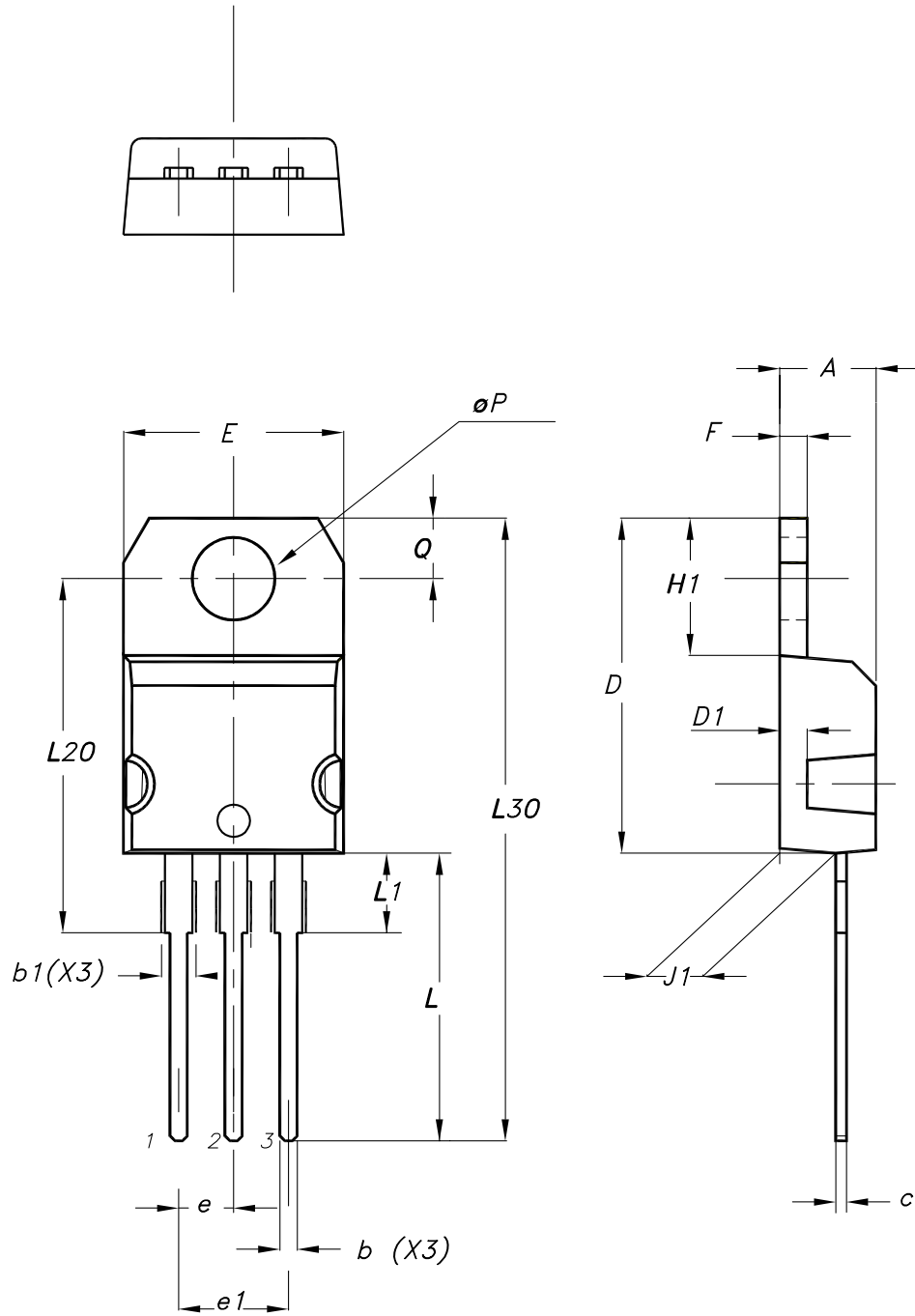
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Figure 26. D²PAK reel outline


AM06038v1

Table 9. 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 quantity | | 1000 |
| P2 | 1.9 | 2.1 | Bulk quantity | | 1000 |
| R | 50 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 23.7 | 24.3 | | | |

4.3 TO-220 type A package information
Figure 27. TO-220 type A package outline


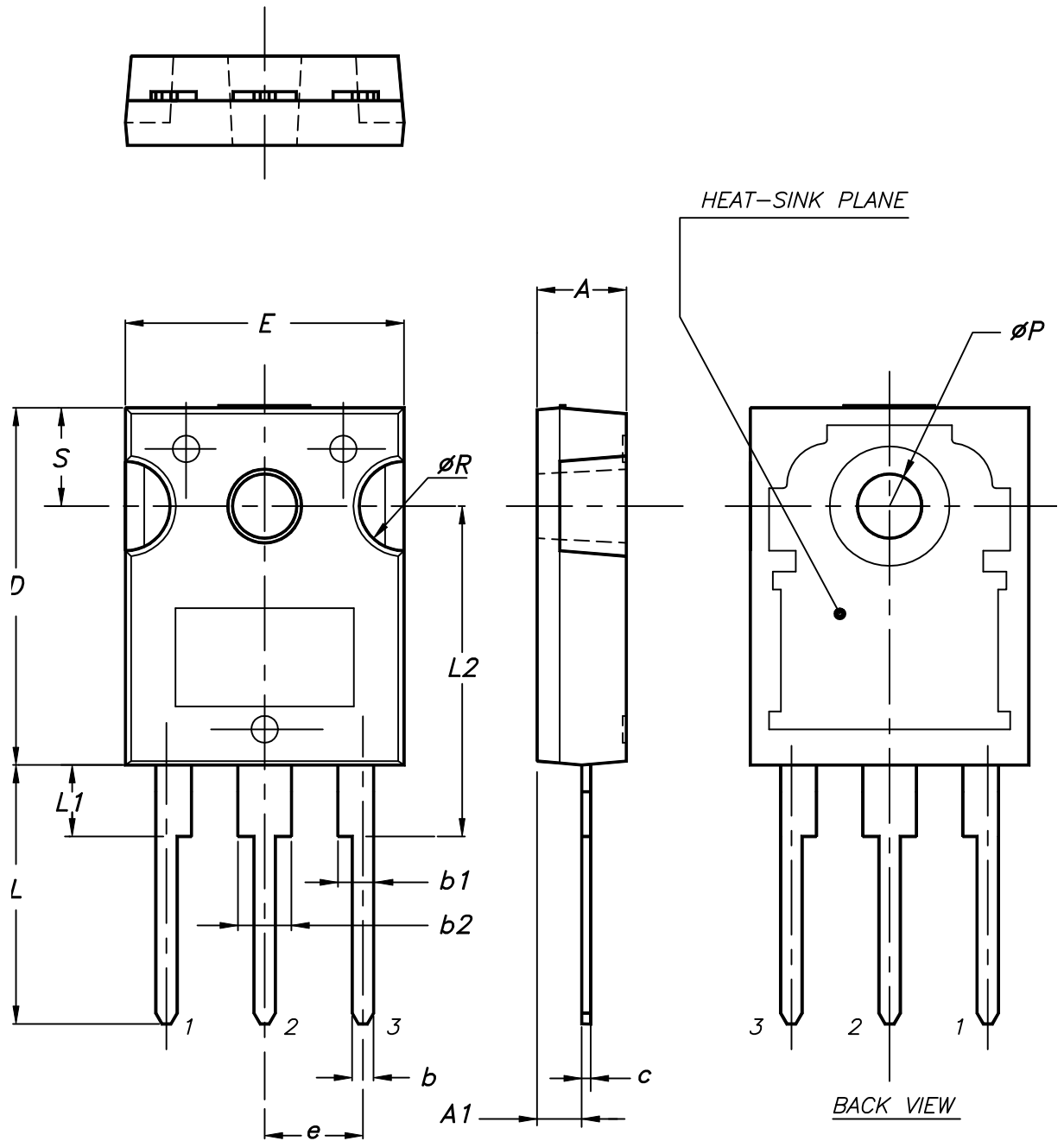
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Table 10. TO-220 type A package mechanical data

| 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 |
| Slug flatness | | 0.03 | 0.10 |

4.4 TO-247 package information

Figure 28. TO-247 package outline



0075325_9

Table 11. 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 12. Order codes

| Order code | Marking | Package | Packing |
|-------------|----------|--------------------|-------------|
| STB33N60DM2 | 33N60DM2 | D ² PAK | Tape e reel |
| STP33N60DM2 | | TO-220 | Tube |
| STW33N60DM2 | | TO-247 | Tube |

Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 16-Oct-2014 | 1 | First release. |
| 02-Nov-2015 | 2 | Document status promoted from preliminary to production data. Updated title and features in cover page. Updated <i>Table 2: "Absolute maximum ratings"</i> , <i>Table 4: "Avalanche characteristics"</i> , <i>Table 5: "Static"</i> , <i>Table 6: "Dynamic"</i> , <i>Table 7: "Switching times"</i> and <i>Table 8: "Source-drain diode"</i> . Added <i>Section 2.1 Electrical characteristics (curves)</i> . |
| 19-Oct-2020 | 3 | Updated Section 1 Electrical ratings . Minor text changes. |



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