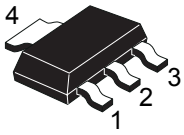
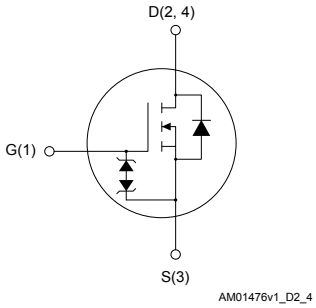
# N-channel 600 V, 10.4 Ω typ., 0.44 A SuperMESH Power MOSFET in a SOT-223 package




SOT-223




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STN1NK60ZL | 600 V | 15 Ω | 0.44 A |

- 100% avalanche tested
- Extremely high dv/dt capability
- Gate charge minimized
- Logic level $V_{GS(th)}$
- Zener-protected

## Applications

- Switching applications

## Description

This high-voltage device is a Zener-protected N-channel Power MOSFET developed using the SuperMESH technology by STMicroelectronics, an optimization of the well-established PowerMESH. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

| Product status link |
|---|
| STN1NK60ZL |

| Product summary | |
|---|---|
| **Order code** | STN1NK60ZL |
| **Marking** | 1NK60ZL |
| **Package** | SOT-223 |
| **Packing** | Tube |



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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain-source voltage | 600 | V |
| $V_{GS}$ | Gate-source voltage | ±20 | V |
| $I_D$ | Drain current (continuous) at $T_A$ = 25 °C | 0.44 | A |
| | Drain current (continuous) at $T_A$ = 100 °C | 0.3 | |
| $I_{DM}$(1) | Drain current (pulsed) | 1.8 | A |
| $P_{TOT}$ | Total power dissipation at $T_A$ = 25 °C | 3.3 | W |
| dv/dt(2) | Peak diode recovery voltage slope | 3 | 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. *$I_{SD}$ ≤ 0.3 A, di/dt ≤ 200 A/µs, $V_{DD}$ = 480 V.*

**Table 2. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJA}$(1) | Thermal resistance, junction-to-ambient | 38 | °C/W |

1. *When mounted on a standard 1 inch$^2$ area of FR-4 PCB with 2-oz copper.*

**Table 3. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max.) | 0.3 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 35 V) | 150 | mJ |


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# 2 Electrical characteristics

$T_C$ = 25 °C unless otherwise specified.

**Table 4. On/off states**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D$ = 1 mA, $V_{GS}$ = 0 V | 600 | - | - | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V | - | - | 1 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V, $T_C$ = 125 °C(1) | - | - | 50 | |
| $I_{GSS}$ | Gate-body leakage current | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | - | - | ±10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 50 µA | 0.9 | 1.7 | 2 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 0.25 A | - | 10.4 | 15 | Ω |

1. *Specified by design, not tested in production.*

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$ = 25 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 125 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 13 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 2 | - | pF |
| $Q_g$ | Total gate charge | $V_{DD}$ = 480 V, $I_D$ = 0.8 A, $V_{GS}$ = 0 to 10 V (see the Figure 14. Test circuit for gate charge behavior) | - | 9.4 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 0.8 | - | nC |
| $Q_{gd}$ | Gate-drain charge | | - | 4.5 | - | nC |

**Table 6. Switching times**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 300 V, $I_D$ = 0.4 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see the Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | - | 4.4 | - | ns |
| $t_r$ | Rise time | | - | 4 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 18.4 | - | ns |
| $t_f$ | Fall time | | - | 41 | - | ns |


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**Table 7. Source-drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | - | 0.44 | A |
| $I_{SDM}$(1) | Source-drain current (pulsed) | | - | - | 1.8 | A |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$ = 0.44 A, $V_{GS}$ = 0 V | - | - | 1.6 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 0.8 A, di/dt = 100 A/µs, | - | 155 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | $V_{DD}$ = 60 V | - | 232 | - | nC |
| $I_{RRM}$ | Reverse recovery current | (see the Figure 15. Test circuit for inductive load switching and diode recovery times) | - | 3 | - | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 0.8 A, di/dt = 100 A/µs, | - | 186 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | $V_{DD}$ = 60 V, $T_J$ = 150 °C | - | 297 | - | nC |
| $I_{RRM}$ | Reverse recovery current | (see the Figure 15. Test circuit for inductive load switching and diode recovery times) | - | 3.2 | - | A |

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


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## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area**

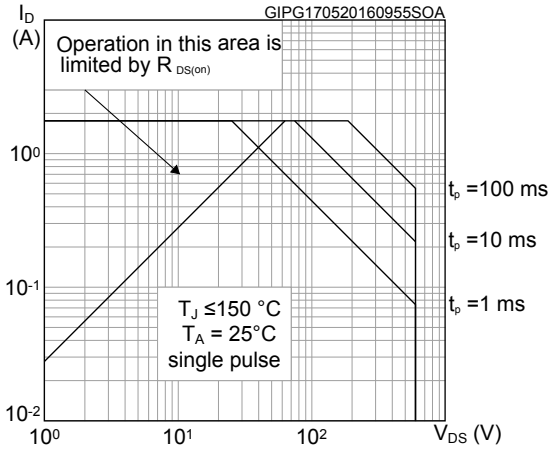



**Figure 2. Normalized transient thermal impedance**

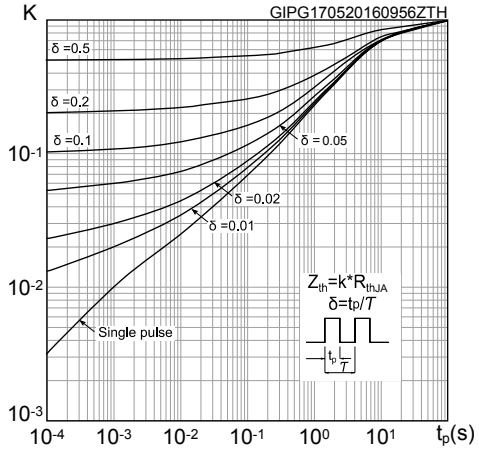



**Figure 3. Typical output characteristics**

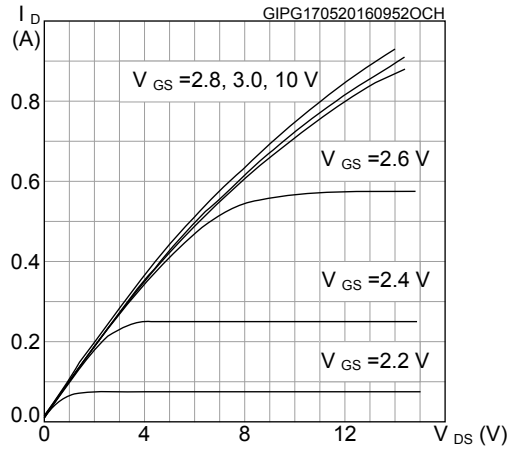



**Figure 4. Typical transfer characteristics**

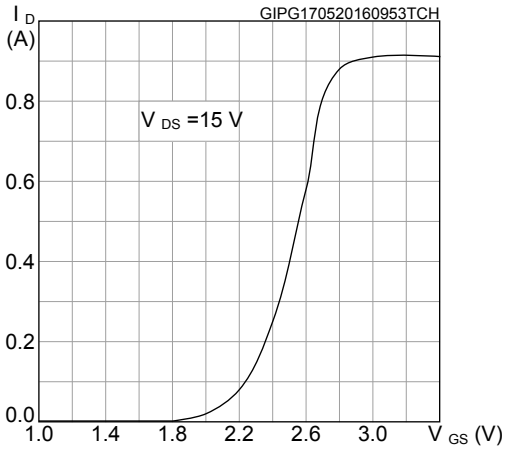



**Figure 5. Typical gate charge characteristics**

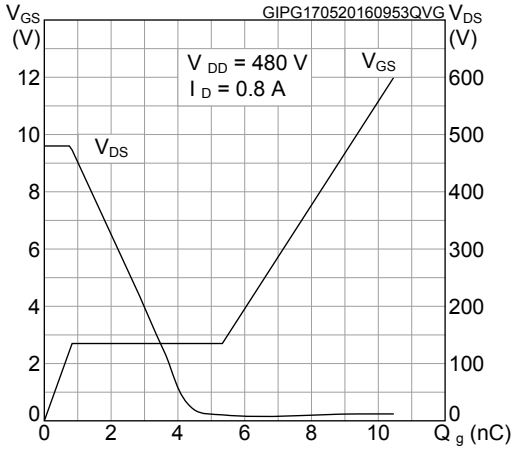
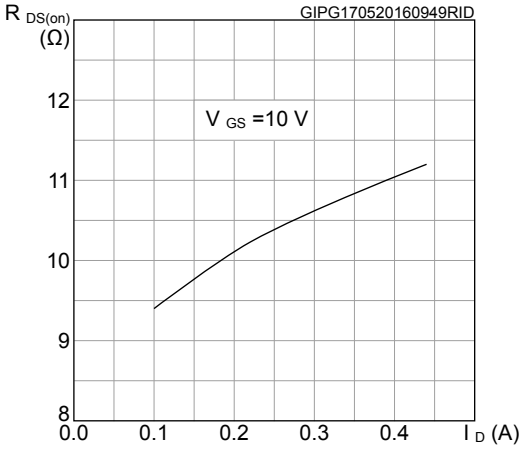



**Figure 6. Typical drain-source on-resistance**





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**Figure 7. Typical capacitance characteristics**

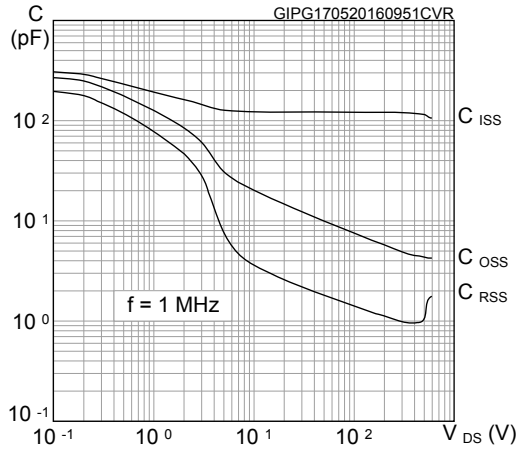



**Figure 8. Normalized gate threshold vs temperature**

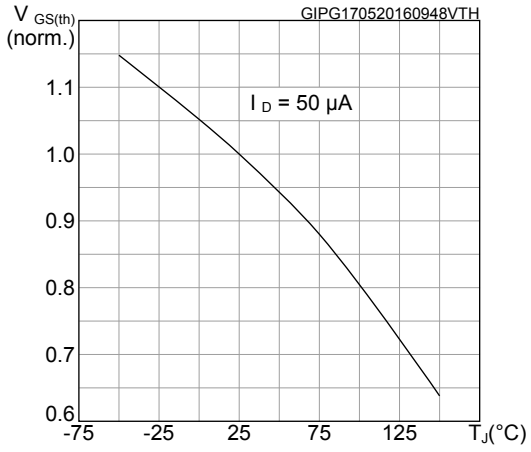



**Figure 9. Normalized on-resistance vs temperature**

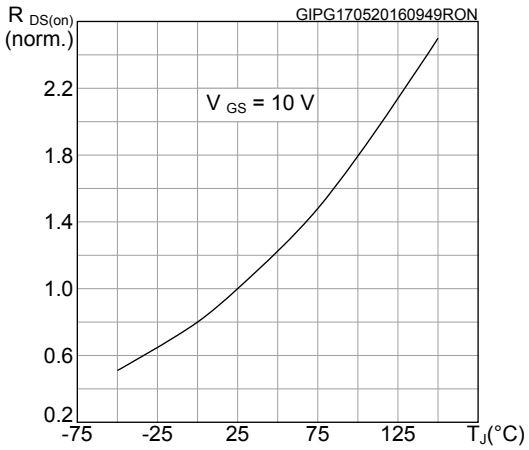



**Figure 10. Normalized breakdown voltage vs temperature**

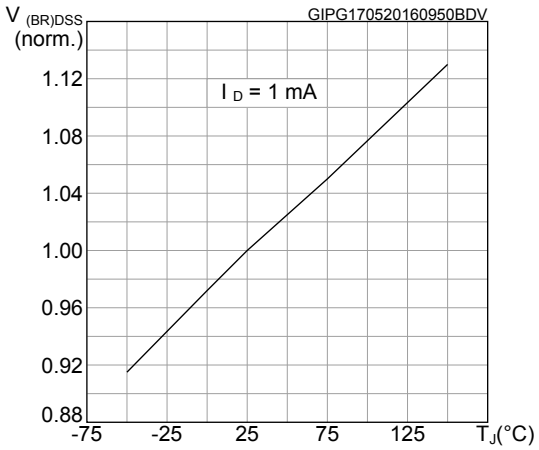



**Figure 11. Maximum avalanche energy vs temperature**

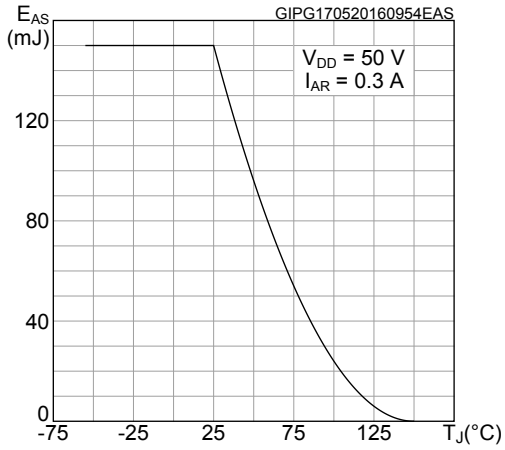
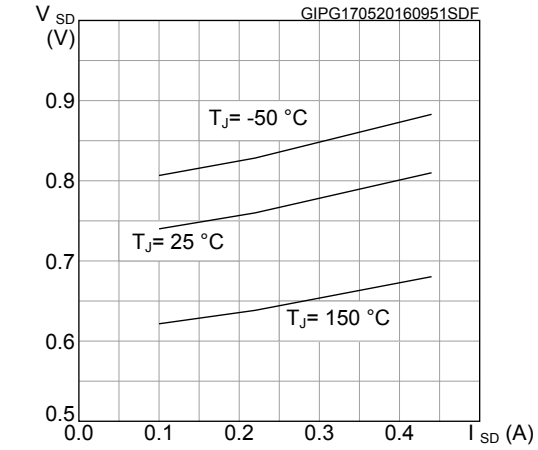



**Figure 12. Typical reverse diode forward characteristics**

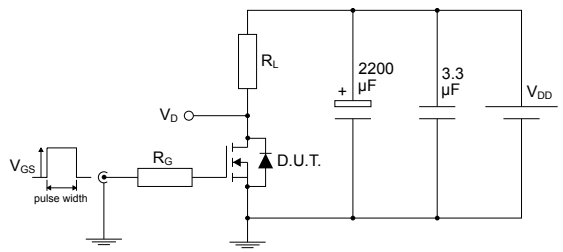




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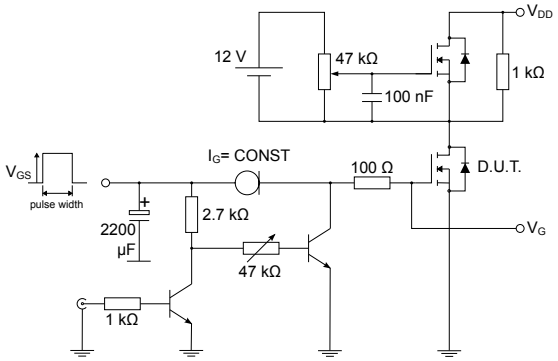
# 3 Test circuits

**Figure 13. Test circuit for resistive load switching times**



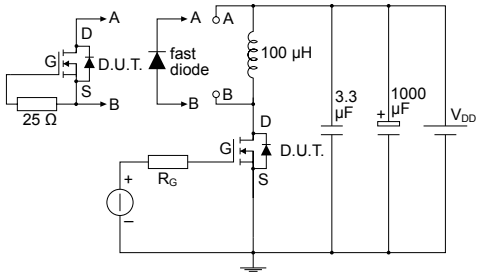

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**Figure 14. Test circuit for gate charge behavior**



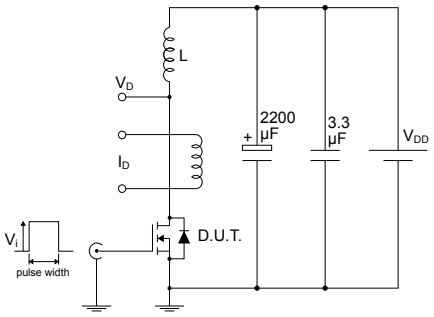

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**Figure 15. Test circuit for inductive load switching and diode recovery times**



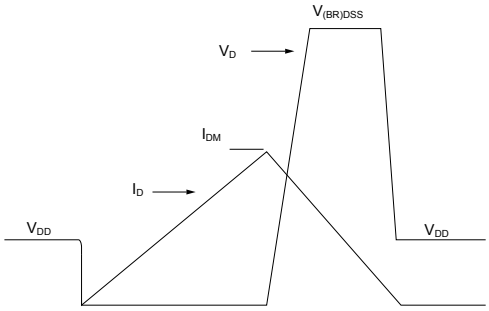

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**Figure 16. Unclamped inductive load test circuit**



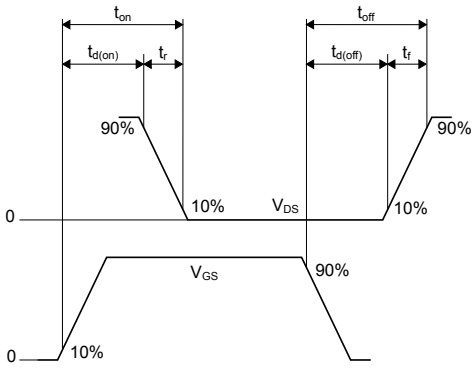

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**Figure 17. Unclamped inductive waveform**




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**Figure 18. Switching time waveform**




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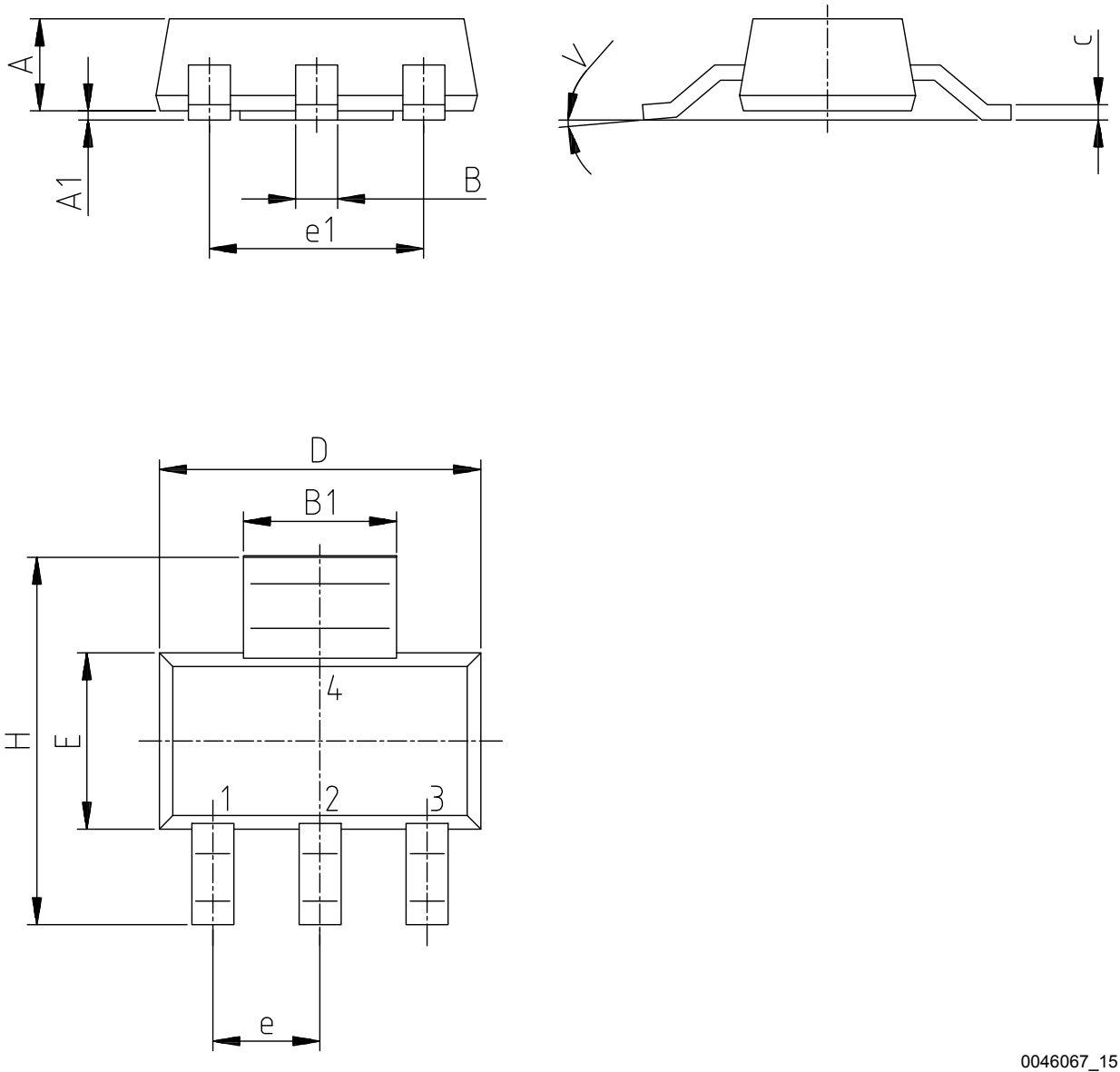

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# 4 Package information

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 SOT-223 package information

**Figure 19. SOT-223 package outline**



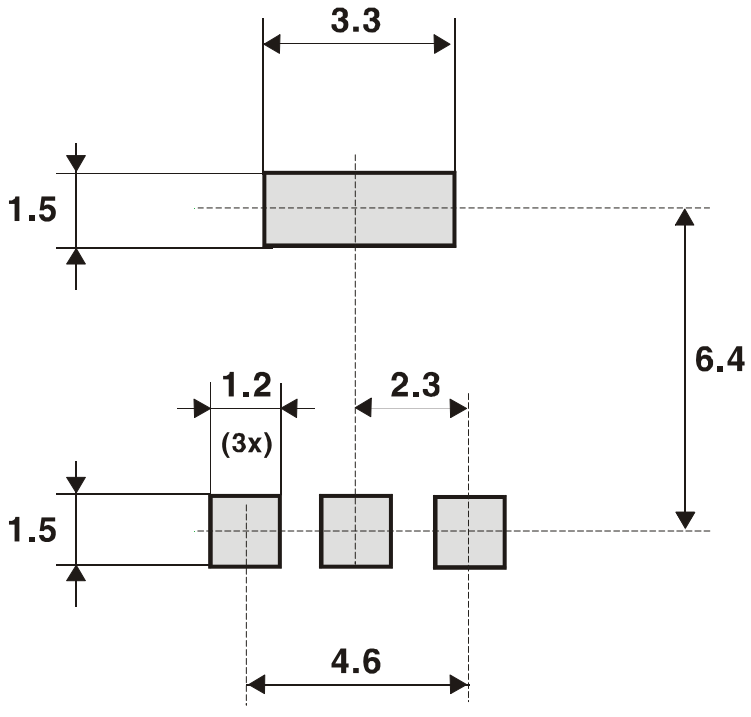


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Table 8. **SOT-223 package mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | | | 1.8 |
| B | 0.6 | 0.7 | 0.85 |
| B1 | 2.9 | 3 | 3.15 |
| c | 0.24 | 0.26 | 0.35 |
| D | 6.3 | 6.5 | 6.7 |
| e | | 2.3 | |
| e1 | | 4.6 | |
| E | 3.3 | 3.5 | 3.7 |
| H | 6.7 | 7 | 7.3 |
| V | | | 10 deg |
| A1 | 0.02 | | 0.1 |

Figure 20. **SOT-223 recommended footprint (dimensions are in mm)**





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## 4.2 SOT-223 packing information

Figure 21. **SOT-223 tape outline**

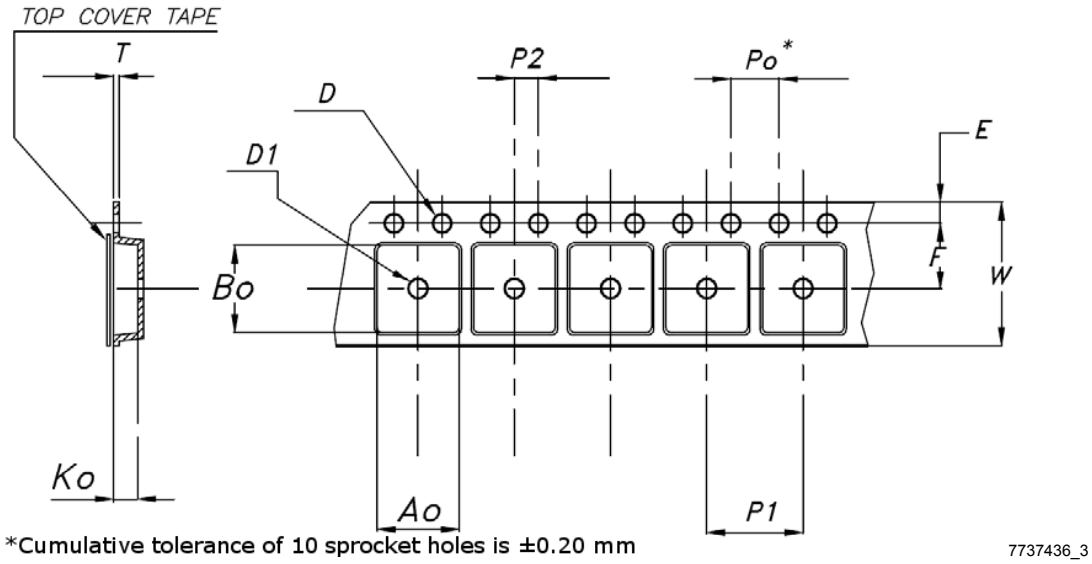
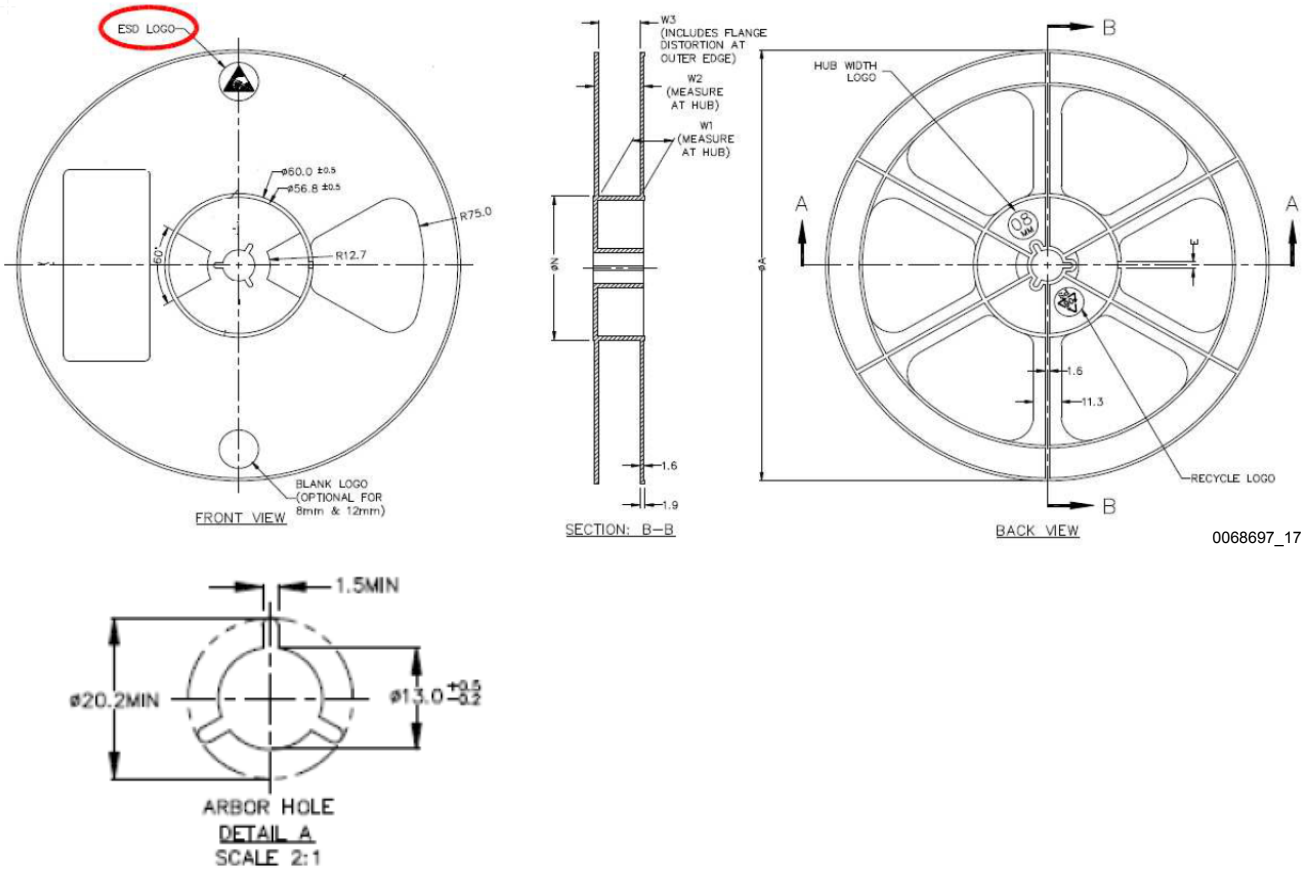



Figure 22. **SOT-223 reel outline**



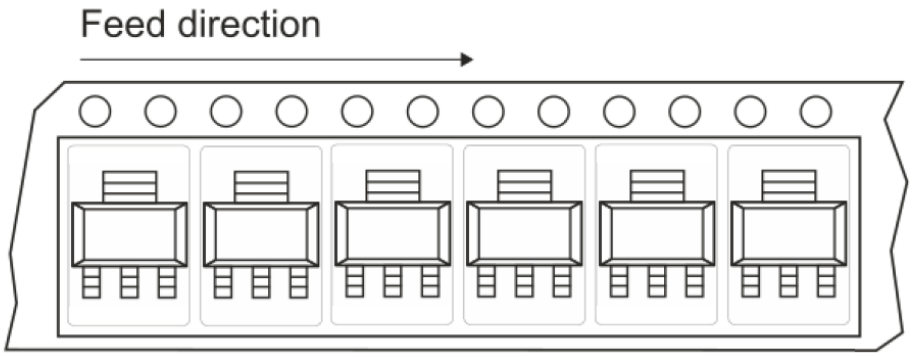


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Table 9. **SOT-223 tape and reel mechanical data**

| Tape | | | | Tape | | |
|---|---|---|---|---|---|---|
| Dim. | mm | | | Dim. | mm | |
| | Min. | Typ. | Max. | | Min. | Max. |
| A0 | 6.75 | 6.85 | 6.95 | A | | 180 |
| B0 | 7.30 | 7.40 | 7.50 | N | 60 | |
| K0 | 1.80 | 1.90 | 2.00 | W1 | | 12.4 |
| F | 5.40 | 5.50 | 5.60 | W2 | | 18.4 |
| E | 1.65 | 1.75 | 1.85 | W3 | 11.9 | 15.4 |
| W | 11.7 | 12.0 | 12.3 | | | |
| P2 | 1.90 | 2.00 | 2.10 | Base quantity pcs | | 1000 |
| P0 | 3.90 | 4.00 | 4.10 | Bulk quantity pcs | | 1000 |
| P1 | 7.90 | 8.00 | 8.10 | | | |
| T | 0.25 | 0.30 | 0.35 | | | |
| DΦ | 1.50 | 1.55 | 1.60 | | | |
| D1Φ | 1.50 | 1.60 | 1.70 | | | |

Figure 23. **SOT-223 package orientation in carrier tape**




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## Revision history

Table 10. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 12-Nov-2015 | 1 | First release. |
| 05-Dec-2016 | 2 | Modified: features in cover page.<br>Modified *Table 2: "Absolute maximum ratings"*, *Table 3: "Thermal data"*, *Table 4: "Avalanche characteristics"*, *Table 5: "On/off-state"*, *Table 6: "Dynamic"*, *Table 7: "Switching times"* and *Table 8: "Sourcedrain diode"*.<br>Datasheet promoted from preliminary data to production data.<br>Modified *Section 3.1: "Electrical characteristics (curves)"*.<br>Minor text changes. |
| 16-Jan-2026 | 3 | Updated *Section Features* and *Section Description.*<br>Updated *Table 4. On/off states.*<br>Updated *Section 4: Package information.*<br>Minor text changes. |
| 14-Jul-2026 | 4 | Added Figure 23. SOT-223 package orientation in carrier tape.<br>Minor text changes. |


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