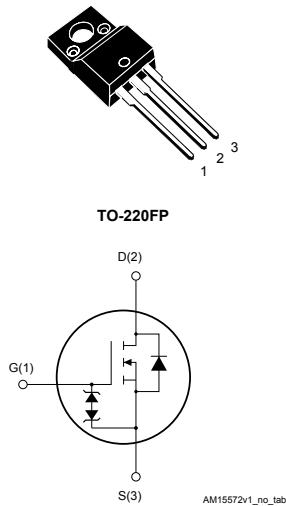


## N-channel 600 V, 0.95 $\Omega$ typ., 5 A MDmesh™ DM2 Power MOSFET in a TO-220FP package



### Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ | $P_{TOT}$ |
|------------|----------|-------------------|-------|-----------|
| STF6N60DM2 | 600 V    | 1.10 $\Omega$     | 5 A   | 20 W      |

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-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 DM2 fast-recovery diode series. It offers very low recovery charge ( $Q_{rr}$ ) and time ( $t_{rr}$ ) combined with low  $R_{DS(on)}$ , rendering it suitable for the most demanding high-efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

#### Product status link

[STF6N60DM2](#)

#### Product summary

|            |            |
|------------|------------|
| Order code | STF6N60DM2 |
| Marking    | 6N60DM2    |
| Package    | TO-220FP   |
| Packing    | 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 $T_{case} = 25\text{ }^{\circ}\text{C}$                                                                   | 5          | A                  |
|                | Drain current (continuous) at $T_{case} = 100\text{ }^{\circ}\text{C}$                                                                  | 3.2        |                    |
| $I_{DM}^{(1)}$ | Drain current (pulsed)                                                                                                                  | 20         | A                  |
| $P_{TOT}$      | Total power dissipation at $T_{case} = 25\text{ }^{\circ}\text{C}$                                                                      | 20         | W                  |
| $dv/dt^{(2)}$  | Peak diode recovery voltage slope                                                                                                       | 50         | V/ns               |
| $dv/dt^{(3)}$  | MOSFET $dv/dt$ ruggedness                                                                                                               | 50         |                    |
| $V_{ISO}$      | 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.  $I_{SD} \leq 5\text{ A}$ ,  $di/dt = 900\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 480\text{ V}$ .
3.  $V_{DS} \leq 480\text{ V}$ .

**Table 2. Thermal data**

| Symbol         | Parameter                           | Value | Unit                        |
|----------------|-------------------------------------|-------|-----------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case    | 6.25  | $^{\circ}\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient | 62.5  |                             |

**Table 3. Avalanche characteristics**

| Symbol         | Parameter                                       | Value | Unit |
|----------------|-------------------------------------------------|-------|------|
| $I_{AR}^{(1)}$ | Avalanche current, repetitive or not repetitive | 1.7   | A    |
| $E_{AS}^{(2)}$ | Single pulse avalanche energy                   | 132   | mJ   |

1. Pulse width limited by  $T_{jmax}$ .
2. starting  $T_j = 25\text{ }^{\circ}\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$ .

## 2 Electrical characteristics

( $T_{\text{case}} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified)

**Table 4. Static**

| Symbol                      | Parameter                         | Test conditions                                                                                                                   | Min. | Typ. | Max.    | Unit          |
|-----------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|------|------|---------|---------------|
| $V_{(\text{BR})\text{DSS}}$ | Drain-source breakdown voltage    | $V_{\text{GS}} = 0\text{ V}$ , $I_{\text{D}} = 1\text{ mA}$                                                                       | 600  |      |         | V             |
| $I_{\text{DSS}}$            | Zero gate voltage drain current   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 600\text{ V}$                                                                     |      |      | 1       | $\mu\text{A}$ |
|                             |                                   | $V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 600\text{ V}$ ,<br>$T_{\text{case}} = 125\text{ }^{\circ}\text{C}$ <sup>(1)</sup> |      |      | 100     |               |
| $I_{\text{GSS}}$            | Gate-body leakage current         | $V_{\text{DS}} = 0\text{ V}$ , $V_{\text{GS}} = \pm 25\text{ V}$                                                                  |      |      | $\pm 5$ | $\mu\text{A}$ |
| $V_{\text{GS(th)}}$         | Gate threshold voltage            | $V_{\text{DS}} = V_{\text{GS}}$ , $I_{\text{D}} = 250\text{ }\mu\text{A}$                                                         | 3.25 | 4    | 4.75    | V             |
| $R_{\text{DS(on)}}$         | Static drain-source on-resistance | $V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 2.5\text{ A}$                                                                     |      | 0.95 | 1.10    | $\Omega$      |

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

**Table 5. Dynamic**

| Symbol                              | Parameter                     | Test conditions                                                                                                                                                    | Min. | Typ. | Max. | Unit     |
|-------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{\text{iss}}$                    | Input capacitance             | $V_{\text{DS}} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0\text{ V}$                                                                                 | -    | 274  | -    | pF       |
| $C_{\text{oss}}$                    | Output capacitance            |                                                                                                                                                                    | -    | 15   | -    |          |
| $C_{\text{rss}}$                    | Reverse transfer capacitance  |                                                                                                                                                                    | -    | 2    | -    |          |
| $C_{\text{oss eq.}}$ <sup>(1)</sup> | Equivalent output capacitance | $V_{\text{DS}} = 0\text{ to }480\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$                                                                                          | -    | 25   | -    | pF       |
| $R_{\text{G}}$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_{\text{D}} = 0\text{ A}$                                                                                                                   | -    | 6.5  | -    | $\Omega$ |
| $Q_{\text{g}}$                      | Total gate charge             | $V_{\text{DD}} = 480\text{ V}$ , $I_{\text{D}} = 5\text{ A}$ ,<br>$V_{\text{GS}} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior) | -    | 6.2  | -    | nC       |
| $Q_{\text{gs}}$                     | Gate-source charge            |                                                                                                                                                                    | -    | 1.8  | -    |          |
| $Q_{\text{gd}}$                     | Gate-drain charge             |                                                                                                                                                                    | -    | 2.7  | -    |          |

1.  $C_{\text{oss eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{\text{oss}}$  when  $V_{\text{DS}}$  increases from 0 to 80%  $V_{\text{DSS}}$ .

**Table 6. Switching times**

| Symbol              | Parameter           | Test conditions                                                                                                                                                                                                                                | Min. | Typ. | Max. | Unit |
|---------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{\text{d(on)}}$  | Turn-on delay time  | $V_{\text{DD}} = 300\text{ V}$ , $I_{\text{D}} = 2.5\text{ A}$ , $R_{\text{G}} = 4.7\text{ }\Omega$ ,<br>$V_{\text{GS}} = 10\text{ V}$ (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform) | -    | 9.2  | -    | ns   |
| $t_{\text{r}}$      | Rise time           |                                                                                                                                                                                                                                                | -    | 5.6  | -    |      |
| $t_{\text{d(off)}}$ | Turn-off delay time |                                                                                                                                                                                                                                                | -    | 12   | -    |      |
| $t_{\text{f}}$      | Fall time           |                                                                                                                                                                                                                                                | -    | 19.6 | -    |      |

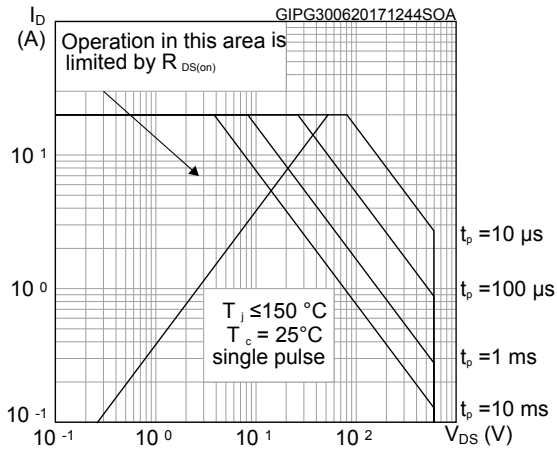
**Table 7. Source-drain diode**

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                   | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                   | -    |      | 5    | A    |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                   | -    |      | 20   | A    |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 5\text{ A}$                                                                                                                                                                     | -    |      | 1.6  | V    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$<br>(see Figure 15. Test circuit for inductive load switching and diode recovery times)                                     | -    | 60   |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                   | -    | 135  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                   | -    | 4.5  |      | A    |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$<br>(see Figure 15. Test circuit for inductive load switching and diode recovery times) | -    | 132  |      | ns   |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                   | -    | 429  |      | nC   |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                   | -    | 6.5  |      | A    |

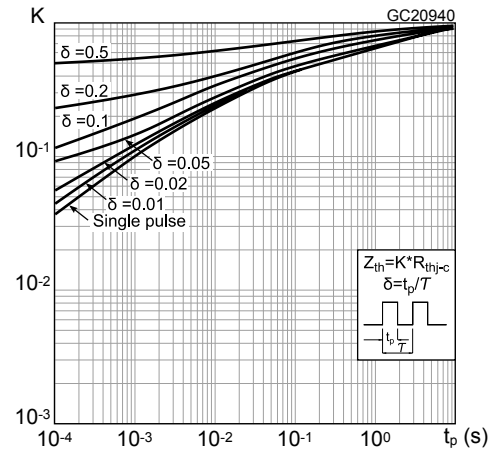
1. Pulse width is limited by safe operating area.
2. Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

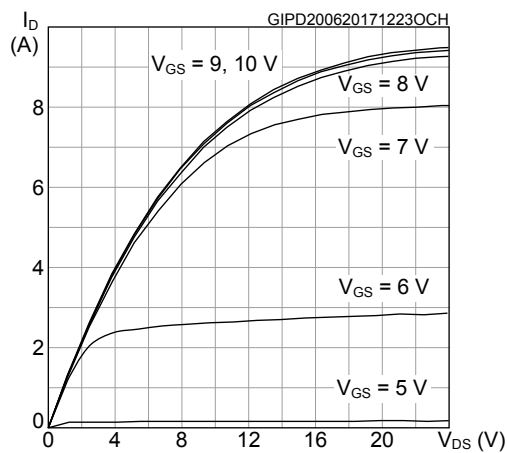
**Figure 1. Safe operating area**



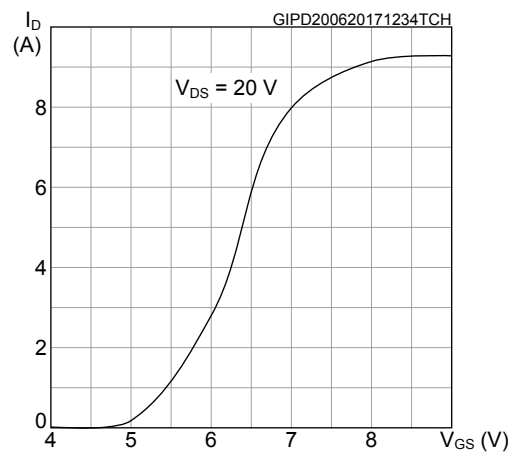
**Figure 2. Thermal impedance**



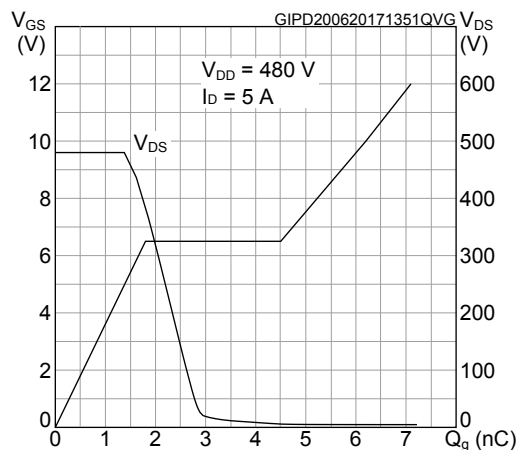
**Figure 3. Output characteristics**



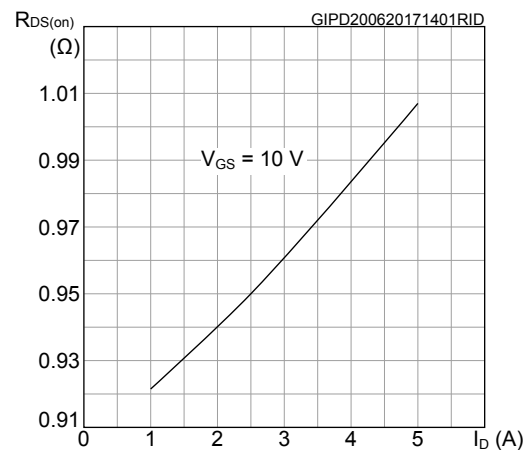
**Figure 4. Transfer characteristics**



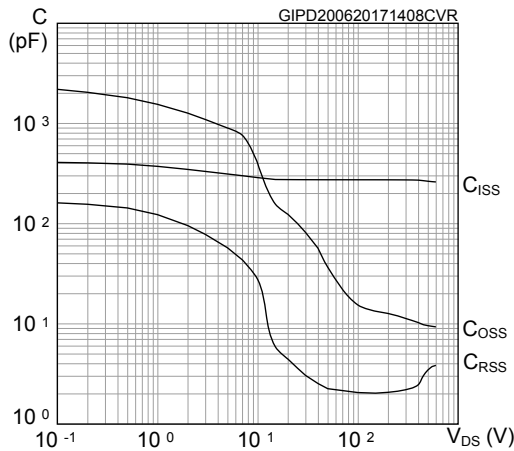
**Figure 5. Gate charge vs gate-source voltage**



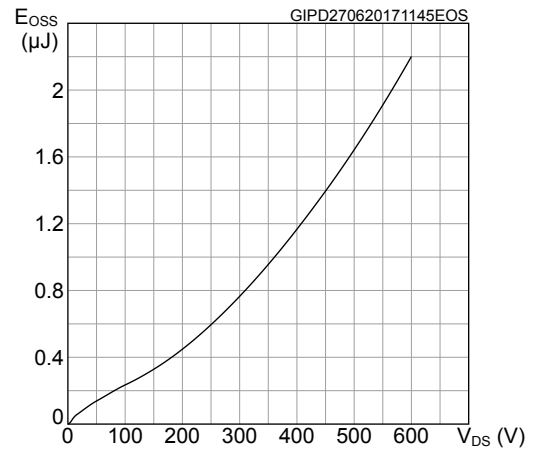
**Figure 6. Static drain-source on-resistance**



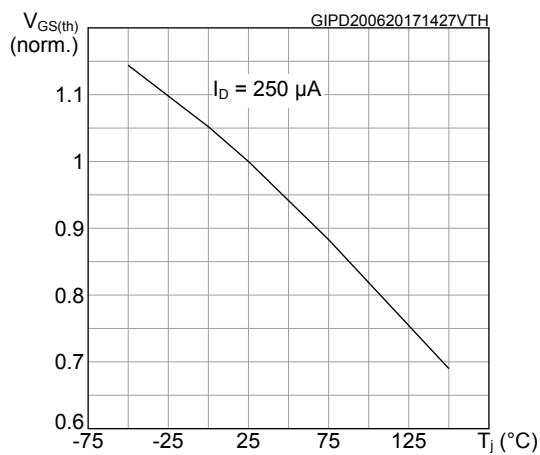
**Figure 7. Capacitance variations**



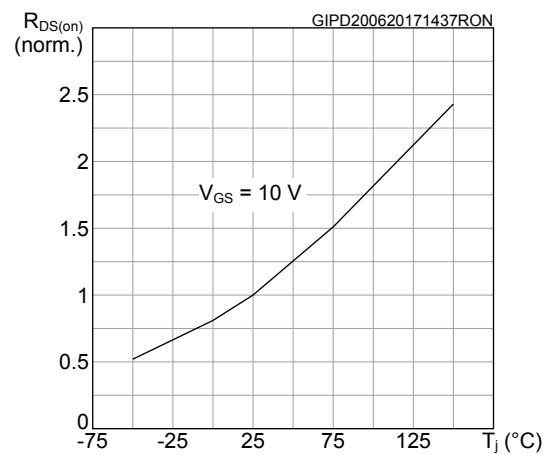
**Figure 8. Output capacitance stored energy**



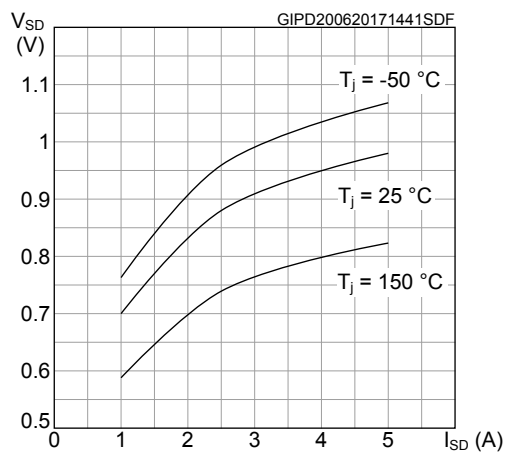
**Figure 9. Normalized gate threshold voltage vs temperature**



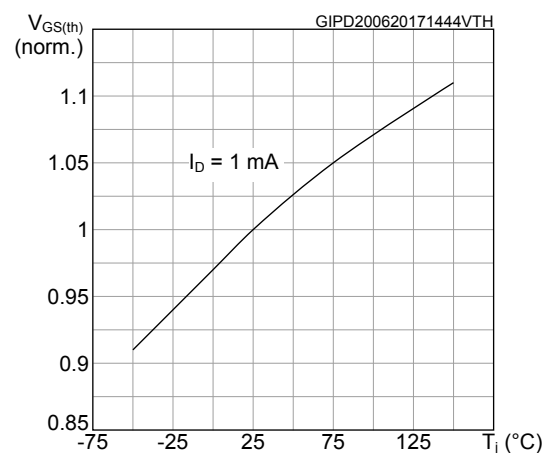
**Figure 10. Normalized on-resistance vs temperature**



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



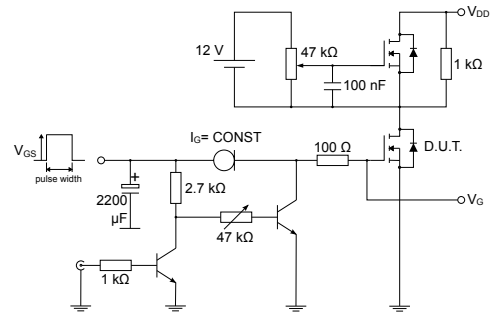
**Figure 12. Normalized  $V_{(BR)DSS}$  vs temperature**



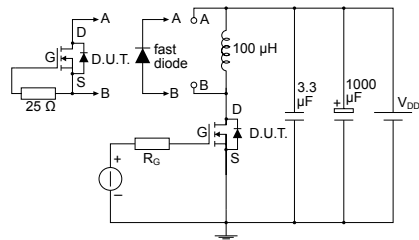
### 3 Test circuits

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


AM01468v1

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


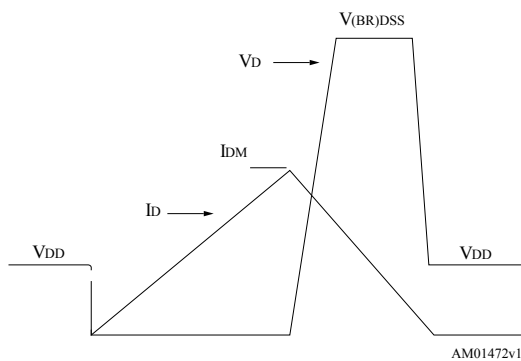
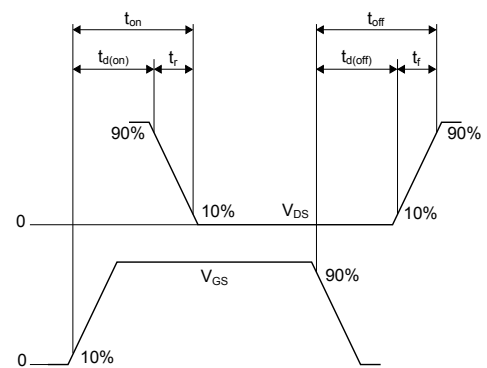
AM01469v1

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


AM01470v1

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


AM01471v1

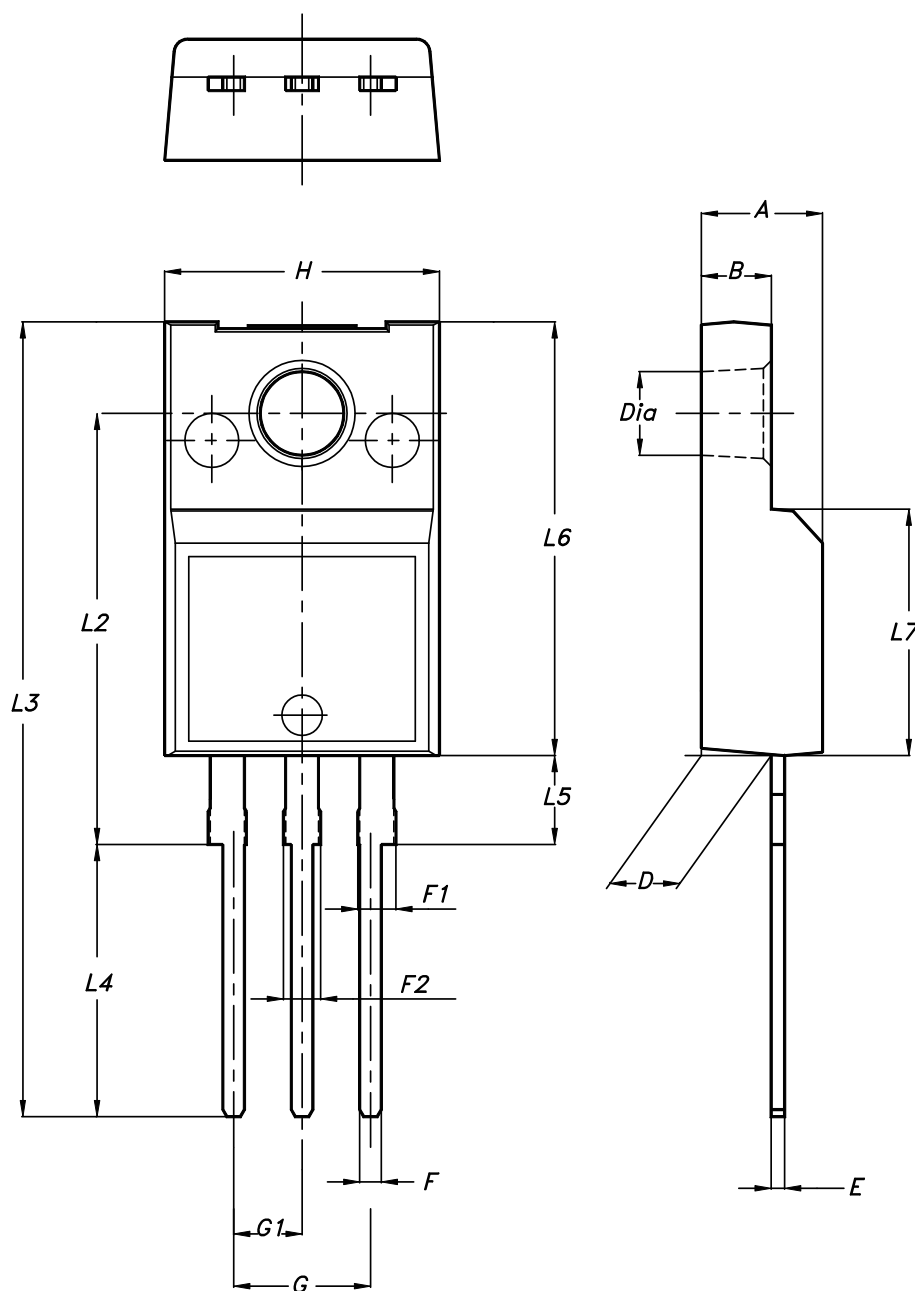
**Figure 17. Unclamped inductive waveform**

**Figure 18. Switching time waveform**


## 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                                                                                  |
|-------------|---------|------------------------------------------------------------------------------------------|
| 03-Jul-2017 | 1       | First release                                                                            |
| 12-Jun-2018 | 2       | Updated Table 1. Absolute maximum ratings, Table 2. Thermal data and Table 5. Dynamic.   |
| 16-Mar-2020 | 3       | Updated <a href="#">Section Features</a> . Minor text change to improve the readability. |

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