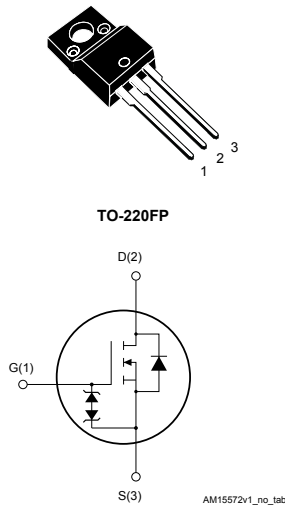


## N-channel 600 V, 115 mΩ typ., 25 A, MDmesh DM6 Power MOSFET in a TO-220FP package



### Features

| Order code  | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|-------------|----------|-------------------|-------|
| STF33N60DM6 | 600 V    | 128 mΩ            | 25 A  |

- Fast-recovery body diode
- Lower  $R_{DS(on)}$  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 ( $Q_{rr}$ ), recovery time ( $t_{rr}$ ) and excellent improvement in  $R_{DS(on)}$  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

[STF33N60DM6](#)

#### Product summary

|                   |             |
|-------------------|-------------|
| <b>Order code</b> | STF33N60DM6 |
| <b>Marking</b>    | 33N60DM6    |
| <b>Package</b>    | TO-220FP    |
| <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 $T_C = 25\text{ }^\circ\text{C}$   | 35         | W                |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope   | 100        | V/ns             |
| $di/dt^{(2)}$  | Peak diode recovery current slope   | 1000       | A/ $\mu$ s       |
| $dv/dt^{(3)}$  | MOSFET $dv/dt$ ruggedness   | 100        | V/ns             |
| $V_{ISO}$      | Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ ; $T_C = 25\text{ }^\circ\text{C}$ ) | 2.5        | kV               |
| $T_{stg}$      | 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    | 3.6   | $^\circ\text{C/W}$ |
| $R_{thj-amb}$  | 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     | 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 | -    | pF       |
| $C_{oss}$                  | Output capacitance            |   | -    | 115  | -    | pF       |
| $C_{riss}$                 | Reverse transfer capacitance  |   | -    | 3    | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$   | -    | 225  | -    | 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   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |   | -    | 10   | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |   | -    | 15   | -    | 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   |

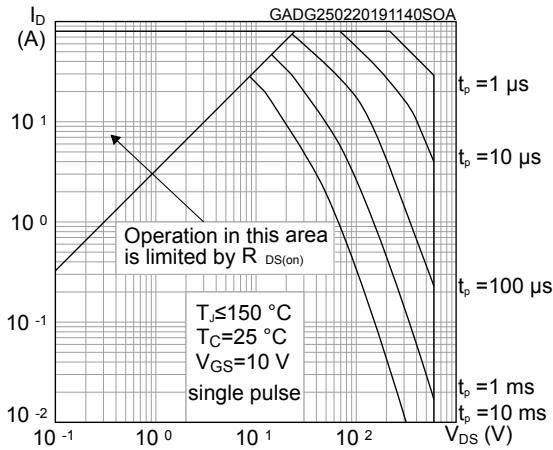
**Table 7. Source drain diode**

| 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   |               |

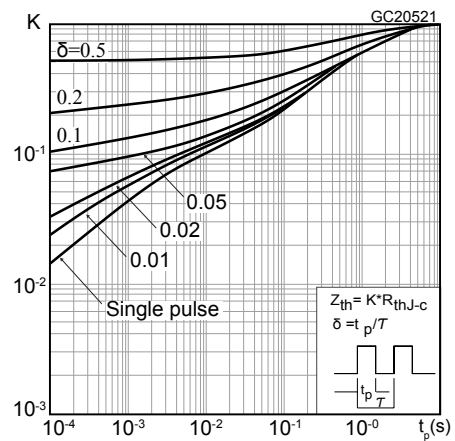
1. Pulse width is limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

## 2.1 Electrical characteristics (curves)

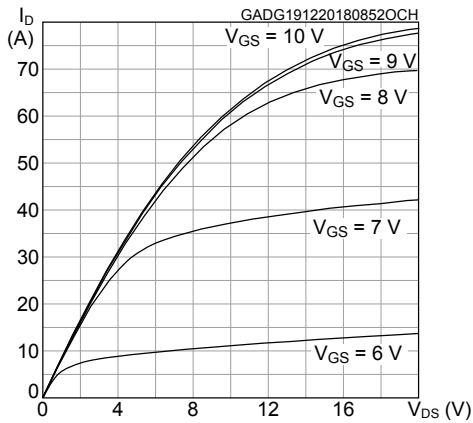
**Figure 1. Safe operating area**



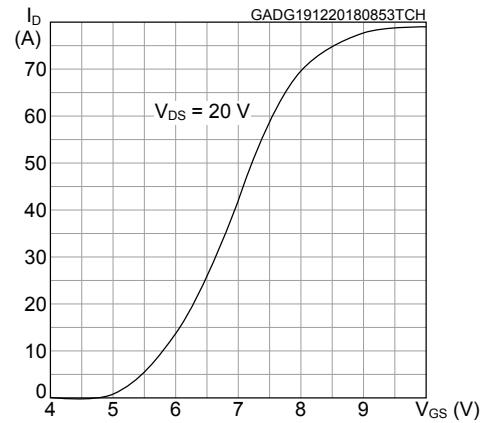
**Figure 2. Normalized thermal impedance**



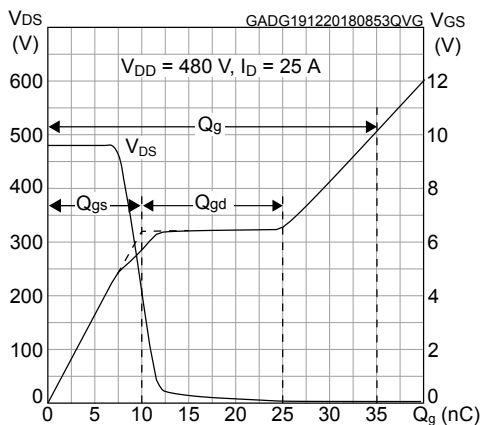
**Figure 3. Output characteristics**



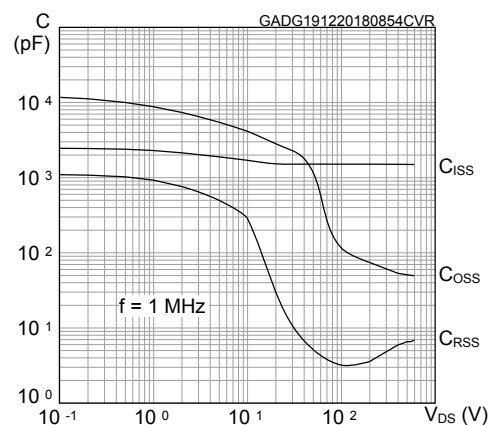
**Figure 4. Transfer characteristics**



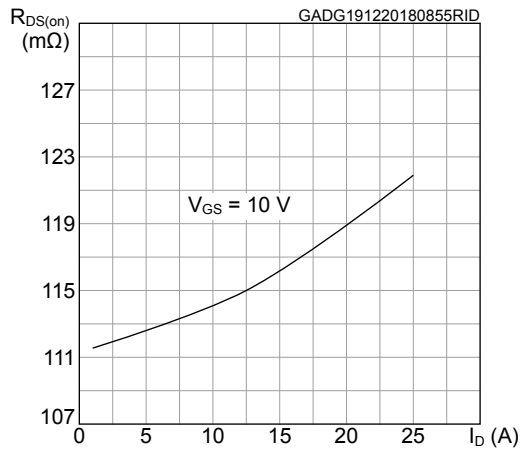
**Figure 5. Gate charge vs gate-source voltage**



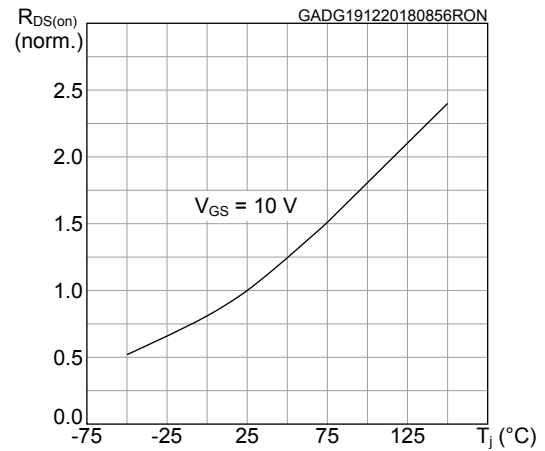
**Figure 6. Capacitance variations**



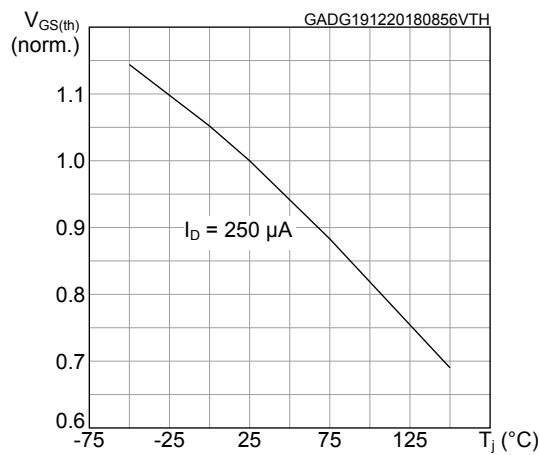
**Figure 7. Static drain-source on-resistance**



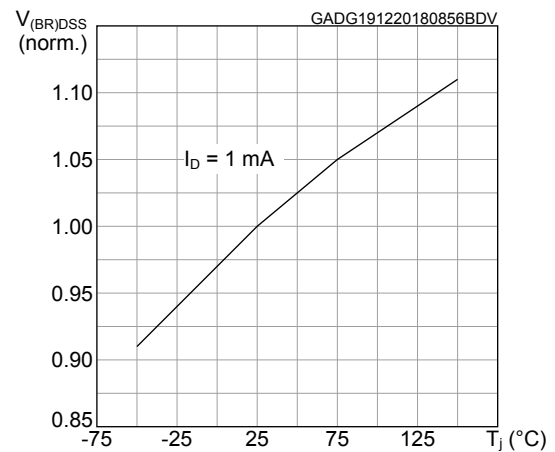
**Figure 8. Normalized on-resistance vs temperature**



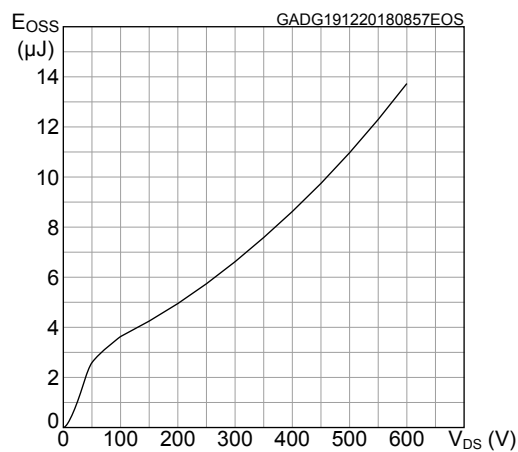
**Figure 9. Normalized gate threshold voltage vs temperature**



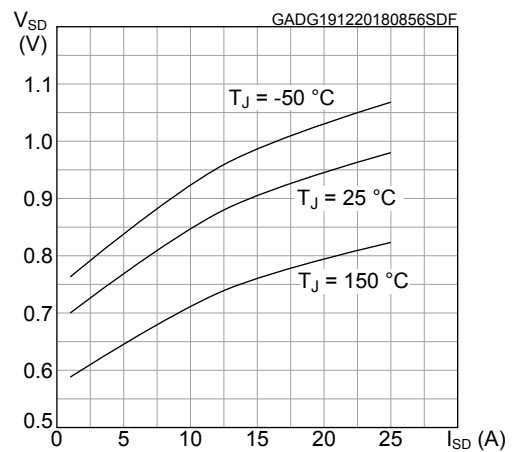
**Figure 10. Normalized  $V_{(BR)DSS}$  vs temperature**



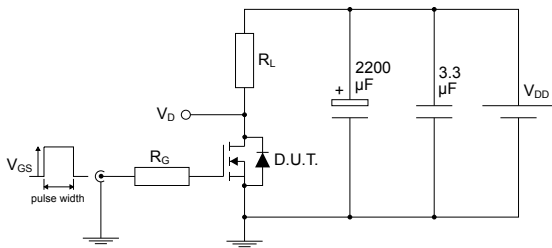
**Figure 11. Output capacitance stored energy**



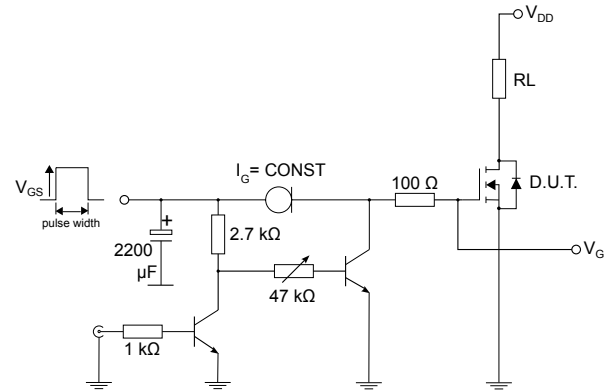
**Figure 12. Source-drain diode forward characteristics**



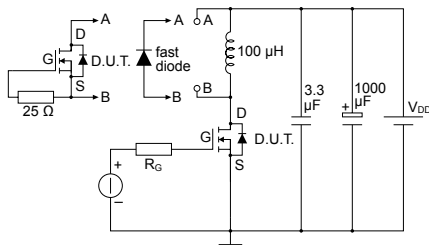
### 3 Test circuits

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


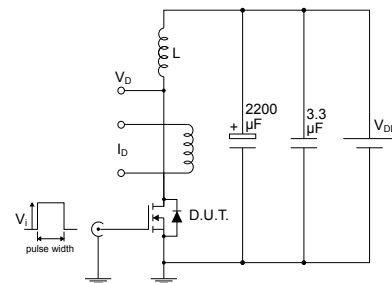
AM01468v1

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


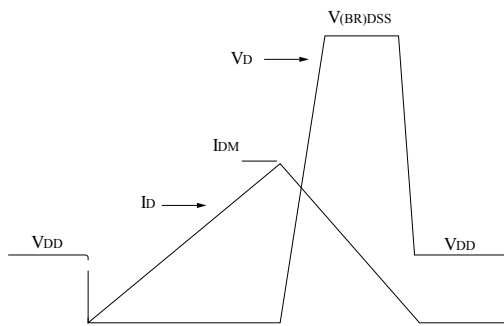
AM01469v10

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


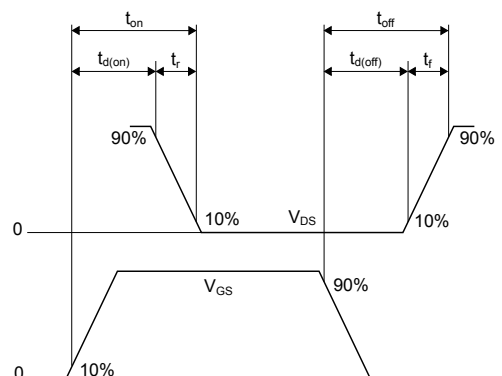
AM01470v1

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


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


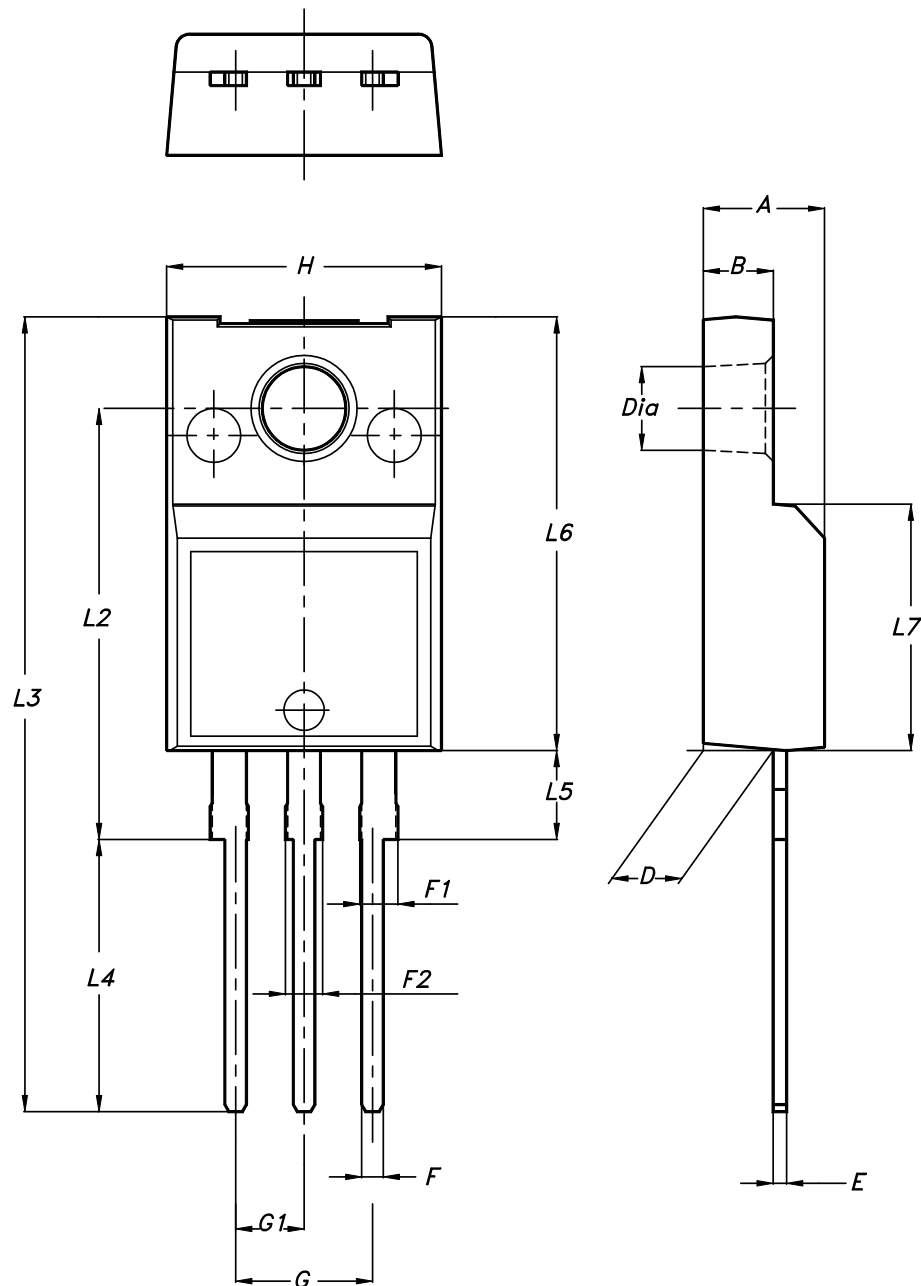
AM01473v1

## 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-220FP package information

Figure 19. TO-220FP package outline



7012510\_Rev\_13\_B



**Table 8. TO-220FP package mechanical data**

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| B    | 2.50  |       | 2.70  |
| D    | 2.50  |       | 2.75  |
| E    | 0.45  |       | 0.70  |
| F    | 0.75  |       | 1.00  |
| F1   | 1.15  |       | 1.70  |
| F2   | 1.15  |       | 1.70  |
| G    | 4.95  |       | 5.20  |
| G1   | 2.40  |       | 2.70  |
| H    | 10.00 |       | 10.40 |
| L2   |       | 16.00 |       |
| L3   | 28.60 |       | 30.60 |
| L4   | 9.80  |       | 10.60 |
| L5   | 2.90  |       | 3.60  |
| L6   | 15.90 |       | 16.40 |
| L7   | 9.00  |       | 9.30  |
| Dia  | 3.00  |       | 3.20  |

## Revision history

**Table 9. Document revision history**

| Date        | Version | Changes  |
|-------------|---------|--|
| 25-Feb-2019 | 1       | First release.   |
| 01-Jul-2020 | 2       | Updated Table 1. Absolute maximum ratings and Table 7. Source drain diode. |

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