

## N-channel 600 V, 0.55 $\Omega$ typ., 7.5 A MDmesh™ M2 Power MOSFET in a TO-220FP wide creepage package

Datasheet - production data

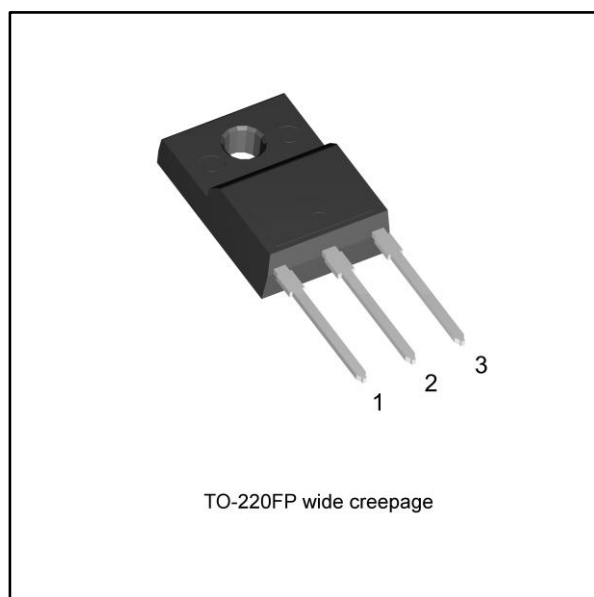
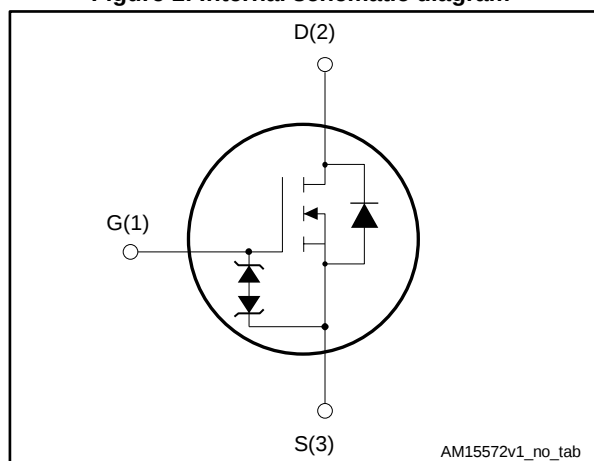


Figure 1: Internal schematic diagram



### Features

| Order code  | V <sub>DS</sub> @ T <sub>Jmax</sub> | R <sub>DS(on)</sub> max | I <sub>D</sub> |
|-------------|-------------------------------------|-------------------------|----------------|
| STFH10N60M2 | 650 V                               | 0.60 $\Omega$           | 7.5 A          |

- Extremely low gate charge
- Excellent output capacitance (C<sub>oss</sub>) profile
- 100% avalanche tested
- Zener-protected
- Wide distance of 4.25 mm between the pins

### Applications

- Switching applications
- LLC converters, resonant converters

### Description

This device is an N-channel Power MOSFET developed using MDmesh™ M2 technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance and optimized switching characteristics, rendering it suitable for the most demanding high efficiency converters.

The TO-220FP wide creepage package provides increased surface insulation for Power MOSFETs to prevent failure due to arcing, which can occur in polluted environments.

Table 1: Device summary

| Order code  | Marking | Package                | Packing |
|-------------|---------|------------------------|---------|
| STFH10N60M2 | 10N60M2 | TO-220FP wide creepage | Tube    |

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## Contents

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol            | Parameter                                                                                                                               | Value       | Unit               |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|
| $V_{GS}$          | Gate-source voltage                                                                                                                     | $\pm 25$    | V                  |
| $I_D^{(1)}$       | Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$                                                                        | 7.5         | A                  |
| $I_D^{(1)}$       | Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$                                                                       | 4.9         | A                  |
| $I_{DM}^{(1)(2)}$ | Drain current (pulsed)                                                                                                                  | 30          | A                  |
| $P_{TOT}$         | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$                                                                                 | 25          | W                  |
| $dv/dt^{(3)}$     | Peak diode recovery voltage slope                                                                                                       | 15          | V/ns               |
| $dv/dt^{(4)}$     | MOSFET $dv/dt$ ruggedness                                                                                                               | 50          | V/ns               |
| $V_{ISO}$         | Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ ; $T_C = 25\text{ }^{\circ}\text{C}$ ) | 2500        | V                  |
| $T_{stg}$         | Storage temperature range                                                                                                               | - 55 to 150 | $^{\circ}\text{C}$ |
| $T_j$             | Operating junction temperature range                                                                                                    |             |                    |

**Notes:**

(1)Limited by package.

(2)Pulse width limited by package.

(3) $I_{SD} \leq 7.5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS(peak)} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ (4) $V_{DS} \leq 480\text{ V}$ 

Table 3: Thermal data

| Symbol         | Parameter                           | Value | Unit                        |
|----------------|-------------------------------------|-------|-----------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case    | 5     | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 62.5  | $^{\circ}\text{C}/\text{W}$ |

Table 4: Avalanche characteristics

| Symbol   | Parameter                                                                                                        | Value | Unit |
|----------|------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )                             | 1.5   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j=25\text{ }^{\circ}\text{C}$ , $I_D=I_{AR}$ ; $V_{DD}=50\text{ V}$ ) | 110   | mJ   |

## 2 Electrical characteristics

(T<sub>C</sub> = 25 °C unless otherwise specified)

Table 5: On /off states

| Symbol               | Parameter                         | Test conditions                                                                        | Min. | Typ. | Max. | Unit |
|----------------------|-----------------------------------|----------------------------------------------------------------------------------------|------|------|------|------|
| V <sub>(BR)DSS</sub> | Drain-source breakdown voltage    | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA                                           | 600  |      |      | V    |
| I <sub>DSS</sub>     | Zero gate voltage drain current   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 600 V                                         |      |      | 1    | μA   |
|                      |                                   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 600 V, T <sub>C</sub> = 125 °C <sup>(1)</sup> |      |      | 100  | μA   |
| I <sub>GSS</sub>     | Gate-body leakage current         | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±25 V                                         |      |      | ±10  | μA   |
| V <sub>GS(th)</sub>  | Gate threshold voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                            | 2    | 3    | 4    | V    |
| R <sub>DS(on)</sub>  | Static drain-source on-resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 3 A                                           |      | 0.55 | 0.60 | Ω    |

**Notes:**

<sup>(1)</sup>Defined by design, not subject to production test.

Table 6: Dynamic

| Symbol                              | Parameter                     | Test conditions                                                                                                                                           | Min. | Typ. | Max. | Unit |
|-------------------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| C <sub>iss</sub>                    | Input capacitance             | V <sub>DS</sub> = 100 V, f = 1 MHz, V <sub>GS</sub> = 0 V                                                                                                 | -    | 400  | -    | pF   |
| C <sub>oss</sub>                    | Output capacitance            |                                                                                                                                                           | -    | 22   | -    | pF   |
| C <sub>rss</sub>                    | Reverse transfer capacitance  |                                                                                                                                                           | -    | 0.84 | -    | pF   |
| C <sub>oss eq.</sub> <sup>(1)</sup> | Equivalent output capacitance | V <sub>DS</sub> = 0 to 480 V, V <sub>GS</sub> = 0 V                                                                                                       | -    | 83   | -    | pF   |
| R <sub>G</sub>                      | Intrinsic gate resistance     | f = 1 MHz, I <sub>D</sub> = 0 A                                                                                                                           | -    | 6.4  | -    | Ω    |
| Q <sub>g</sub>                      | Total gate charge             | V <sub>DD</sub> = 480 V, I <sub>D</sub> = 7.5 A, V <sub>GS</sub> = 0 to 10 V<br>(see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> ) | -    | 13.5 | -    | nC   |
| Q <sub>gs</sub>                     | Gate-source charge            |                                                                                                                                                           | -    | 2.1  | -    | nC   |
| Q <sub>gd</sub>                     | Gate-drain charge             |                                                                                                                                                           | -    | 7.2  | -    | nC   |

**Notes:**

<sup>(1)</sup>C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>

Table 7: Switching times

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                                                      | Min. | Typ. | Max. | Unit |
|--------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 3.75\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a><br>and <a href="#">Figure 19: "Switching time waveform"</a> ) | -    | 8.8  | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                                      | -    | 8    | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                                                      | -    | 32.5 | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                                      | -    | 13.2 | -    | ns   |

Table 8: Source drain diode

| Symbol             | Parameter                     | Test conditions                                                                                                                                                                                                                      | Min. | Typ. | Max. | Unit          |
|--------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}^{(1)}$     | Source-drain current          |                                                                                                                                                                                                                                      | -    |      | 7.5  | A             |
| $I_{SDM}^{(1)(2)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                                      | -    |      | 30   | A             |
| $V_{SD}^{(3)}$     | Forward on voltage            | $I_{SD} = 7.5\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                                                                                                                                      | -    |      | 1.6  | V             |
| $t_{rr}$           | Reverse recovery time         | $I_{SD} = 7.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$<br>(see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )                                     | -    | 270  |      | ns            |
| $Q_{rr}$           | Reverse recovery charge       |                                                                                                                                                                                                                                      | -    | 2    |      | $\mu\text{C}$ |
| $I_{RRM}$          | Reverse recovery current      |                                                                                                                                                                                                                                      | -    | 14.4 |      | A             |
| $t_{rr}$           | Reverse recovery time         | $I_{SD} = 7.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> ) | -    | 376  |      | ns            |
| $Q_{rr}$           | Reverse recovery charge       |                                                                                                                                                                                                                                      | -    | 2.8  |      | $\mu\text{C}$ |
| $I_{RRM}$          | Reverse recovery current      |                                                                                                                                                                                                                                      | -    | 15   |      | A             |

**Notes:**

(1)Limited by package.

(2)Pulse width limited by safe operating area.

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

## 2.1 Electrical characteristics (curves)

Figure 2: Safe operating area

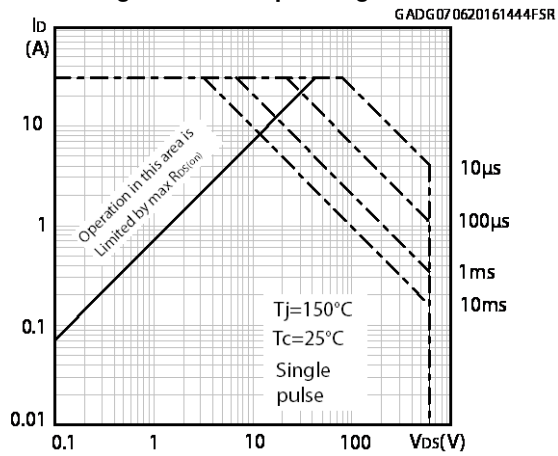


Figure 3: Thermal impedance

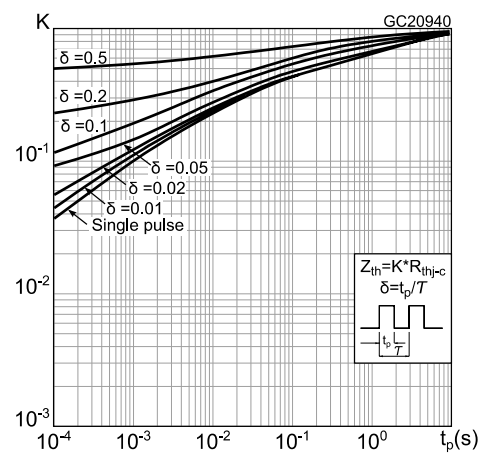


Figure 4: Output characteristics

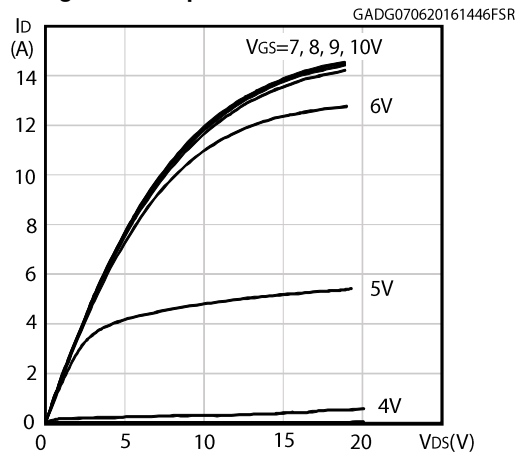


Figure 5: Transfer characteristics

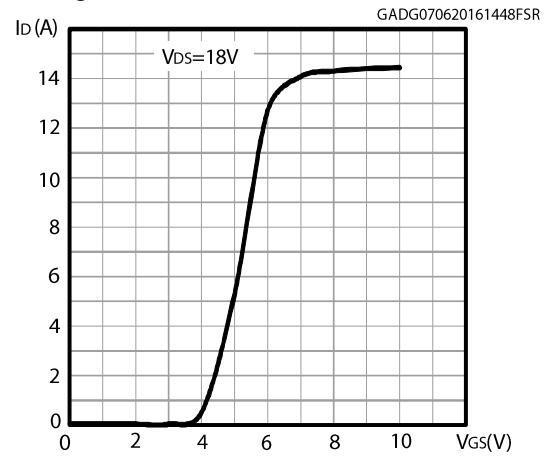


Figure 6: Gate charge vs gate-source voltage

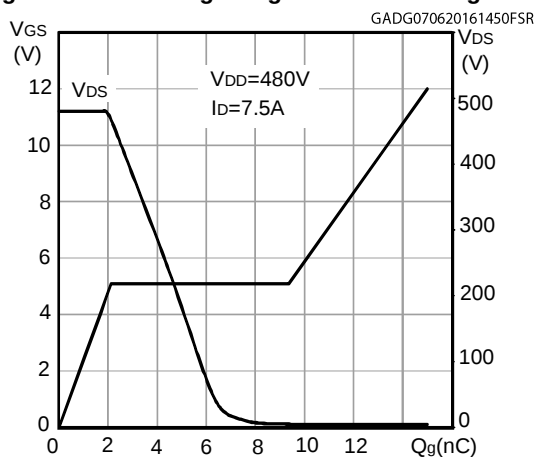


Figure 7: Static drain-source on-resistance

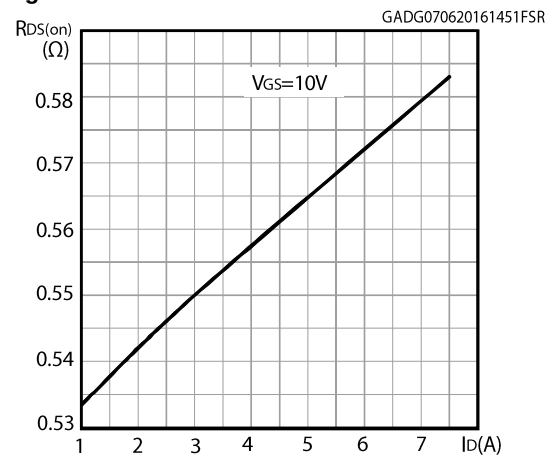


Figure 8: Capacitance variations

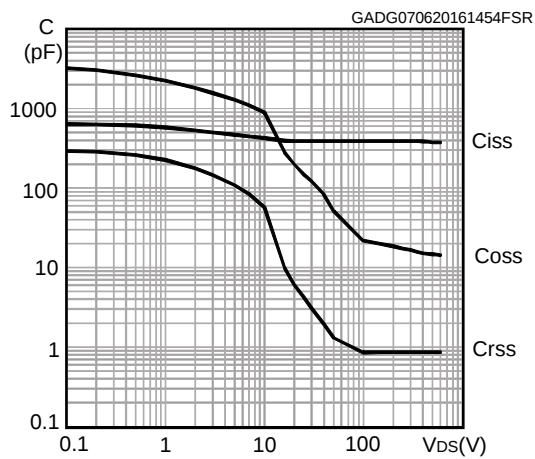


Figure 9: Normalized gate threshold voltage vs. temperature



Figure 10: Normalized on-resistance vs temperature

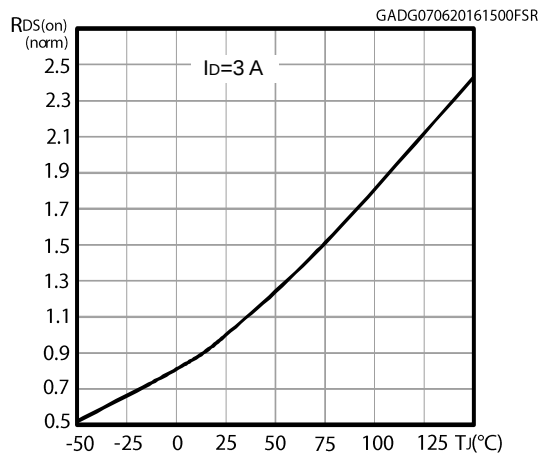


Figure 11: Source-drain diode forward characteristics

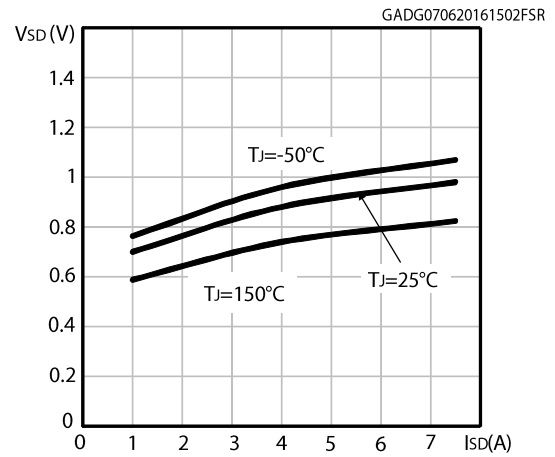
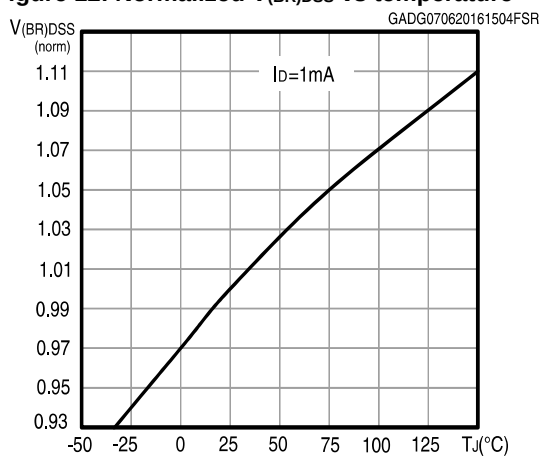
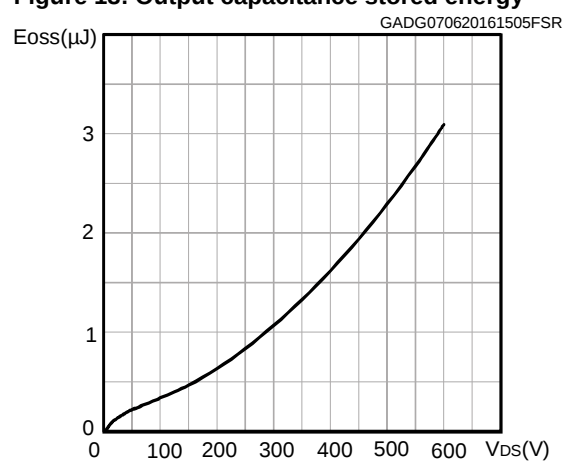
Figure 12: Normalized  $V_{(BR)DSS}$  vs temperature

Figure 13: Output capacitance stored energy



### 3 Test circuits

**Figure 14: Test circuit for resistive load switching times**



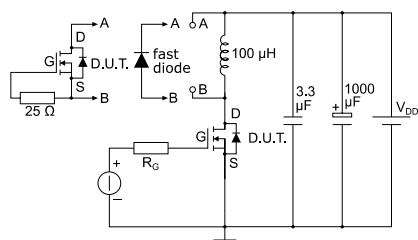
AM01468v1

**Figure 15: Test circuit for gate charge behavior**



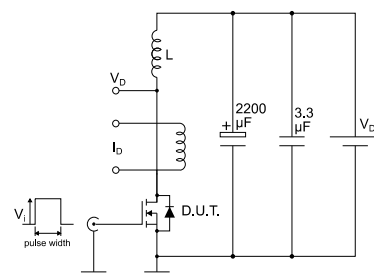
AM01469v1

**Figure 16: Test circuit for inductive load switching and diode recovery times**



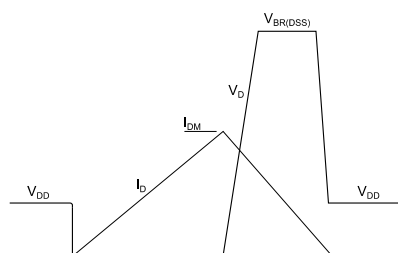
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**Figure 17: Unclamped inductive load test circuit**



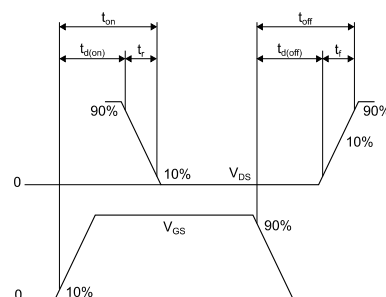
AM01471v1

**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: 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 wide creepage package information

Figure 20: TO-220FP wide creepage package outline

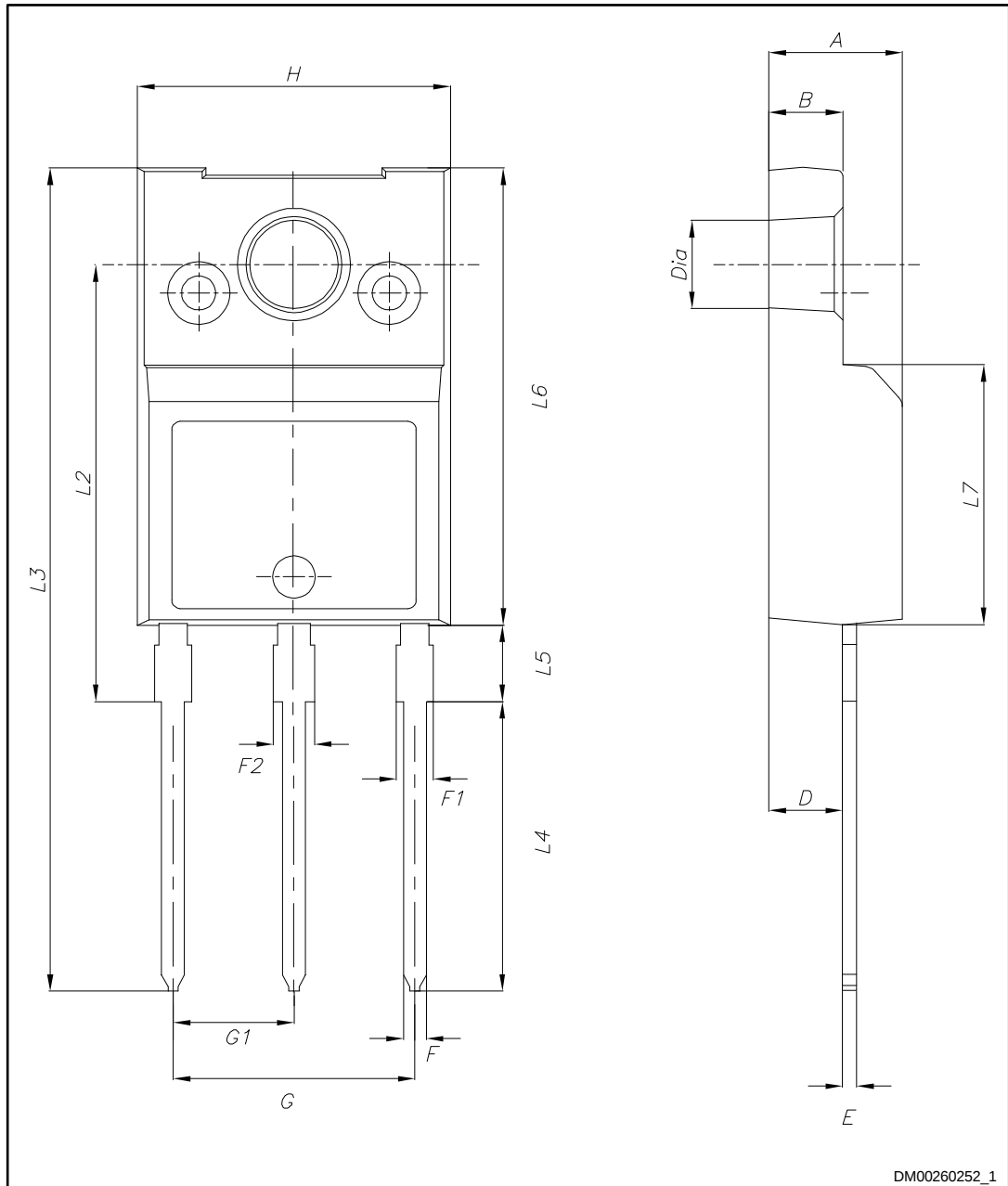


Table 9: TO-220FP wide creepage package mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.60  | 4.70  | 4.80  |
| B    | 2.50  | 2.60  | 2.70  |
| D    | 2.49  | 2.59  | 2.69  |
| E    | 0.46  |       | 0.59  |
| F    | 0.76  |       | 0.89  |
| F1   | 0.96  |       | 1.25  |
| F2   | 1.11  |       | 1.40  |
| G    | 8.40  | 8.50  | 8.60  |
| G1   | 4.15  | 4.25  | 4.35  |
| H    | 10.90 | 11.00 | 11.10 |
| L2   | 15.25 | 15.40 | 15.55 |
| L3   | 28.70 | 29.00 | 29.30 |
| L4   | 10.00 | 10.20 | 10.40 |
| L5   | 2.55  | 2.70  | 2.85  |
| L6   | 16.00 | 16.10 | 16.20 |
| L7   | 9.05  | 9.15  | 9.25  |
| Dia  | 3.00  | 3.10  | 3.20  |

## 5 Revision history

**Table 10: Document revision history**

| Date        | Revision | Changes                                                                                                                                                          |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 07-Jun-2016 | 1        | First release.                                                                                                                                                   |
| 16-Jun-2016 | 2        | Document status promoted from preliminary data to production data.<br>Minor text changes.                                                                        |
| 18-Aug-2016 | 3        | Modified: title and $R_{DS(on)}$ in cover page<br>Modified: <i>Table 5: "On /off states"</i> and <i>Table 7: "Switching times"</i><br>Minor text changes         |
| 08-May-2017 | 4        | Modified features on cover page.<br>Modified <i>Table 2: "Absolute maximum ratings"</i> and <i>Table 4: "Avalanche characteristics"</i> .<br>Minor text changes. |

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