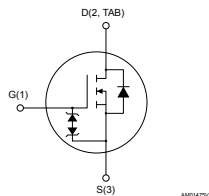
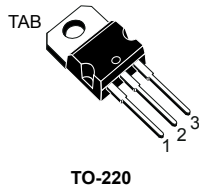


## N-channel 600 V, 115 mΩ typ., 25 A, MDmesh™ DM6 Power MOSFET in a TO-220 package



### Features

| Order code  | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|-------------|-----------------|--------------------------|----------------|
| STP33N60DM6 | 600 V           | 128 mΩ                   | 25 A           |

- 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
- High-creepage package

### 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

[STP33N60DM6](#)

#### Product summary

|                   |             |
|-------------------|-------------|
| <b>Order code</b> | STP33N60DM6 |
| <b>Marking</b>    | 33N60DM6    |
| <b>Package</b>    | TO-220      |
| <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 $T_C = 25\text{ }^\circ\text{C}$  | 25         | A                |
|                | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 16         | A                |
| $I_{DM}^{(1)}$ | Drain current (pulsed)  | 80         | A                |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$     | 190        | 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                            |            |                  |

1. Pulse width is limited by safe operating area.
2.  $I_{SD} \leq 25\text{ A}$ ,  $V_{DS(peak)} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$
3.  $V_{DS} \leq 480\text{ V}$

**Table 2. Thermal data**

| Symbol         | Parameter                           | Value | Unit               |
|----------------|-------------------------------------|-------|--------------------|
| $R_{thj-case}$ | Thermal resistance junction-case    | 0.66  | $^\circ\text{C/W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 62.5  | $^\circ\text{C/W}$ |

**Table 3. Avalanche characteristics**

| Symbol   | Parameter  | Value | Unit |
|----------|--|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )                                 | 4     | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ ) | 360   | mJ   |

## 2 Electrical characteristics

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

**Table 4. On/off states**

| Symbol        | Parameter                         | Test conditions  | Min. | Typ. | Max.    | Unit             |
|---------------|-----------------------------------|--|------|------|---------|------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$                                      | 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>$T_C = 125\text{ °C}^{(1)}$ |      |      | 100     | $\mu\text{A}$    |
| $I_{GSS}$     | 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 | $V_{GS} = 10\text{ V}$ , $I_D = 12.5\text{ A}$                                   |      | 115  | 128     | $\text{m}\Omega$ |

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

**Table 5. Dynamic**

| Symbol                     | Parameter                     | Test conditions   | Min. | Typ. | Max. | Unit        |
|----------------------------|-------------------------------|---|------|------|------|-------------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0\text{ V}$   | -    | 1500 | -    | $\text{pF}$ |
| $C_{oss}$                  | Output capacitance            |   | -    | 115  | -    | $\text{pF}$ |
| $C_{riss}$                 | Reverse transfer capacitance  |   | -    | 3    | -    | $\text{pF}$ |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$   | -    | 225  | -    | $\text{pF}$ |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$   | -    | 1.8  | -    | $\Omega$    |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 25\text{ A}$ ,<br>$V_{GS} = 0\text{ to }10\text{ V}$<br>(see Figure 14. Test circuit for gate charge behavior) | -    | 35   | -    | $\text{nC}$ |
| $Q_{gs}$                   | Gate-source charge            |   | -    | 10   | -    | $\text{nC}$ |
| $Q_{gd}$                   | Gate-drain charge             |   | -    | 15   | -    | $\text{nC}$ |

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  | $V_{DD} = 300\text{ V}$ , $I_D = 12.5\text{ A}$ ,<br>$R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ | -    | 14   | -    | ns   |
| $t_r$        | Rise time           |   | -    | 9    | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time | (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | -    | 7    | -    | ns   |
| $t_f$        | Fall time           |   | -    | 35   | -    | ns   |

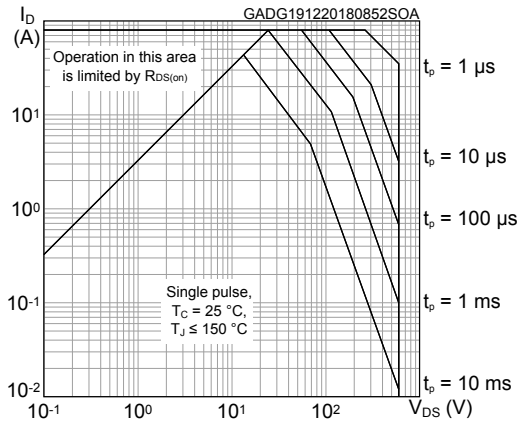
**Table 7. Source drain diode**

| Symbol          | Parameter                     | Test conditions   | Min.  | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---|---|------|------|---------------|
| $I_{SD}$        | Source-drain current          |   | -   |      | 25   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |   | -   |      | 80   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 25\text{ A}$  | -   |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 25\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$                                     | -   | 105  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |   | -   | 0.47 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      | (see Figure 15. Test circuit for inductive load switching and diode recovery times)   | -   | 9    |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 25\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ | -   | 210  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |   | -   | 1.68 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |   | (see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 16   |               |

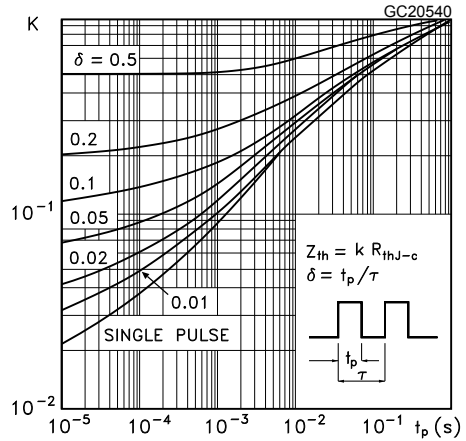
1. Pulse width is limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

## 2.1 Electrical characteristics (curves)

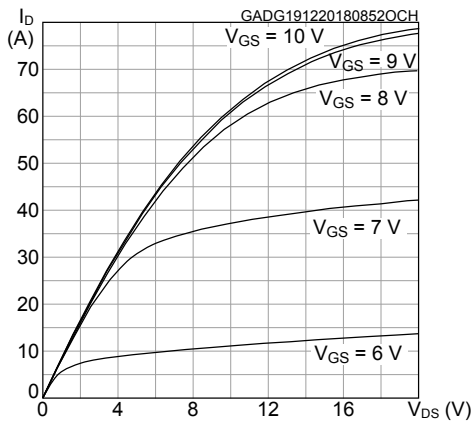
**Figure 1. Safe operating area**



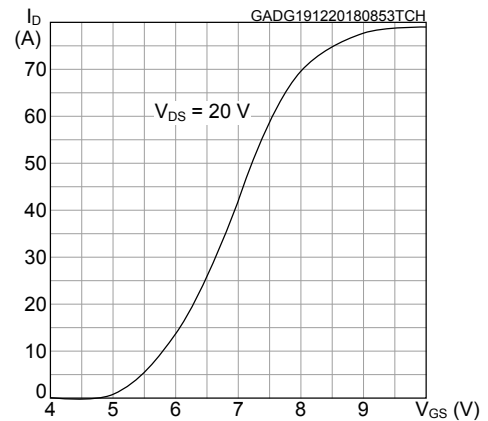
**Figure 2. Normalized thermal impedance**



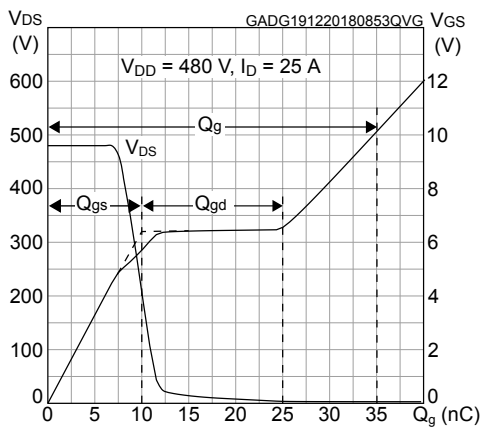
**Figure 3. Output characteristics**



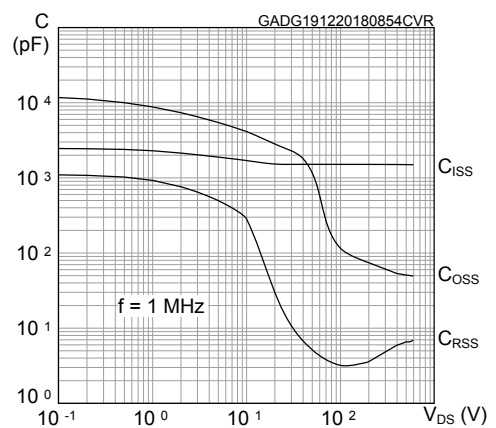
**Figure 4. Transfer characteristics**



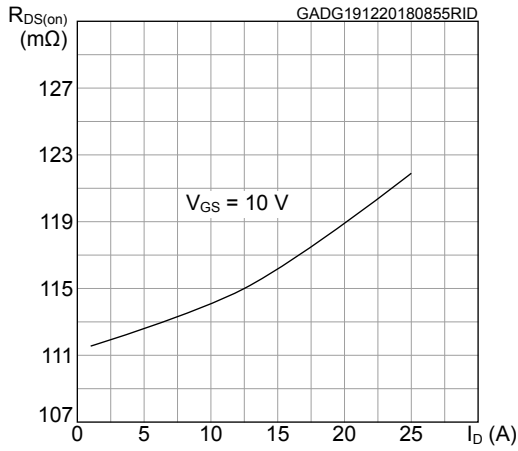
**Figure 5. Gate charge vs gate-source voltage**



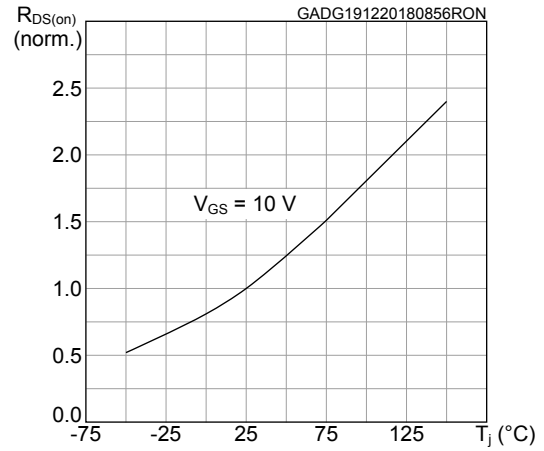
**Figure 6. Capacitance variations**



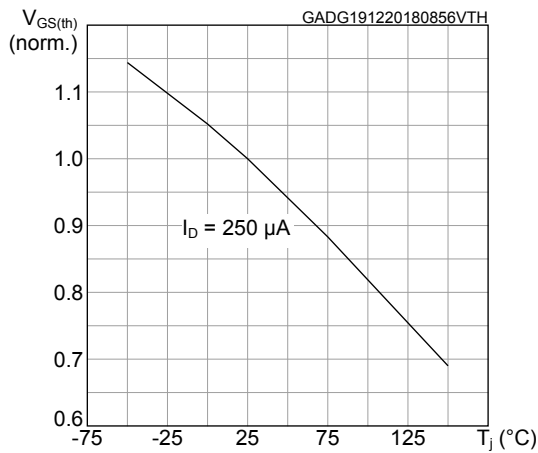
**Figure 7. Static drain-source on-resistance**



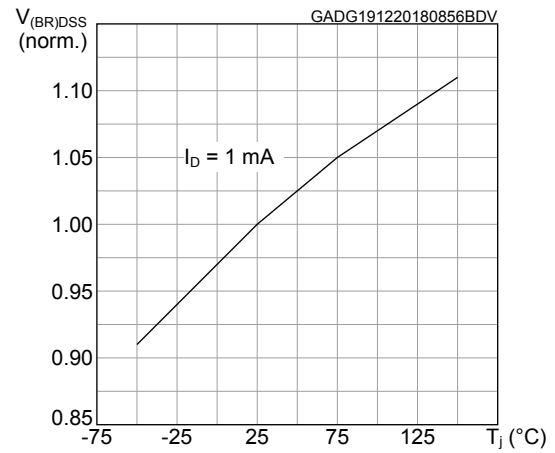
**Figure 8. Normalized on-resistance vs temperature**



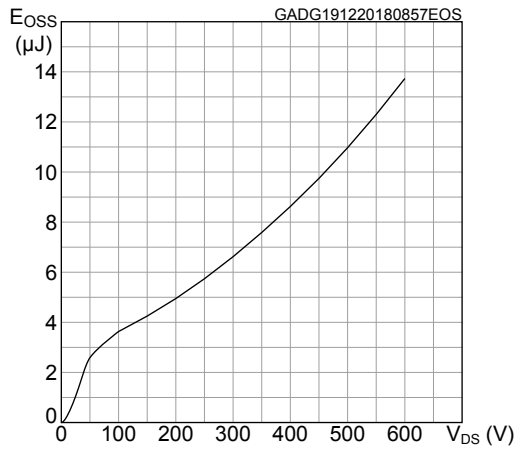
**Figure 9. Normalized gate threshold voltage vs temperature**



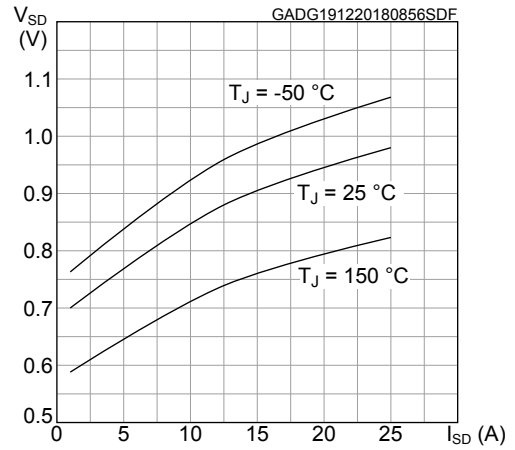
**Figure 10. Normalized  $V_{(BR)DSS}$  vs temperature**



**Figure 11. Output capacitance stored energy**

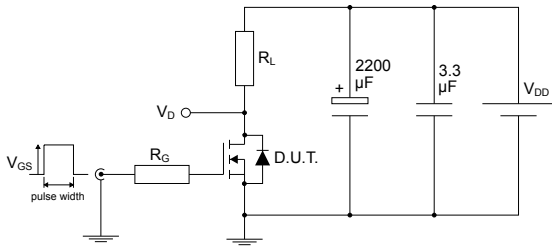


**Figure 12. Source-drain diode forward characteristics**



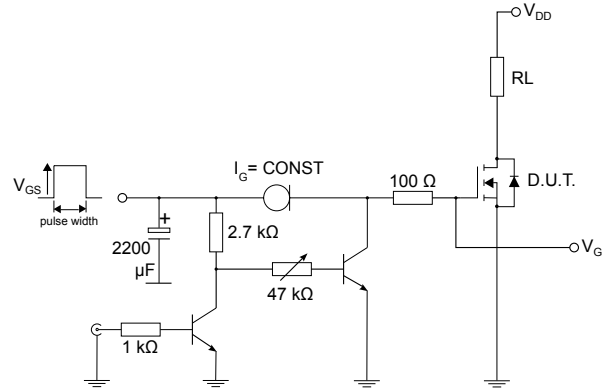
### 3 Test circuits

Figure 13. Test circuit for resistive load switching times



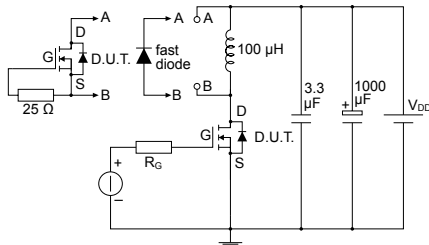
AM01468v1

Figure 14. Test circuit for gate charge behavior



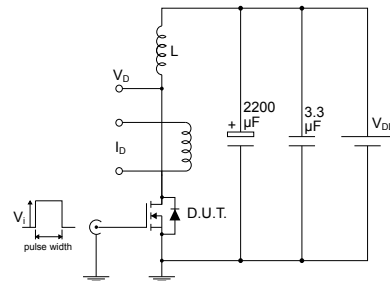
AM01469v10

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



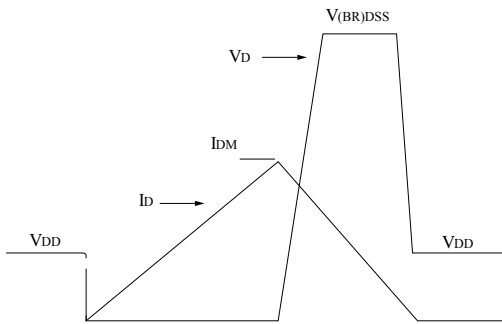
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Figure 16. Unclamped inductive load test circuit



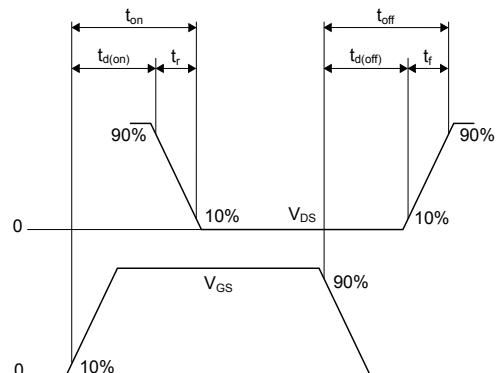
AM01471v1

Figure 17. Unclamped inductive waveform



AM01472v1

Figure 18. Switching time waveform



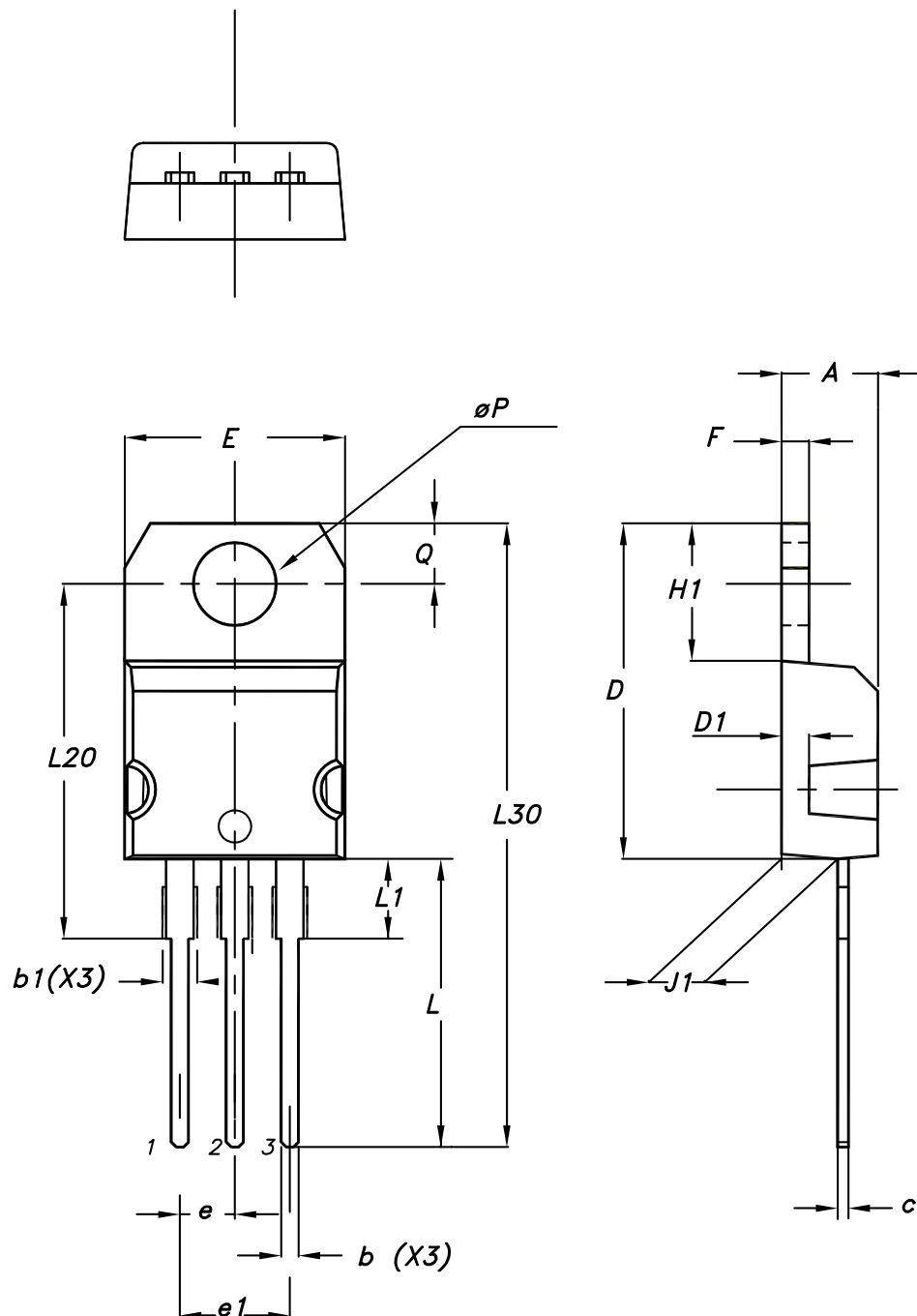
AM01473v1

## 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 TO-220 type A package information

Figure 19. TO-220 type A package outline



0015988\_typeA\_Rev\_23



**Table 8. 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  |

## Revision history

**Table 9. Document revision history**

| Date        | Version | Changes   |
|-------------|---------|---|
| 10-Jan-2019 | 1       | First release.  |
| 25-Jan-2019 | 2       | Updated ID current values in front page and Table 1. Absolute maximum ratings.                              |
| 18-May-2020 | 3       | Updated <a href="#">Table 1. Absolute maximum ratings</a> and <a href="#">Table 7. Source drain diode</a> . |

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