

## N-channel 600 V, 0.150 $\Omega$ typ., 20 A MDmesh™ M2 EP Power MOSFET in TO-220FP package

Datasheet - production data

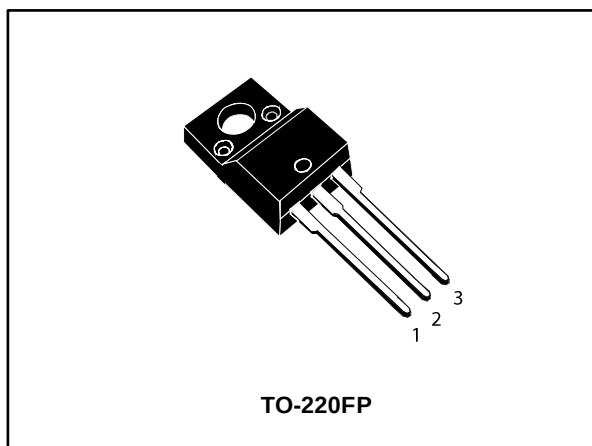
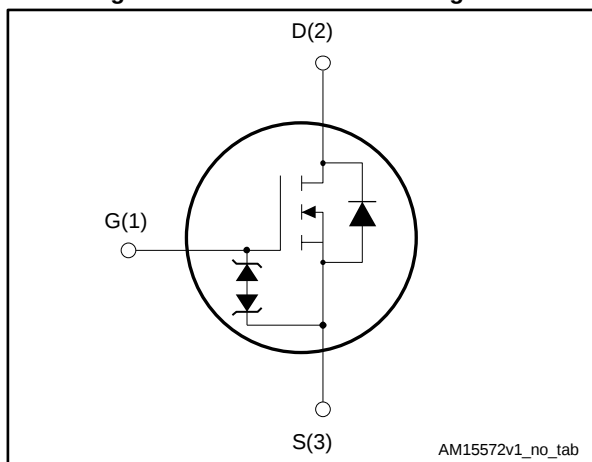


Figure 1: Internal schematic diagram



### Features

| Order code    | V <sub>DS</sub> | R <sub>DS(on)</sub> max | I <sub>D</sub> |
|---------------|-----------------|-------------------------|----------------|
| STF27N60M2-EP | 600 V           | 0.163 $\Omega$          | 20 A           |

- Extremely low gate charge
- Excellent output capacitance (C<sub>oss</sub>) profile
- Very low turn-off switching losses
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications
- Tailored for very high frequency converters (f > 150 kHz)

### Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 EP enhanced performance technology. Thanks to their strip layout and an improved vertical structure, these devices exhibit low on-resistance, optimized switching characteristics with very low turn-off switching losses, rendering them suitable for the most demanding very high frequency converters.

Table 1: Device summary

| Order code    | Marking   | Package  | Packing |
|---------------|-----------|----------|---------|
| STF27N60M2-EP | 27N60M2EP | TO-220FP | 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 $T_C = 25\text{ }^\circ\text{C}$                                                                        | 20          | A                |
| $I_D^{(1)}$    | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$                                                                       | 13          | A                |
| $I_{DM}^{(2)}$ | Drain current (pulsed)                                                                                                                | 80          | A                |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$                                                                                 | 30          | 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 ( $t = 1\text{ s}$ ; $T_C = 25\text{ }^\circ\text{C}$ ) | 2.5         | kV               |
| $T_{stg}$      | Storage temperature                                                                                                                   | - 55 to 150 | $^\circ\text{C}$ |
| $T_j$          | Operating junction temperature                                                                                                        |             |                  |

**Notes:**<sup>(1)</sup>Limited by maximum junction temperature<sup>(2)</sup>Pulse width limited by safe operating area.<sup>(3)</sup> $I_{SD} \leq 20\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS(peak)} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .<sup>(4)</sup> $V_{DS} \leq 480\text{ V}$ 

Table 3: Thermal data

| Symbol         | Parameter                               | Value | Unit                      |
|----------------|-----------------------------------------|-------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max    | 4.2   | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max | 62.5  | $^\circ\text{C}/\text{W}$ |

Table 4: Avalanche characteristics

| Symbol   | Parameter                                                                                                            | Value | Unit |
|----------|----------------------------------------------------------------------------------------------------------------------|-------|------|
| $I_{AR}$ | Avalanche current, repetetive or not repetetive (pulse width limited by $T_{jmax}$ )                                 | 3.6   | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ ; $V_{DD} = 50\text{ V}$ ) | 260   | mJ   |

## 2 Electrical characteristics

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

**Table 5: 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>$T_C = 125\text{ }^{\circ}\text{C}$ |      |       | 100      | $\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current         | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$                                       |      |       | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage            | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                       | 2    | 3     | 4        | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$ , $I_D = 10\text{ A}$                                             |      | 0.150 | 0.163    | $\Omega$      |

**Table 6: Dynamic**

| Symbol                     | Parameter                     | Test conditions                                                                                                                                     | Min. | Typ. | Max. | Unit     |
|----------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$                  | Input capacitance             | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$                                                                                | -    | 1320 | -    | pF       |
| $C_{oss}$                  | Output capacitance            |                                                                                                                                                     | -    | 70   | -    | pF       |
| $C_{rss}$                  | Reverse transfer capacitance  |                                                                                                                                                     | -    | 1    | -    | pF       |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                         | -    | 146  | -    | pF       |
| $R_G$                      | Intrinsic gate resistance     | $f = 1\text{ MHz}$ , $I_D = 0\text{ A}$                                                                                                             | -    | 4    | -    | $\Omega$ |
| $Q_g$                      | Total gate charge             | $V_{DD} = 480\text{ V}$ , $I_D = 20\text{ A}$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> ) | -    | 33   | -    | nC       |
| $Q_{gs}$                   | Gate-source charge            |                                                                                                                                                     | -    | 5.2  | -    | nC       |
| $Q_{gd}$                   | Gate-drain charge             |                                                                                                                                                     | -    | 16   | -    | nC       |

**Notes:**

<sup>(1)</sup> $C_{oss\text{ eq.}}$  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 7: Switching times**

| Symbol       | Parameter           | Test conditions                                                                                                                                                                                                                                    | Min. | Typ. | Max. | Unit |
|--------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $t_{d(on)}$  | Turn-on delay time  | $V_{DD} = 300\text{ V}$ , $I_D = 10\text{ A}$ , $R_G = 4.7\text{ }\Omega$ ,<br>$V_{GS} = 10\text{ V}$ (see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a> and <a href="#">Figure 19: "Switching time waveform"</a> ) | -    | 13.4 | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                                    | -    | 8.1  | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                                                    | -    | 55.6 | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                                    | -    | 6.3  | -    | ns   |

Table 8: Source-drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                         | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                         | -    |      | 20   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                         | -    |      | 80   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 20\text{ A}$                                                                                                                                          | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 20\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$<br>(see <a href="#">Figure 19: "Switching time waveform"</a> )                                     | -    | 271  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                         | -    | 3.44 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                         | -    | 25.4 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 20\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ ,<br>$T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 19: "Switching time waveform"</a> ) | -    | 352  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                         | -    | 4.82 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                         | -    | 27.4 |      | A             |

**Notes:**<sup>(1)</sup>Pulse width is limited by safe operating area<sup>(2)</sup>Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

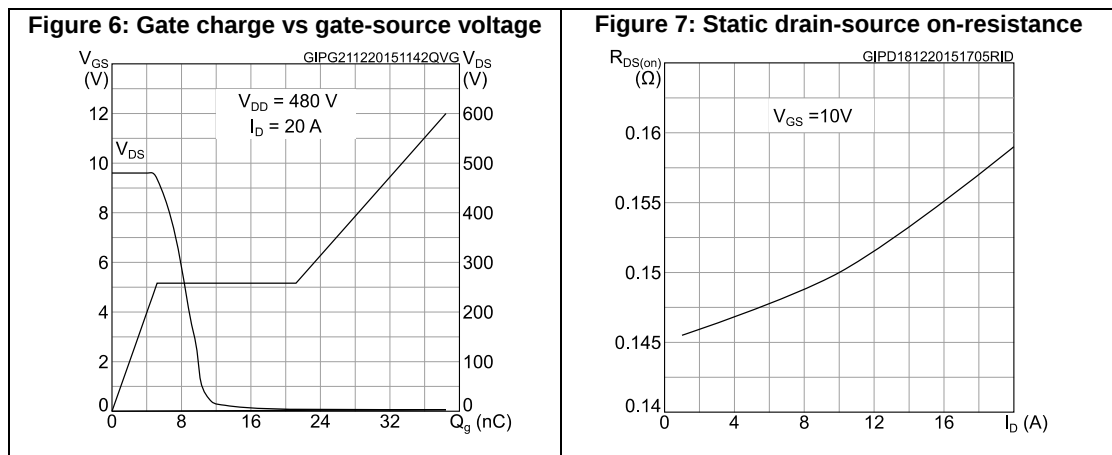
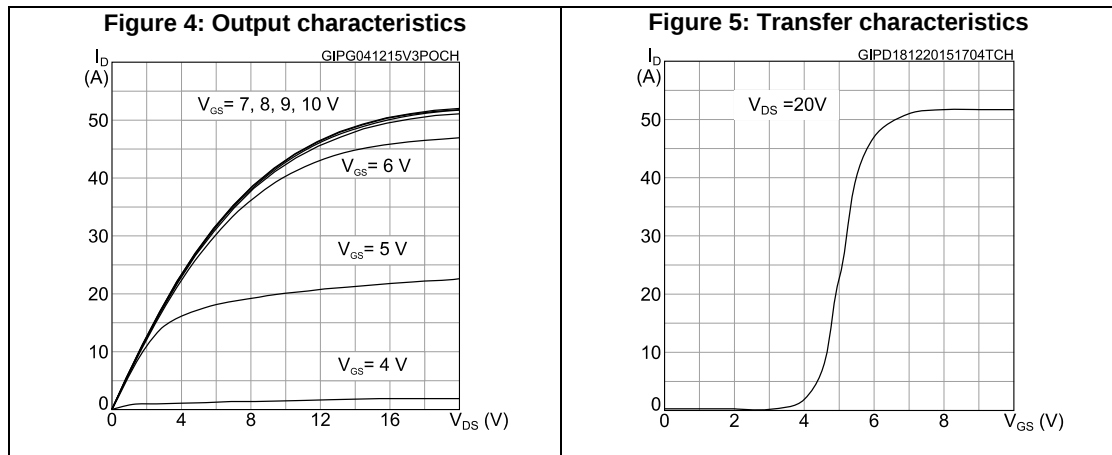
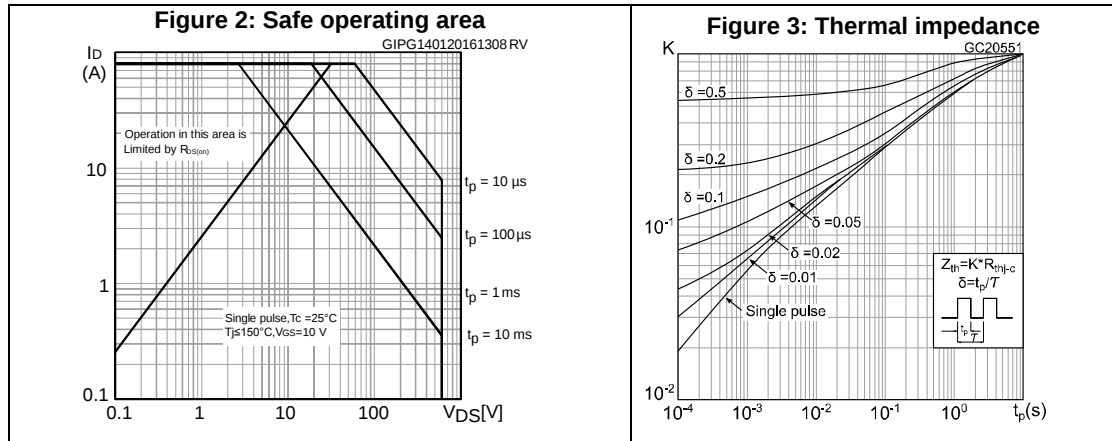


Figure 8: Capacitance variations

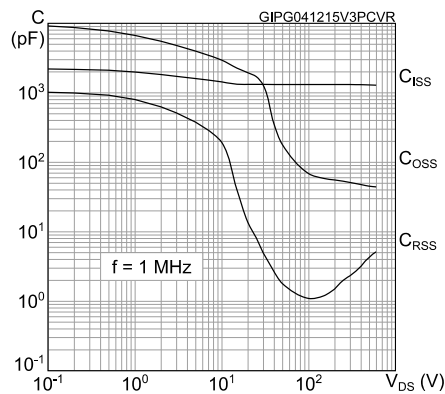


Figure 9: Output capacitance stored energy

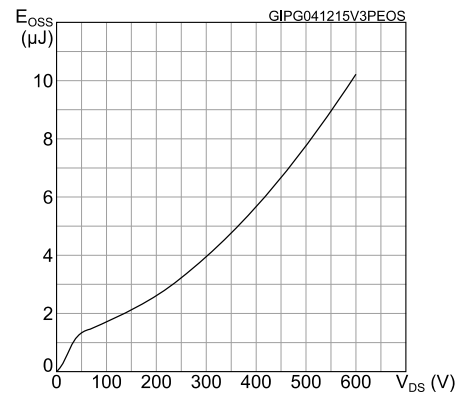
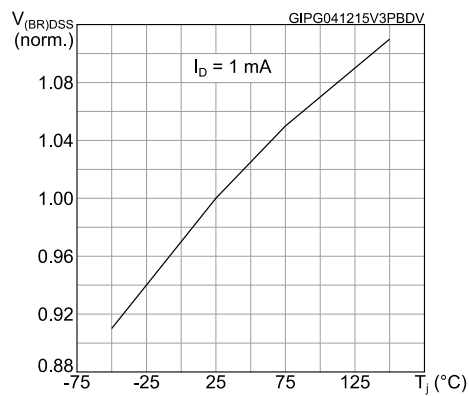
Figure 10: Normalized  $V_{(BR)DSS}$  vs temperature

Figure 11: Normalized gate threshold voltage vs temperature

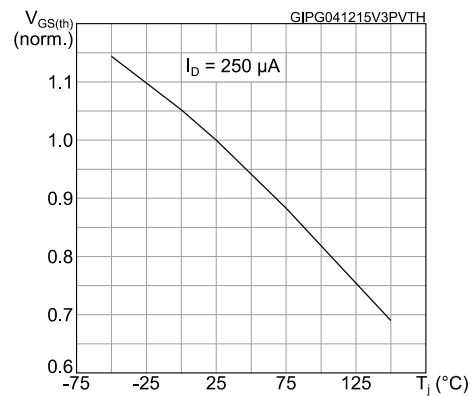


Figure 12: Normalized on-resistance vs temperature

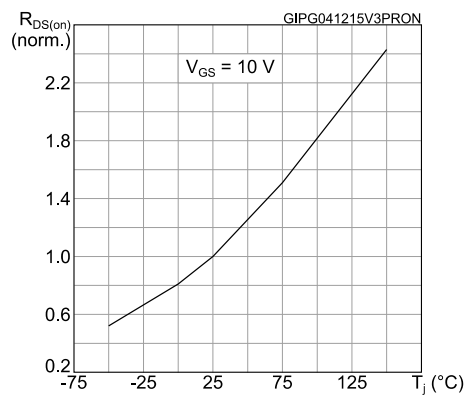
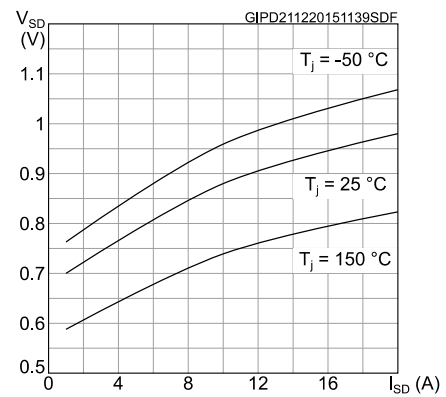
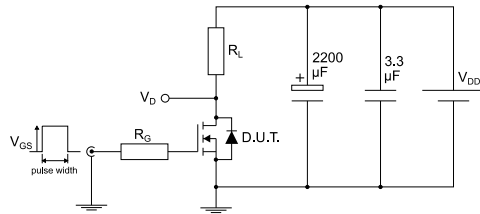


Figure 13: Source-drain diode forward characteristics



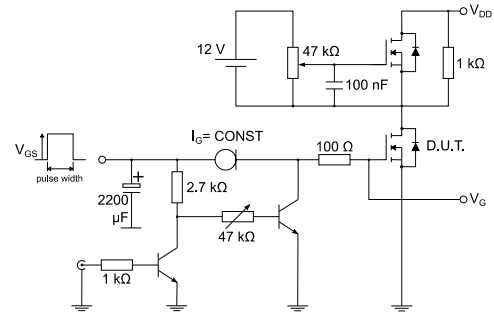
### 3 Test circuits

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



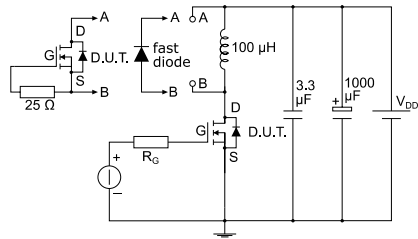
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**Figure 15: Test circuit for gate charge behavior**



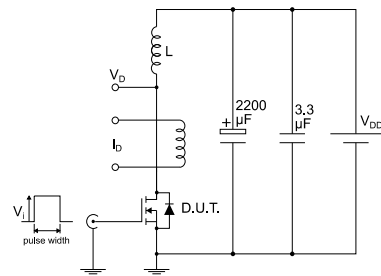
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**Figure 16: Test circuit for inductive load switching and diode recovery times**



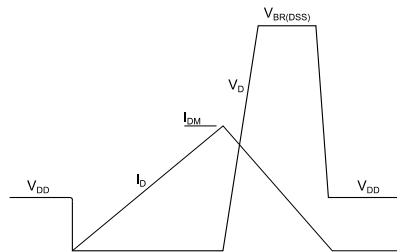
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**Figure 17: Unclamped inductive load test circuit**



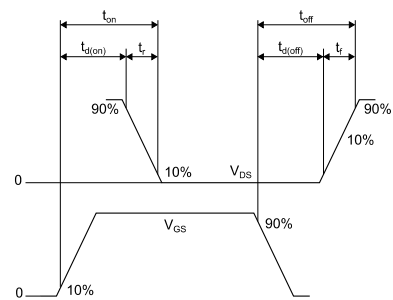
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**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: Switching time waveform**



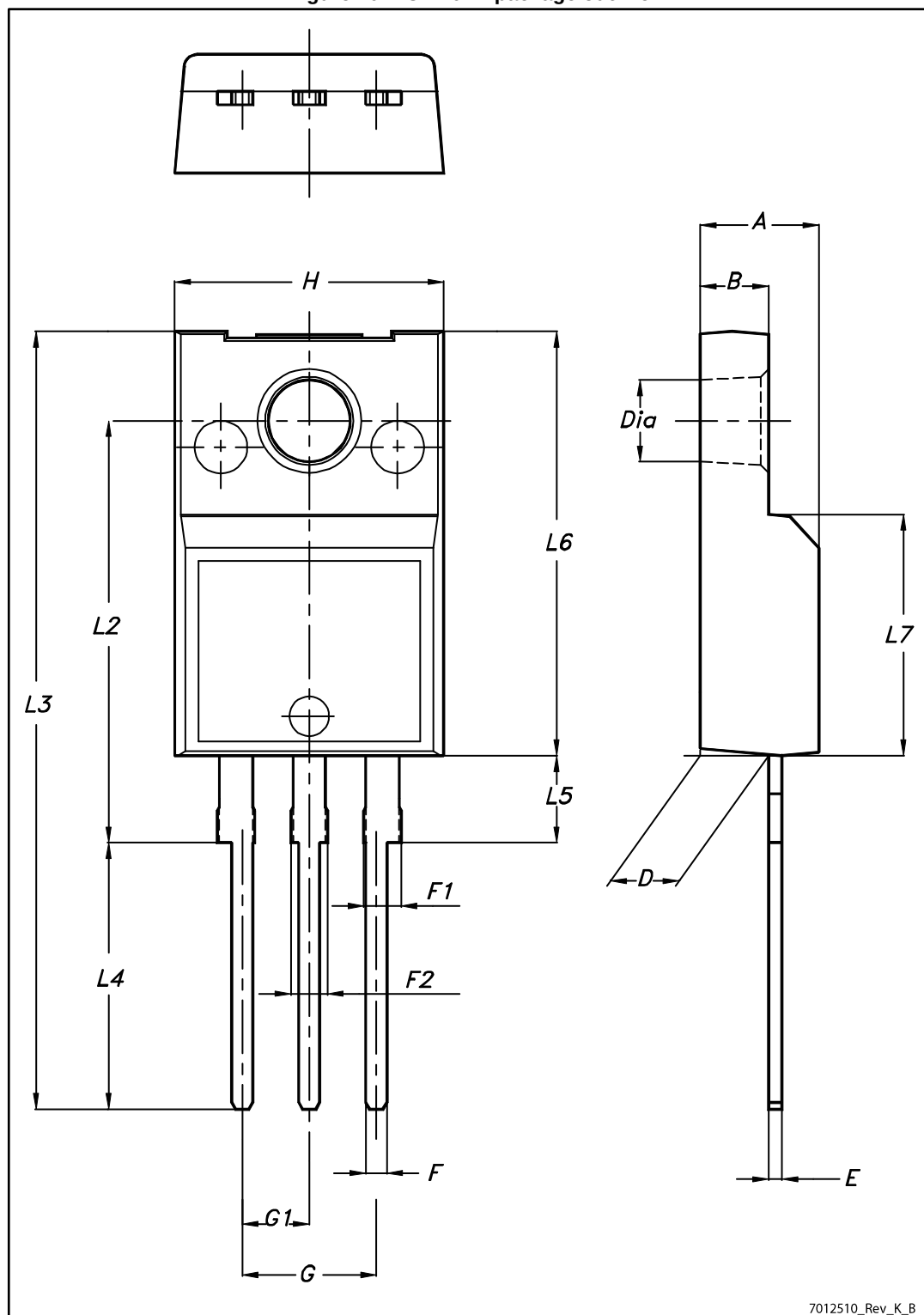
AM01473v1

## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: **[www.st.com](http://www.st.com)**. ECOPACK<sup>®</sup> is an ST trademark.

## 4.1 TO-220FP package information

Figure 20: TO-220FP package outline



7012510\_Rev\_K\_B

Table 9: TO-220FP package mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 4.4  |      | 4.6  |
| B    | 2.5  |      | 2.7  |
| D    | 2.5  |      | 2.75 |
| E    | 0.45 |      | 0.7  |
| F    | 0.75 |      | 1    |
| F1   | 1.15 |      | 1.70 |
| F2   | 1.15 |      | 1.70 |
| G    | 4.95 |      | 5.2  |
| G1   | 2.4  |      | 2.7  |
| H    | 10   |      | 10.4 |
| L2   |      | 16   |      |
| L3   | 28.6 |      | 30.6 |
| L4   | 9.8  |      | 10.6 |
| L5   | 2.9  |      | 3.6  |
| L6   | 15.9 |      | 16.4 |
| L7   | 9    |      | 9.3  |
| Dia  | 3    |      | 3.2  |

## 5 Revision history

Table 10: Document revision history

| Date        | Revision | Changes        |
|-------------|----------|----------------|
| 14-Jan-2016 | 1        | First release. |

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