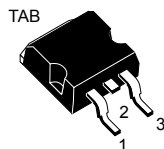
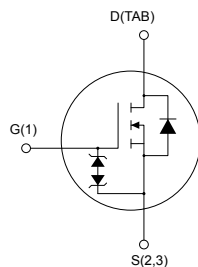


# Automotive-grade N-channel 600 V, 70 mΩ typ., 36 A MDmesh™ DM6 Power MOSFET in an H<sup>2</sup>PAK-2 package


**H<sup>2</sup>PAK-2**


NCHG10TAB523TZ



## Features

| Order code      | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|-----------------|-----------------|--------------------------|----------------|
| STH47N60DM6-2AG | 600 V           | 80 mΩ                    | 36 A           |

- AEC-Q101 qualified 
- Fast-recovery body diode
- Lower R<sub>DS(on)</sub> per area vs previous generation
- Low gate charge, input capacitance and resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

## Applications

- Switching applications

## Description

This high-voltage N-channel Power MOSFET is part of the MDmesh™ DM6 fast-recovery diode series. Compared with the previous MDmesh fast generation, DM6 combines very low recovery charge (Q<sub>rr</sub>), recovery time (t<sub>rr</sub>) and excellent improvement in R<sub>DS(on)</sub> per area with one of the most effective switching behaviors available in the market for the most demanding high-efficiency bridge topologies and ZVS phase-shift converters.

### Product status link

[STH47N60DM6-2AG](#)

### Product summary

|            |                      |
|------------|----------------------|
| Order code | STH47N60DM6-2AG      |
| Marking    | 47N60DM6             |
| Package    | H <sup>2</sup> PAK-2 |
| Packing    | Tape and reel        |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol        | Parameter                                                         | Value      | Unit               |
|---------------|-------------------------------------------------------------------|------------|--------------------|
| $V_{GS}$      | Gate-source voltage                                               | $\pm 25$   | V                  |
| $I_D$         | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$  | 36         | A                  |
| $I_D$         | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$ | 23         | A                  |
| $I_D^{(1)}$   | Drain current (pulsed)                                            | 137        | A                  |
| $P_{TOT}$     | Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$     | 250        | W                  |
| $dv/dt^{(2)}$ | Peak diode recovery voltage slope                                 | 50         | V/ns               |
| $dv/dt^{(3)}$ | MOSFET $dv/dt$ ruggedness                                         | 100        |                    |
| $T_J$         | Operating junction temperature range                              | -55 to 150 | $^{\circ}\text{C}$ |
| $T_{stg}$     | Storage temperature range                                         |            |                    |

1. Pulse width limited by safe operating area
2.  $I_{SD} \leq 36\text{ A}$ ,  $di/dt \leq 800\text{ A}/\mu\text{s}$ ,  $V_{DS(peak)} < V_{(BR)DSS}$ ,  $V_{DD} = 480\text{ V}$
3.  $V_{DS} \leq 480\text{ V}$

**Table 2. Thermal data**

| Symbol              | Parameter                        | Value | Unit                        |
|---------------------|----------------------------------|-------|-----------------------------|
| $R_{thj-case}$      | Thermal resistance junction-case | 0.5   | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-pcb}^{(1)}$ | Thermal resistance junction-pcb  | 30    |                             |

1. When mounted on FR-4 board of 1 inch<sup>2</sup>, 2oz Cu.

**Table 3. Avalanche characteristics**

| Symbol   | Parameter                                                                                                               | Value | Unit |
|----------|-------------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{Jmax}$ )                                    | 7     | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 100\text{ V}$ ) | 700   | 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    | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$                                                    | 600  |      |         | V                |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$                                                |      |      | 1       | $\mu\text{A}$    |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ ,<br>$T_C = 125\text{ }^{\circ}\text{C}^{(1)}$ |      |      | 100     | $\mu\text{A}$    |
| $I_{GSS}$     | Gate body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$                                             |      |      | $\pm 1$ | $\mu\text{A}$    |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                             | 3.25 | 4    | 4.75    | V                |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 18\text{ A}$                                                   |      | 70   | 80      | $\text{m}\Omega$ |

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

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                                 | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$                                                                            | -    | 2350 | -    | pF       |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                                 | -    | 160  | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                                 | -    | 2    | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                     | -    | 416  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ open drain                                                                                                                   | -    | 1.6  | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 36\text{ A}$ ,<br>$V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 55   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                                 | -    | 12   | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                                 | -    | 31   | -    | 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 6. Switching times**

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                  | Min. | Typ. | Max. | Unit |
|--------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 18\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | -    | 23   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                  | -    | 5.5  | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                  | -    | 57   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                  | -    | 9    | -    | ns   |

**Table 7. Source-drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                    | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                    | -    |      | 36   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                    | -    |      | 137  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 36\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                                                                                                                     | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 36\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$<br>(see Figure 15. Test circuit for inductive load switching and diode recovery times)                                     | -    | 115  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                    | -    | 0.54 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                    | -    | 9.5  |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 36\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 210  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                    | -    | 2.1  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                    | -    | 20.4 |      | A             |

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

**Table 8. Gate-source Zener diode**

| Symbol        | Parameter                     | Test conditions                                 | Min.     | Typ. | Max. | Unit |
|---------------|-------------------------------|-------------------------------------------------|----------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1\text{ mA}$ , $I_D = 0\text{ A}$ | $\pm 30$ | -    | -    | V    |

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

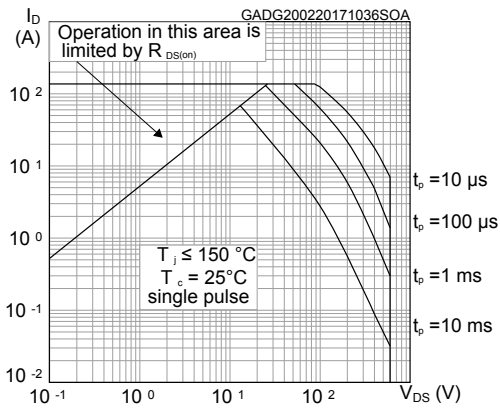


Figure 2. Thermal impedance

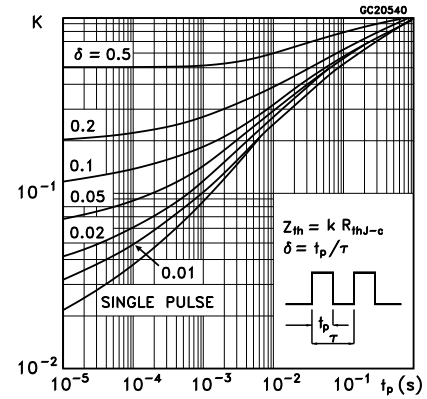


Figure 3. Output characteristics

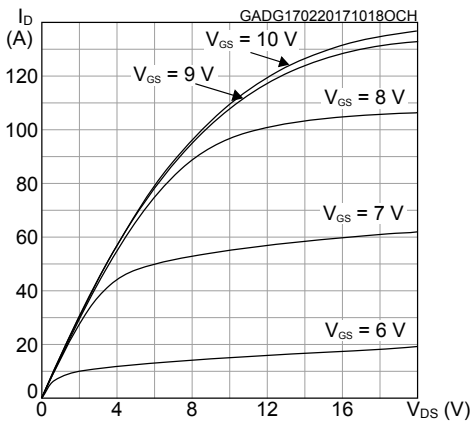


Figure 4. Transfer characteristics

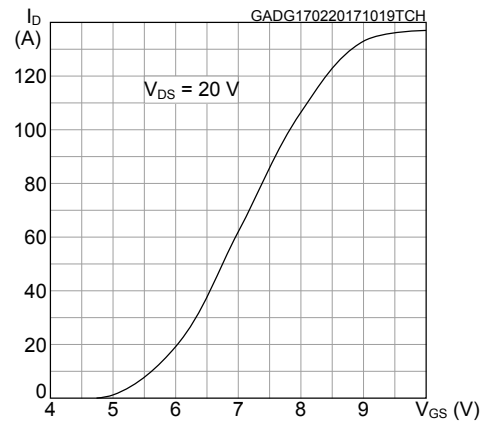


Figure 5. Gate charge vs gate-source voltage

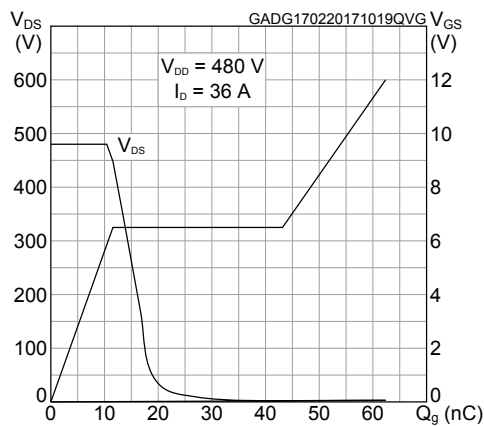


Figure 6. Static drain-source on-resistance

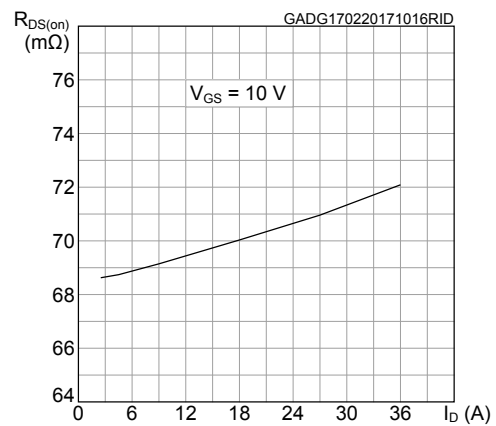


**Figure 7. Capacitance variations**

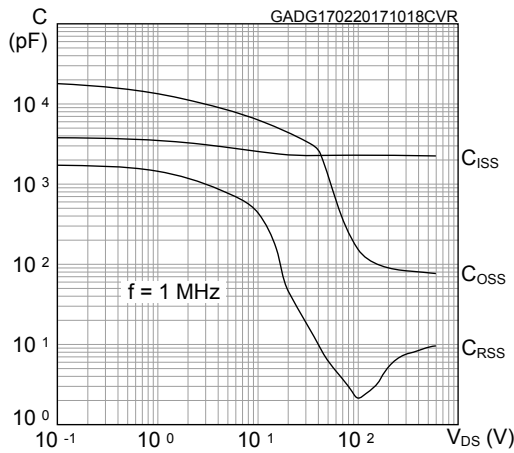


**Figure 8. Normalized gate threshold voltage vs temperature**

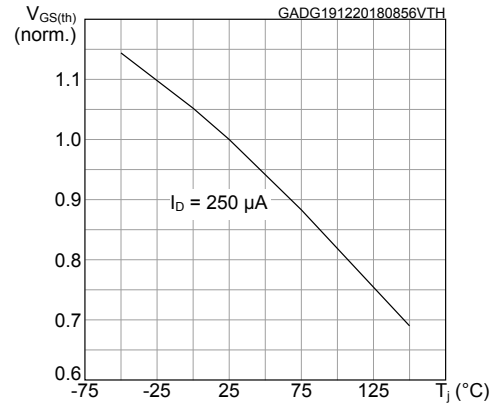


**Figure 9. Normalized on-resistance vs temperature**

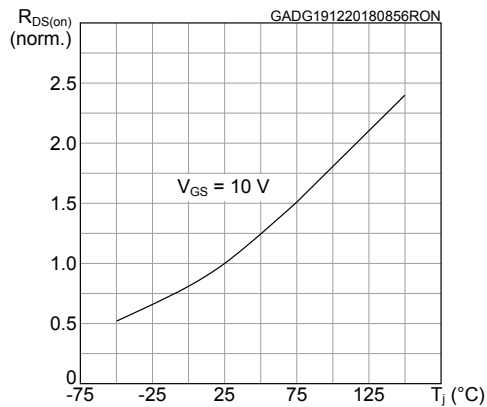


**Figure 10. Normalized  $V_{(BR)DSS}$  vs temperature**

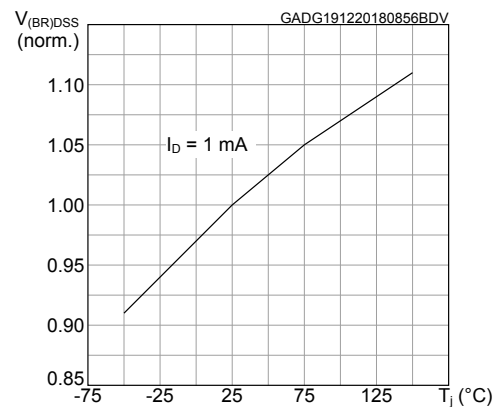


**Figure 11. Source-drain diode forward characteristics**

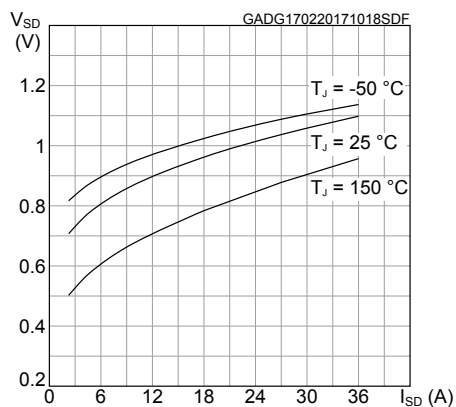
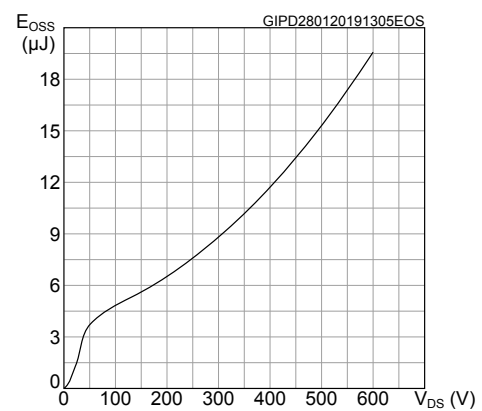
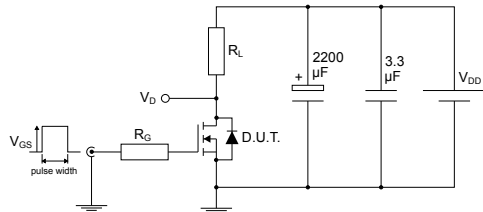


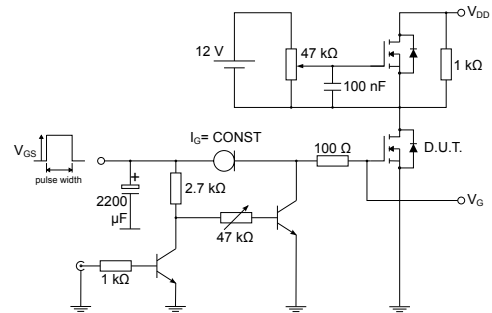
**Figure 12. Output capacitance stored energy**



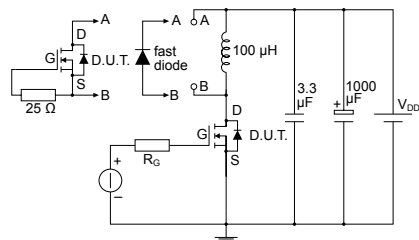
### 3 Test circuits

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


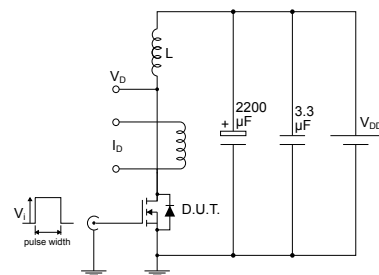
AM01468v1

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


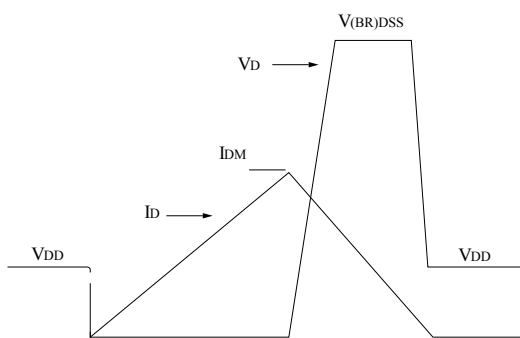
AM01469v1

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


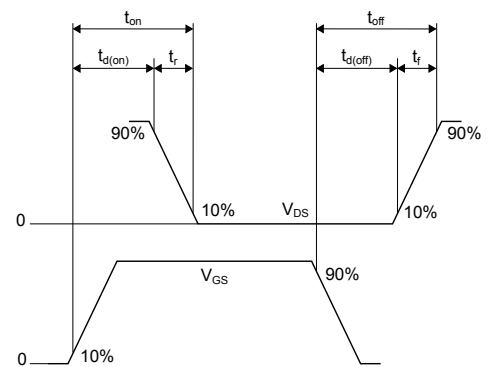
AM01470v1

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


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


AM01473v1

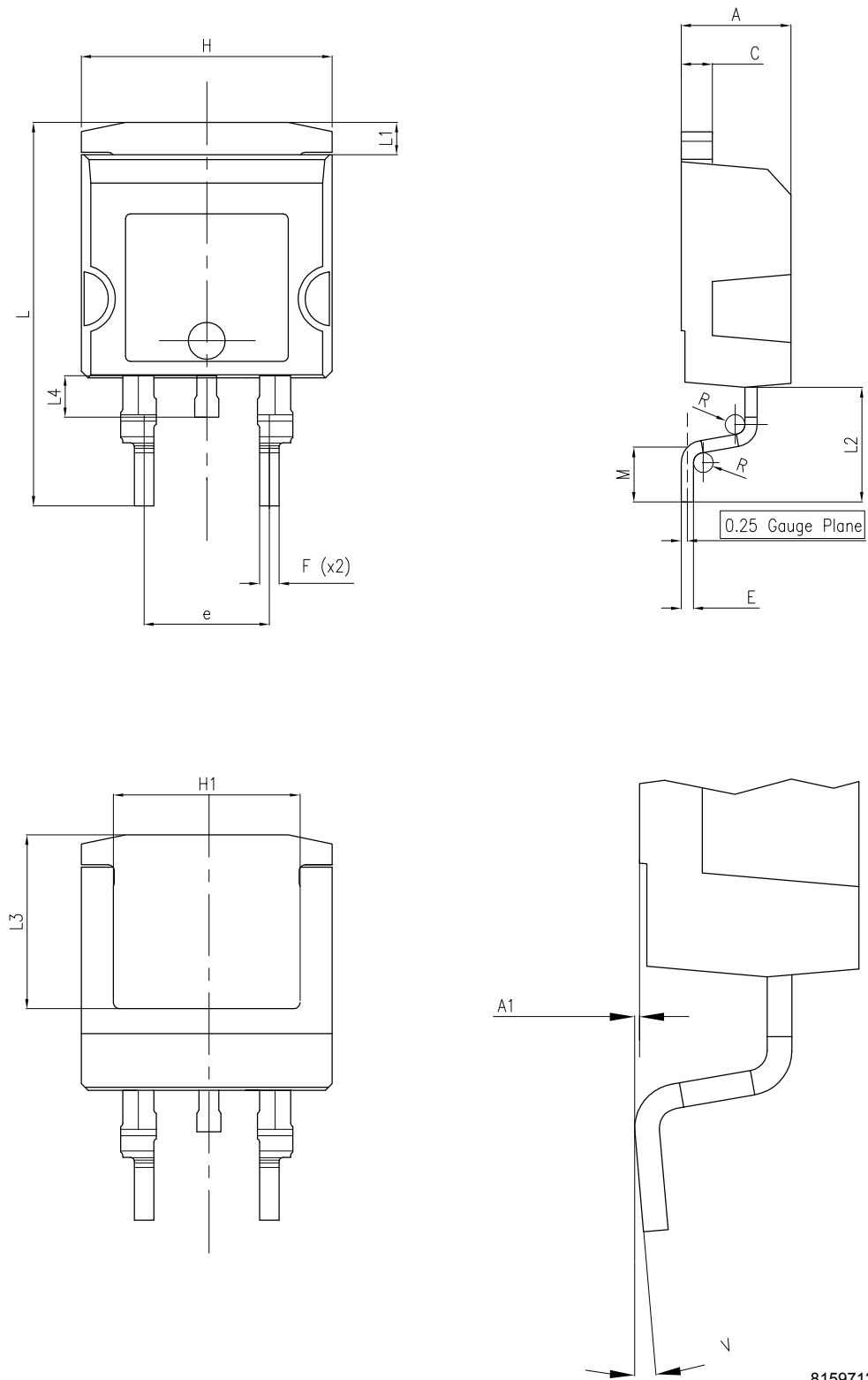
## 4 Package information

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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](http://www.st.com). ECOPACK® is an ST trademark.

## 4.1 H<sup>2</sup>PAK-2 package information

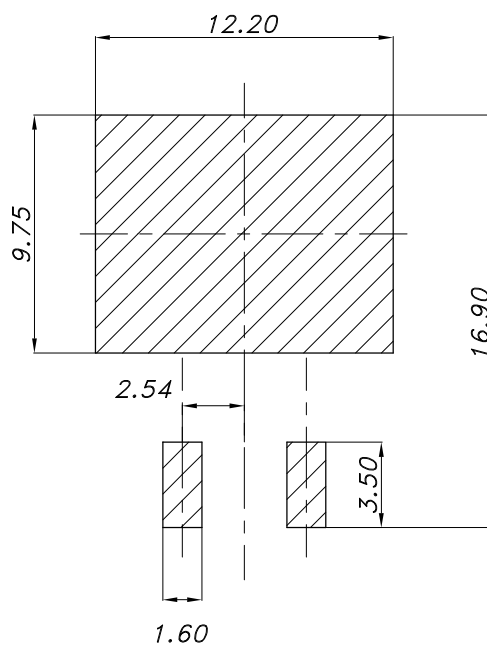
Figure 19. H<sup>2</sup>PAK-2 package outline



8159712\_8

**Table 9. H<sup>2</sup>PAK-2 package mechanical data**

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.30  | -    | 4.70  |
| A1   | 0.03  |      | 0.20  |
| C    | 1.17  |      | 1.37  |
| e    | 4.98  |      | 5.18  |
| E    | 0.50  |      | 0.90  |
| F    | 0.78  |      | 0.85  |
| H    | 10.00 |      | 10.40 |
| H1   | 7.40  |      | 7.80  |
| L    | 15.30 |      | 15.80 |
| L1   | 1.27  |      | 1.40  |
| L2   | 4.93  |      | 5.23  |
| L3   | 6.85  |      | 7.25  |
| L4   | 1.5   |      | 1.7   |
| M    | 2.6   |      | 2.9   |
| R    | 0.20  |      | 0.60  |
| V    | 0°    |      | 8°    |

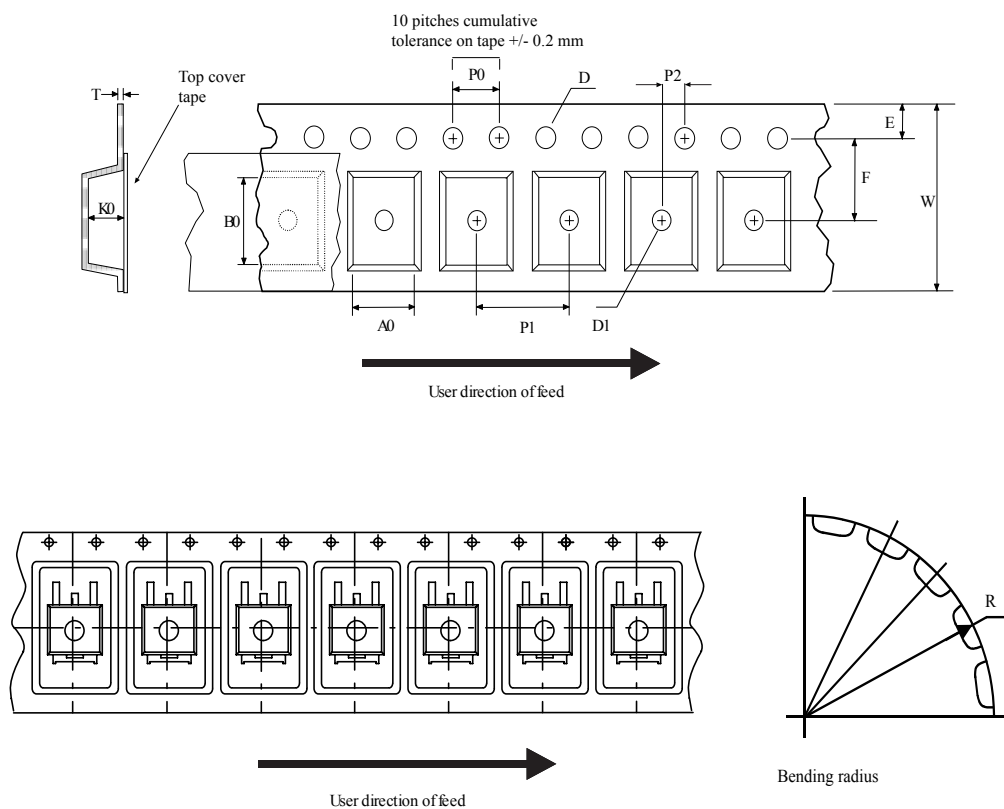
**Figure 20. H<sup>2</sup>PAK-2 recommended footprint**


8159712\_8

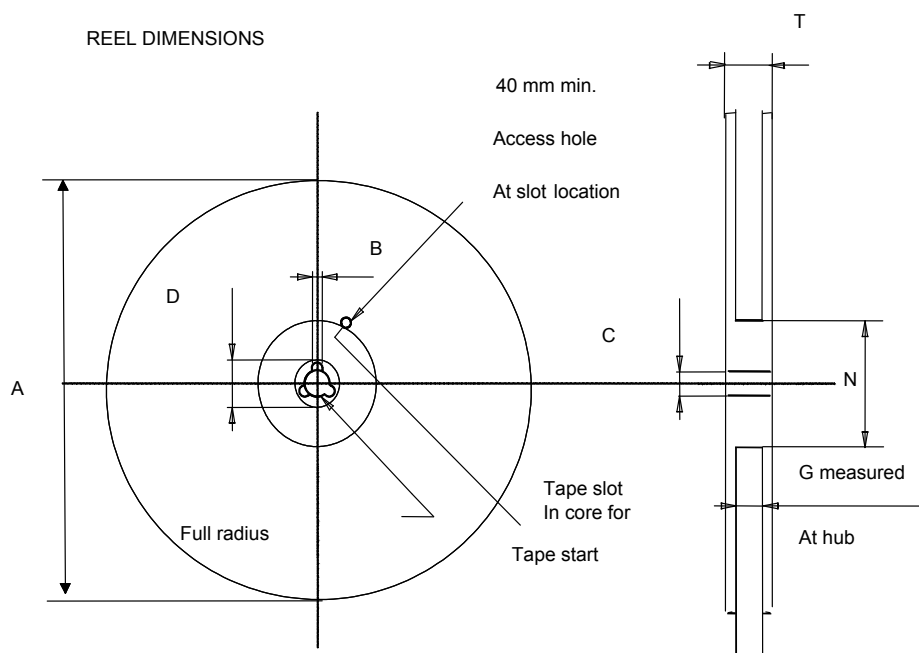
**Note:** Dimensions are in mm.

## 4.2 Packing information

**Figure 21. Tape outline**



AM08852v2

**Figure 22. Reel outline**

**Table 10. 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 |               |      |      |

## Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                 |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 09-Aug-2017 | 1        | Initial release.                                                                                                                                                                                                                                        |
| 11-Mar-2019 | 2        | Modified title and features on cover page.<br>Modified <a href="#">Section 1 Electrical ratings</a> , <a href="#">Section 2 Electrical characteristics</a> and <a href="#">Section 2.1 Electrical characteristics (curves)</a> .<br>Minor text changes. |

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