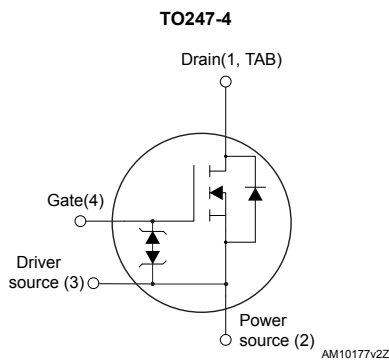
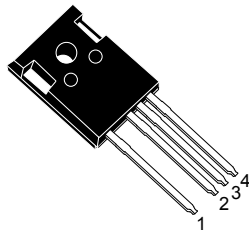



# Automotive N-channel 650 V, 33 mΩ typ., 72 A MDmesh DM6 Power MOSFET in a TO247-4 package



## Features

| Order code      | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|-----------------|-----------------|--------------------------|----------------|
| STW68N65DM6-4AG | 650 V           | 39 mΩ                    | 72 A           |

- Designed for automotive applications 
- 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
- Excellent switching performance thanks to the extra driving source pin
- 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

[STW68N65DM6-4AG](#)

### Product summary

|                   |                 |
|-------------------|-----------------|
| <b>Order code</b> | STW68N65DM6-4AG |
| <b>Marking</b>    | 68N65DM6AG      |
| <b>Package</b>    | TO247-4         |
| <b>Packing</b>    | Tube            |

# 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 $T_C = 25\text{ }^\circ\text{C}$  | 72         | A                |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 46         | A                |
| $I_{DM}^{(1)}$ | Drain current (pulsed)  | 280        | A                |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$     | 480        | W                |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                               | 100        | V/ns             |
| $di/dt^{(2)}$  | Peak diode recovery current slope                               | 1000       | A/ $\mu\text{s}$ |
| $dv/dt^{(3)}$  | MOSFET $dv/dt$ ruggedness                                       | 100        | V/ns             |
| $T_{STG}$      | Storage temperature range                                       | -55 to 150 | $^\circ\text{C}$ |
| $T_J$          | Operating junction temperature range                            |            | $^\circ\text{C}$ |

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 72\text{ A}$ ,  $V_{DS}(\text{peak}) < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .
3.  $V_{DS} \leq 520\text{ V}$ .

**Table 2. Thermal data**

| Symbol         | Parameter                           | Value | Unit               |
|----------------|-------------------------------------|-------|--------------------|
| $R_{thj-case}$ | Thermal resistance junction-case    | 0.26  | $^\circ\text{C/W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 50    | $^\circ\text{C/W}$ |

**Table 3. Avalanche characteristics**

| Symbol   | Parameter   | Value | Unit |
|----------|---|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive ( $t_p$ limited by $T_J$ max)               | 9     | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ ) | 1.9   | J    |

## 2 Electrical characteristics

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

**Table 4. On/off states**

| 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   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$   |      |      | 10      | $\mu\text{A}$    |
|               |                                   | $V_{GS} = 0\text{ V}$ , $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}^{(1)}$ |      |      | 300     |                  |
| $I_{GSS}$     | Gate-body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$  |      |      | $\pm 5$ | $\mu\text{A}$    |
| $V_{GS(th)}$  | 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 | $V_{GS} = 10\text{ V}$ , $I_D = 36\text{ A}$  |      | 33   | 39      | $\text{m}\Omega$ |

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

**Table 5. Dynamic characteristics**

| Symbol                     | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit        |
|----------------------------|-------------------------------|--|------|------|------|-------------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$   | -    | 5900 | -    | $\text{pF}$ |
| $C_{oss}$                  | Output capacitance            |  | -    | 260  | -    |             |
| $C_{riss}$                 | Reverse transfer capacitance  |  | -    | 2.6  | -    |             |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0\text{ V}$  | -    | 867  | -    |             |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$  | -    | 1.4  | -    | $\Omega$    |
| $Q_g$                      | Total gate charge             | $V_{DD} = 520\text{ V}$ , $I_D = 72\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 118  | -    | $\text{nC}$ |
| $Q_{gs}$                   | Gate-source charge            |  | -    | 37   | -    |             |
| $Q_{gd}$                   | Gate-drain charge             |  | -    | 48   | -    |             |

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  | $V_{DD} = 325\text{ V}$ , $I_D = 36\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$   | -    | 34   | -    | ns   |
| $t_r$        | Rise time           |   | -    | 16   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time | (see Figure 13. Switching times test circuit for resistive load and Figure 18. Switching time waveform) | -    | 92   | -    | ns   |
| $t_f$        | Fall time           |   | -    | 10   | -    | ns   |

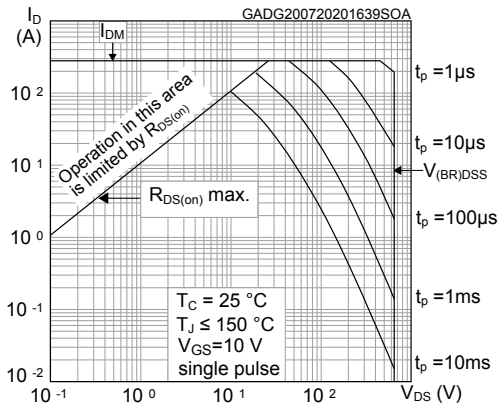
**Table 7. Source-drain diode**

| Symbol          | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |  | -    |      | 72   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |  | -    |      | 280  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 72\text{ A}$   | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 72\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$<br>(see Figure 15. Test circuit for inductive load switching and diode recovery times)  | -    | 142  | -    | ns            |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 0.9  | -    | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 10.6 | -    | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 72\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<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) | -    | 310  | -    | ns            |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 4.5  | -    | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 26   | -    | A             |

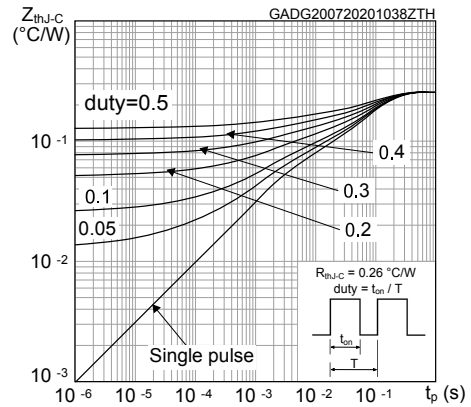
1. Pulse width is limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

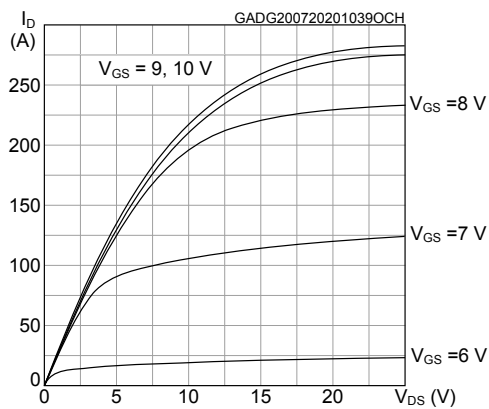
**Figure 1. Safe operating area**



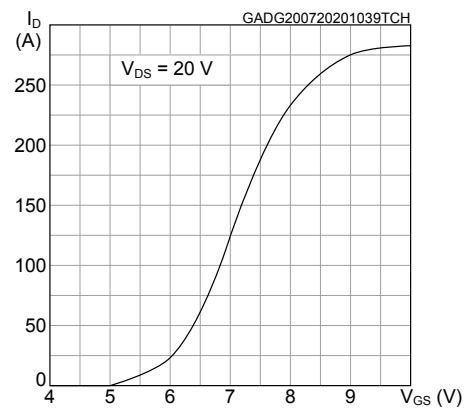
**Figure 2. Maximum transient thermal impedance**



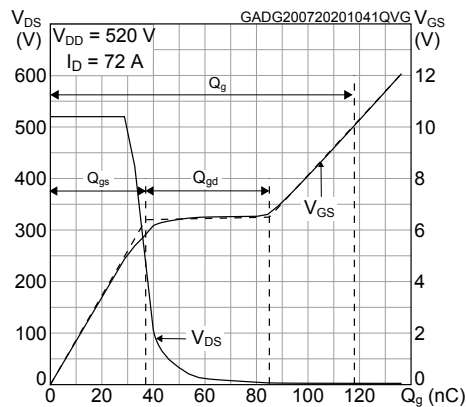
**Figure 3. Typical output characteristics**



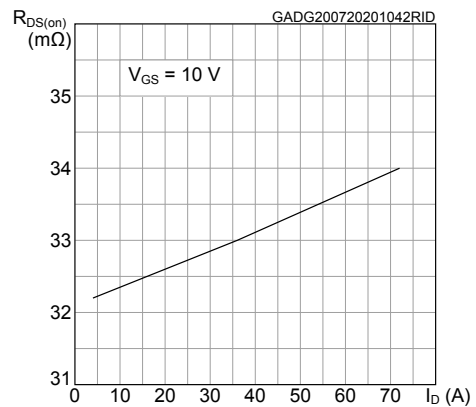
**Figure 4. Typical transfer characteristics**



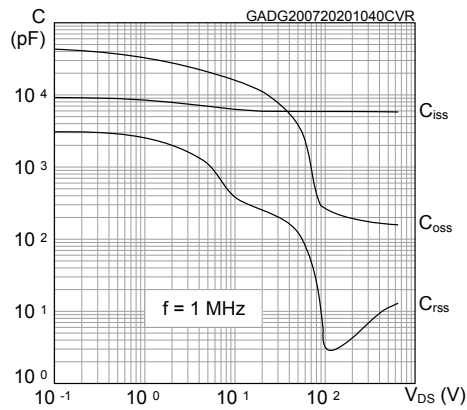
**Figure 5. Typical gate charge characteristics**



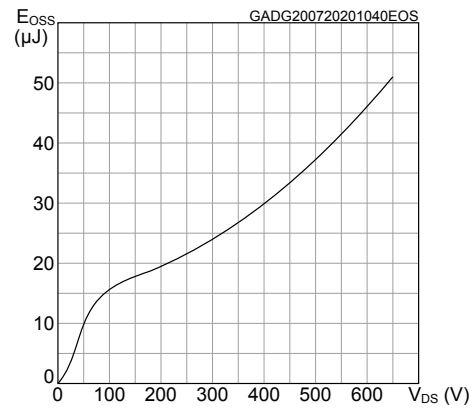
**Figure 6. Typical drain-source on-resistance**



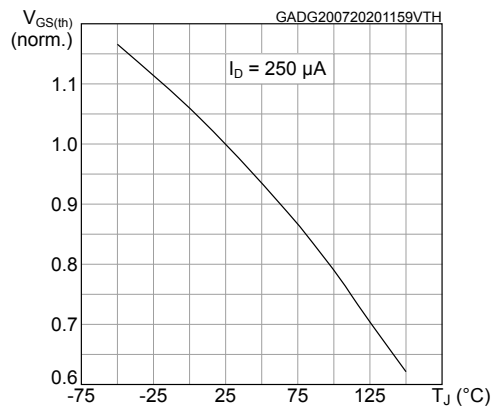
**Figure 7. Typical capacitance characteristics**



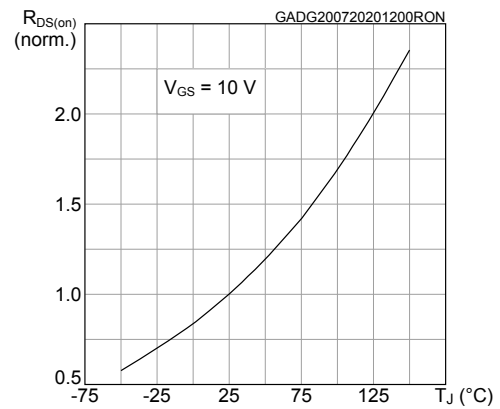
**Figure 8. Typical output capacitance stored energy**



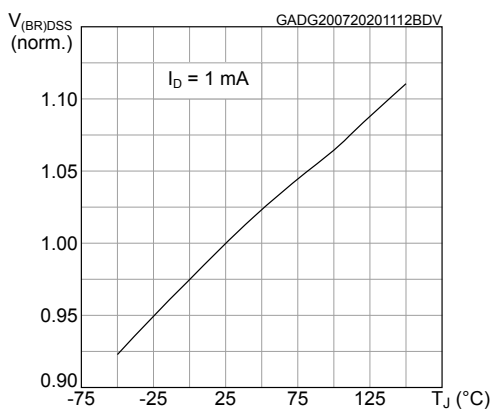
**Figure 9. Normalized gate threshold vs temperature**



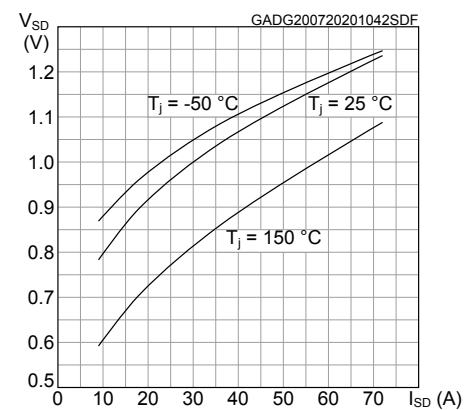
**Figure 10. Normalized on-resistance vs temperature**



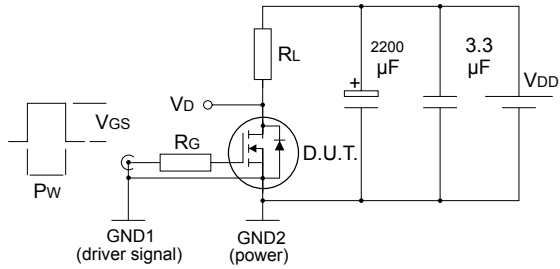
**Figure 11. Normalized breakdown voltage vs temperature**



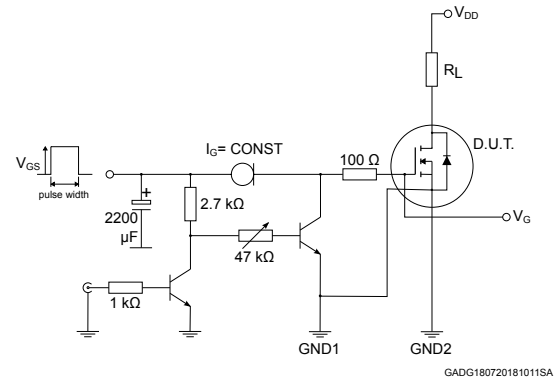
**Figure 12. Typical reverse diode forward characteristics**



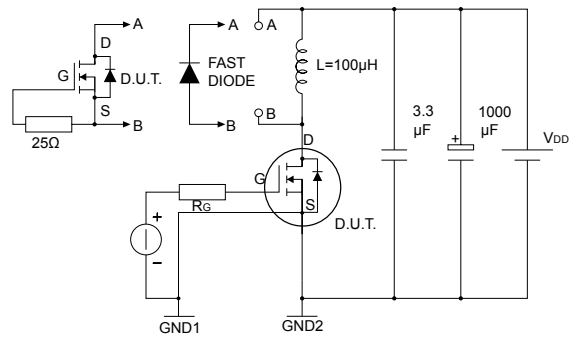
### 3 Test circuits

**Figure 13. Switching times test circuit for resistive load**


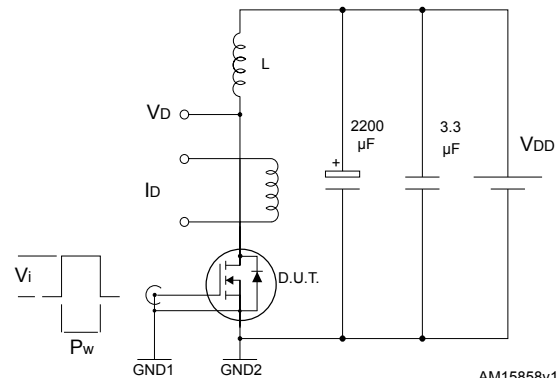
AM15855v1

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


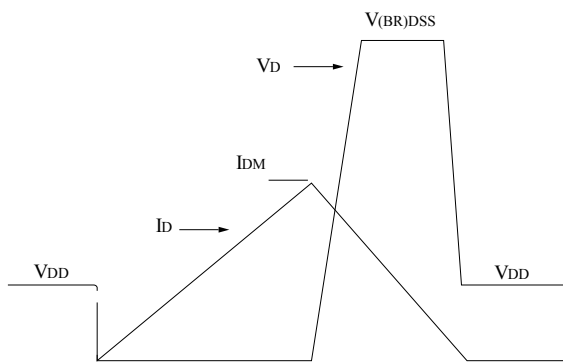
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**Figure 15. Test circuit for inductive load switching and diode recovery times**


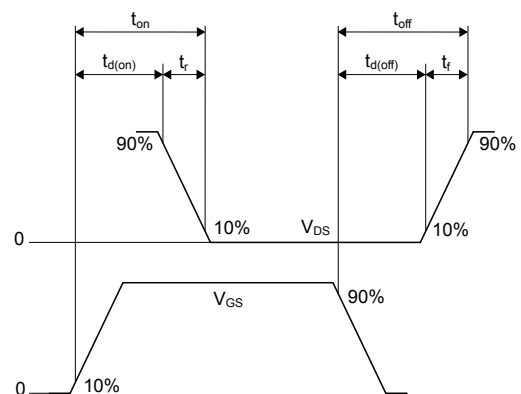
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**Figure 16. Unclamped inductive load test circuit**


AM15858v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


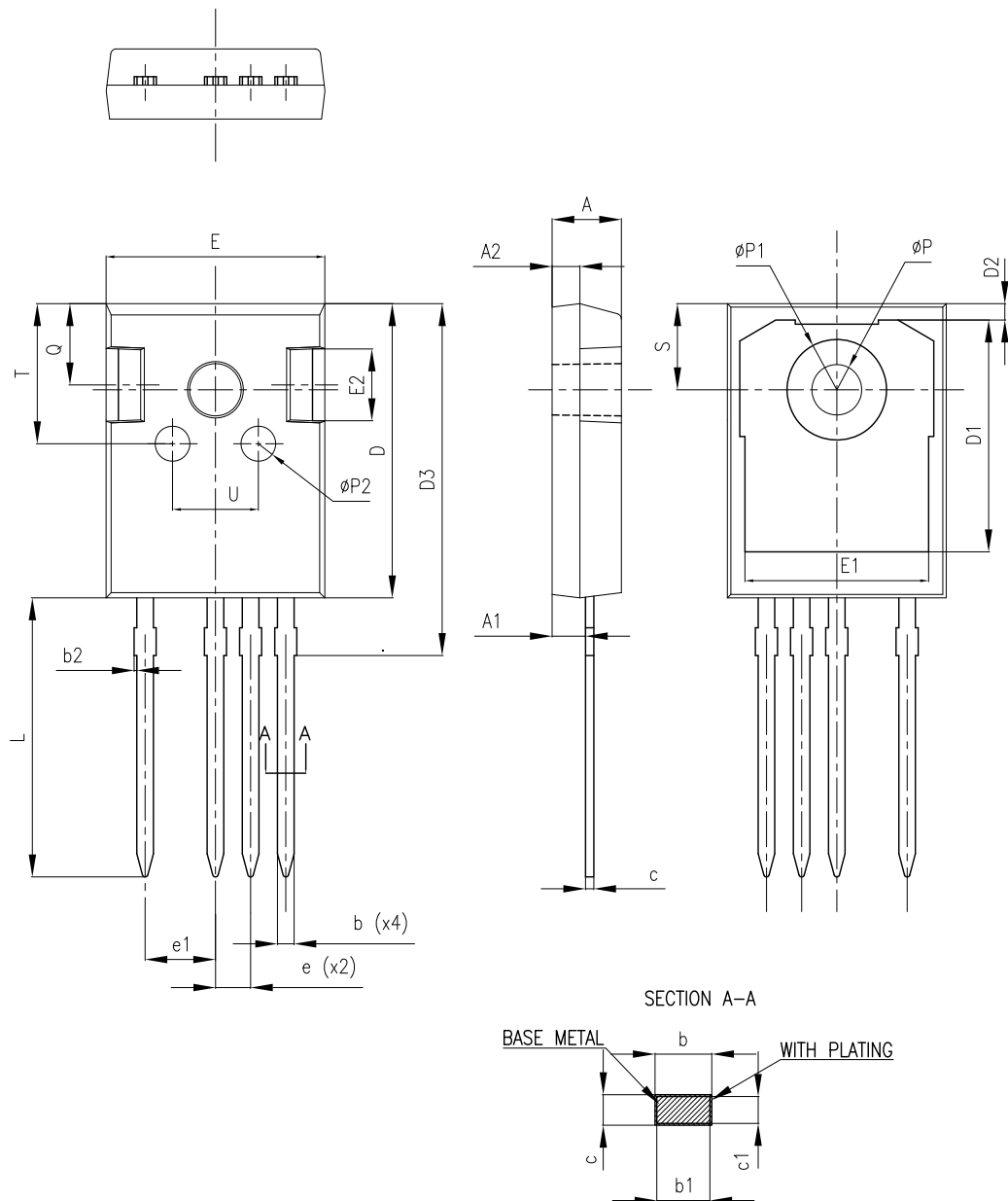
AM01473v1

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

### 4.1 TO247-4 package information

Figure 19. TO247-4 package outline



8405626\_2

**Table 8. TO247-4 mechanical data**

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.90  | 5.00  | 5.10  |
| A1   | 2.31  | 2.41  | 2.51  |
| A2   | 1.90  | 2.00  | 2.10  |
| b    | 1.16  |       | 1.29  |
| b1   | 1.15  | 1.20  | 1.25  |
| b2   | 0     |       | 0.20  |
| c    | 0.59  |       | 0.66  |
| c1   | 0.58  | 0.60  | 0.62  |
| D    | 20.90 | 21.00 | 21.10 |
| D1   | 16.25 | 16.55 | 16.85 |
| D2   | 1.05  | 1.20  | 1.35  |
| D3   | 24.97 | 25.12 | 25.27 |
| E    | 15.70 | 15.80 | 15.90 |
| E1   | 13.10 | 13.30 | 13.50 |
| E2   | 4.90  | 5.00  | 5.10  |
| E3   | 2.40  | 2.50  | 2.60  |
| e    | 2.44  | 2.54  | 2.64  |
| e1   | 4.98  | 5.08  | 5.18  |
| L    | 19.80 | 19.92 | 20.10 |
| P    | 3.50  | 3.60  | 3.70  |
| P1   |       |       | 7.40  |
| P2   | 2.40  | 2.50  | 2.60  |
| Q    | 5.60  |       | 6.00  |
| S    |       | 6.15  |       |
| T    | 9.80  |       | 10.20 |
| U    | 6.00  |       | 6.40  |

## Revision history

**Table 9. Document revision history**

| Date        | Version | Changes  |
|-------------|---------|--|
| 21-Apr-2020 | 1       | First release.   |
| 20-Jul-2020 | 2       | Modified Table 1. Absolute maximum ratings, Table 3. Avalanche characteristics, Table 4. On/off states, Table 5. Dynamic characteristics, Table 6. Switching times and Table 7. Source-drain diode.<br>Added Section 2.1 Electrical characteristics (curves).<br>Minor text changes. |

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