

## N-channel 650 V, 0.6 $\Omega$ typ., 7 A MDmesh™ M2 Power MOSFETs in TO-220FP and I<sup>2</sup>PAKFP packages

Datasheet - production data

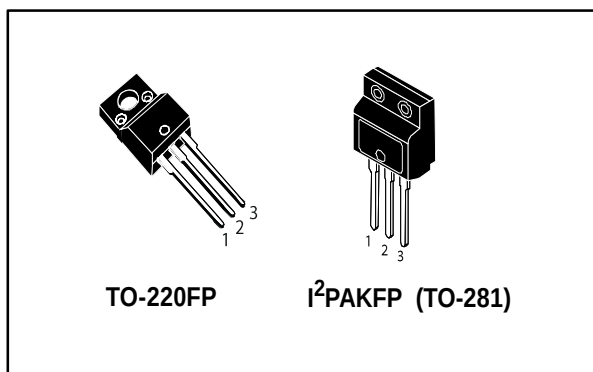
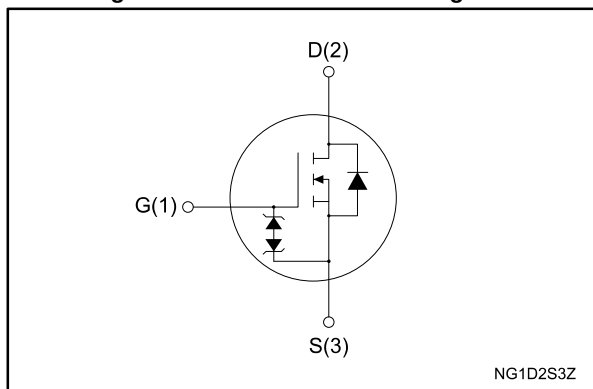


Figure 1: Internal schematic diagram



### Features

| Order code  | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|-----------------|--------------------------|----------------|------------------|
| STF11N65M2  | 650 V           | 0.68 $\Omega$            | 7 A            | 25 W             |
| STFI11N65M2 |                 |                          |                |                  |

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

### Applications

- Switching applications

### Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, these devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1: Device summary

| Order code  | Marking | Package              | Packing |
|-------------|---------|----------------------|---------|
| STF11N65M2  | 11N65M2 | TO-220FP             | Tube    |
| STFI11N65M2 |         | I <sup>2</sup> PAKFP |         |

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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 $T_{case} = 25\text{ }^{\circ}\text{C}$                                                                   | 7          | A                  |
|                  | Drain current (continuous) at $T_{case} = 100\text{ }^{\circ}\text{C}$                                                                  | 4.4        |                    |
| $I_{DM}^{(2)}$   | Drain current (pulsed)                                                                                                                  | 28         | A                  |
| $P_{TOT}$        | Total dissipation at $T_{case} = 25\text{ }^{\circ}\text{C}$                                                                            | 25         | W                  |
| $dv/dt^{(3)(4)}$ | Peak diode recovery voltage slope                                                                                                       | 15         | V/ns               |
| $dv/dt^{(5)}$    | MOSFET $dv/dt$ ruggedness                                                                                                               | 50         |                    |
| $V_{ISO}$        | Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ , $T_c = 25\text{ }^{\circ}\text{C}$ ) | 2500       | V                  |
| $T_{stg}$        | Storage temperature                                                                                                                     | -55 to 150 | $^{\circ}\text{C}$ |
| $T_j$            | Operating junction temperature                                                                                                          |            |                    |

**Notes:**

- (1) The value is rated according to  $R_{thj-case}$  and limited by package.  
 (2) Pulse width limited by  $T_{jmax}$ .  
 (3) starting  $T_j = 25\text{ }^{\circ}\text{C}$ ,  $I_D = I_{AS}$ ,  $V_{DD} = 50\text{ V}$ .  
 (4)  $I_{SD} \leq 7\text{ A}$ ,  $di/dt = 400\text{ A}/\mu\text{s}$ ,  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ .  
 (5)  $V_{DS} \leq 520\text{ V}$ .

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  |                             |

Table 4: Avalanche characteristics

| Symbol         | Parameter                                       | Value | Unit |
|----------------|-------------------------------------------------|-------|------|
| $I_{AR}^{(1)}$ | Avalanche current, repetitive or not repetitive | 1.5   | A    |
| $E_{AS}^{(2)}$ | Single pulse avalanche energy                   | 110   | mJ   |

**Notes:**

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

Table 5: Static

| 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                               | 650  |      |      | V    |
| I <sub>DSS</sub>     | Zero gate voltage drain current   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 650 V                             |      |      | 1    | μA   |
|                      |                                   | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 650 V, T <sub>case</sub> = 125 °C |      |      | 100  |      |
| 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> = 3.5 A                             |      | 0.6  | 0.68 | Ω    |

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                                                                                       | -    | 410  | -    | pF   |
| C <sub>oss</sub>                    | Output capacitance            |                                                                                                                                                 | -    | 20   | -    |      |
| C <sub>rss</sub>                    | Reverse transfer capacitance  |                                                                                                                                                 | -    | 0.95 | -    |      |
| C <sub>oss eq.</sub> <sup>(1)</sup> | Equivalent output capacitance | V <sub>DS</sub> = 0 to 520 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> = 520 V, I <sub>D</sub> = 7 A, V <sub>GS</sub> = 10 V (see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> ) | -    | 12.5 | -    | nC   |
| Q <sub>gs</sub>                     | Gate-source charge            |                                                                                                                                                 | -    | 3.2  | -    |      |
| Q <sub>gd</sub>                     | Gate-drain charge             |                                                                                                                                                 | -    | 5.8  | -    |      |

**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 <sub>d(on)</sub>  | Turn-on delay time  | V <sub>DD</sub> = 325 V, I <sub>D</sub> = 3.5 A<br>R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 V (see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a> and <a href="#">Figure 19: "Switching time waveform"</a> ) | -    | 9.5  | -    | ns   |
| t <sub>r</sub>      | Rise time           |                                                                                                                                                                                                                                                | -    | 7.5  | -    |      |
| t <sub>d(off)</sub> | Turn-off delay time |                                                                                                                                                                                                                                                | -    | 26   | -    |      |
| t <sub>f</sub>      | Fall time           |                                                                                                                                                                                                                                                | -    | 15   | -    |      |

Table 8: Source-drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                                            | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                                            | -    |      | 7    | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                                            | -    |      | 28   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $V_{GS} = 0\text{ V}$ , $I_{SD} = 7\text{ A}$                                                                                                                                                                                              | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 7\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 16</a> :<br>"Test circuit for inductive load<br>switching and diode recovery<br>times")                                     | -    | 318  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                            | -    | 2.5  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                            | -    | 15.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 7\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see<br><a href="#">Figure 16</a> : "Test circuit for<br>inductive load switching and<br>diode recovery times") | -    | 437  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                            | -    | 3.2  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                            | -    | 15   |      | A             |

**Notes:**

<sup>(1)</sup> Pulse width is limited by safe operating area.

<sup>(2)</sup> Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

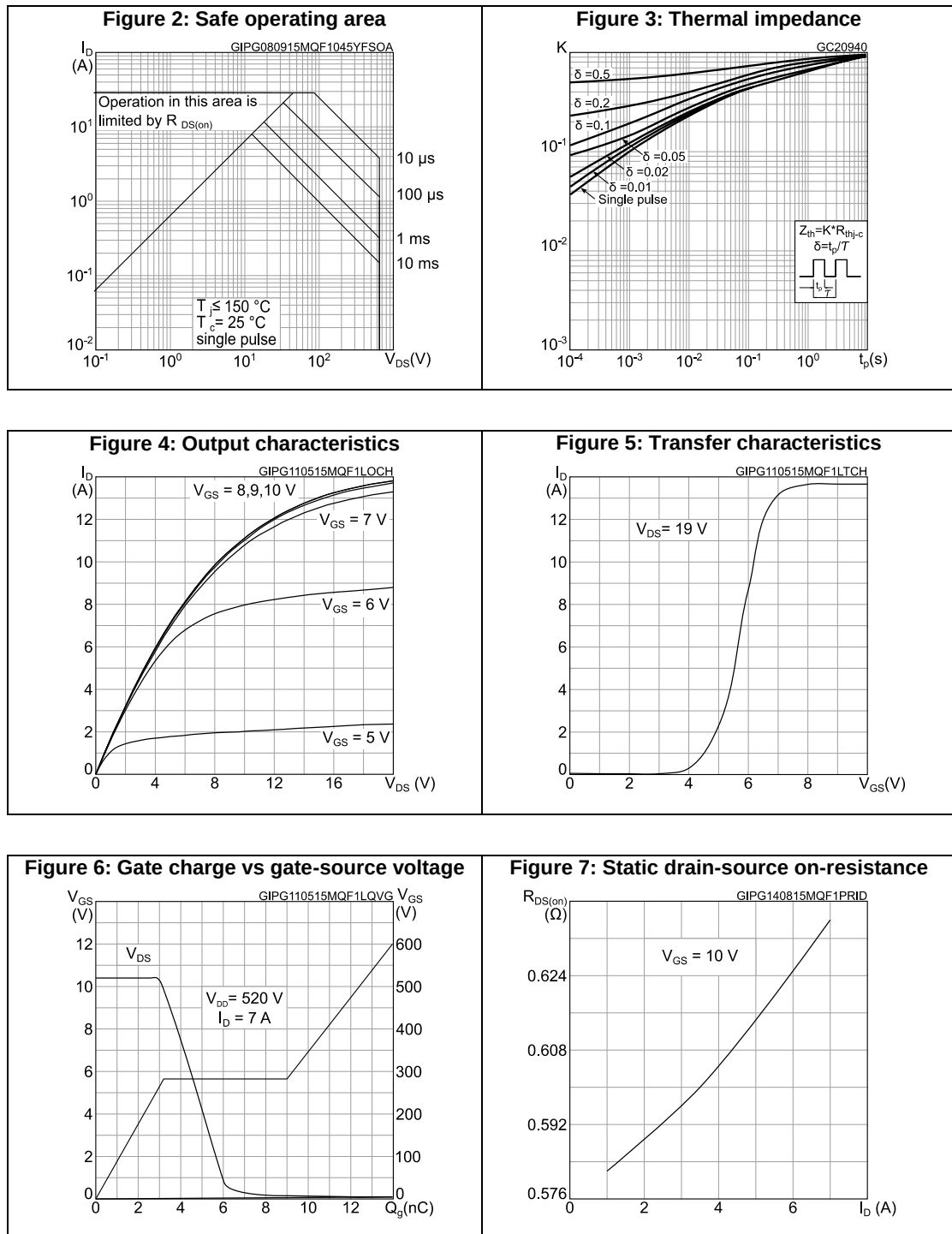


Figure 8: Capacitance variations

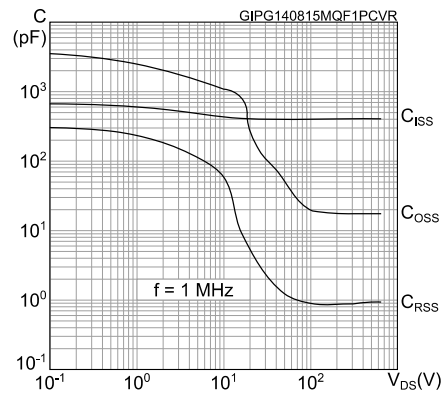


Figure 9: Normalized gate threshold voltage vs temperature

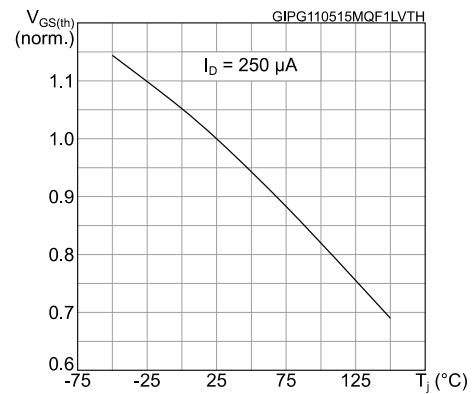


Figure 10: Normalized on-resistance vs temperature

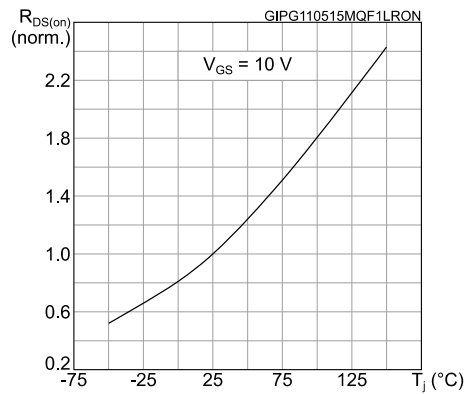


Figure 11: Normalized V(BR)DSS vs temperature

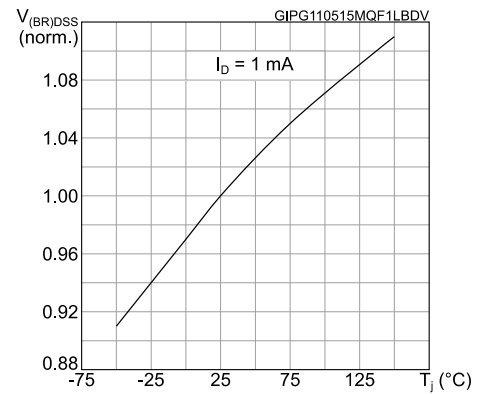


Figure 12: Output capacitance stored energy

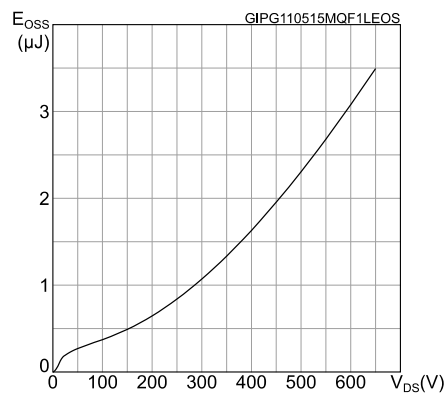
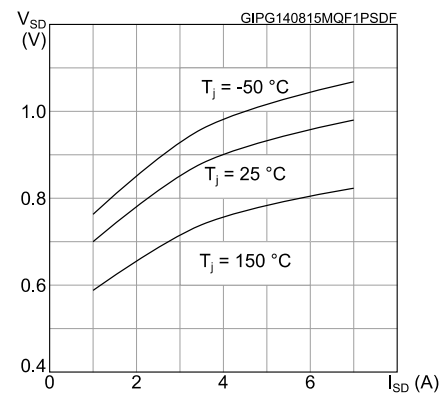
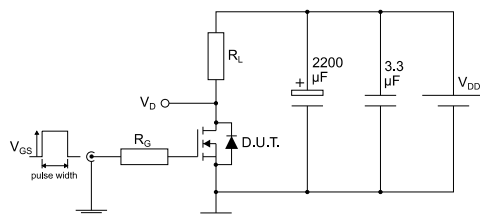


Figure 13: Source- drain diode forward characteristics



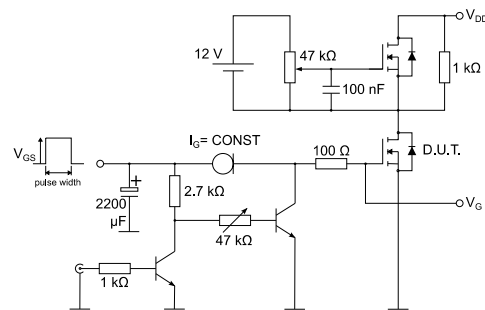
### 3 Test circuits

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



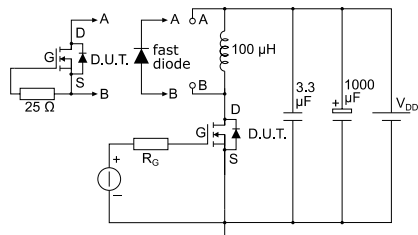
AM01468v1

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



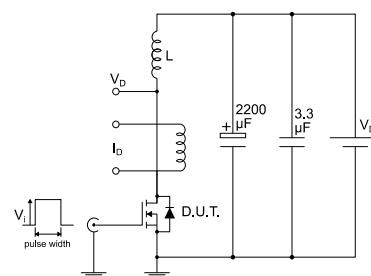
AM01469v1

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



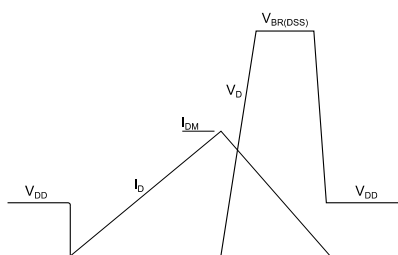
AM01470v1

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



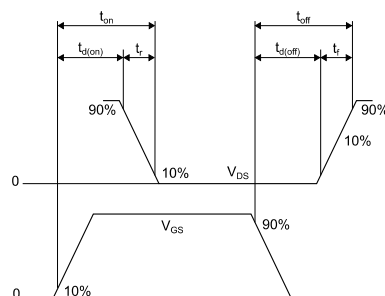
AM01471v1

**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: Switching time waveform**



AM01473v1

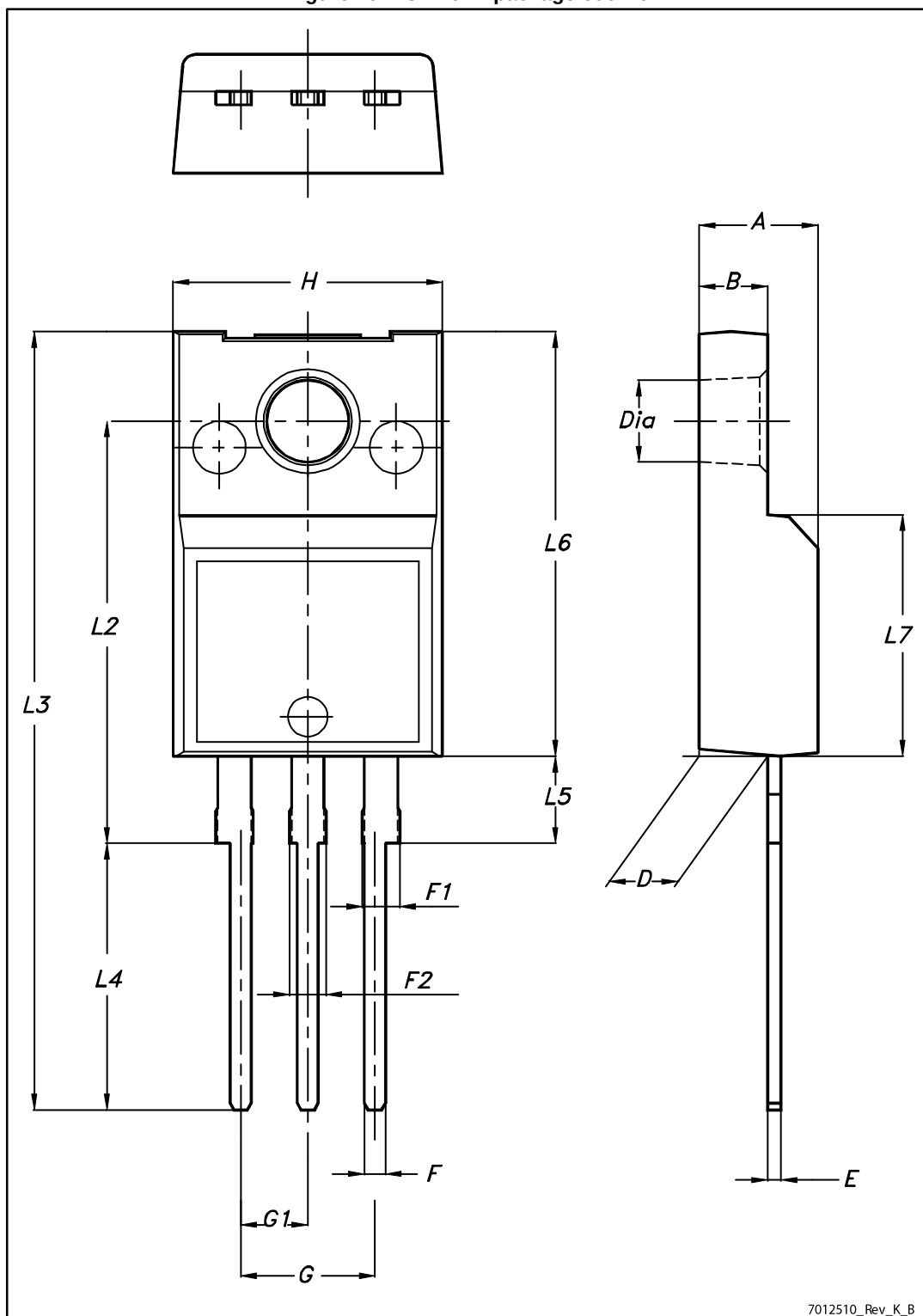


## 4 Package information

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 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  |

## 4.2 I<sup>2</sup>PAKFP (TO-281) package information

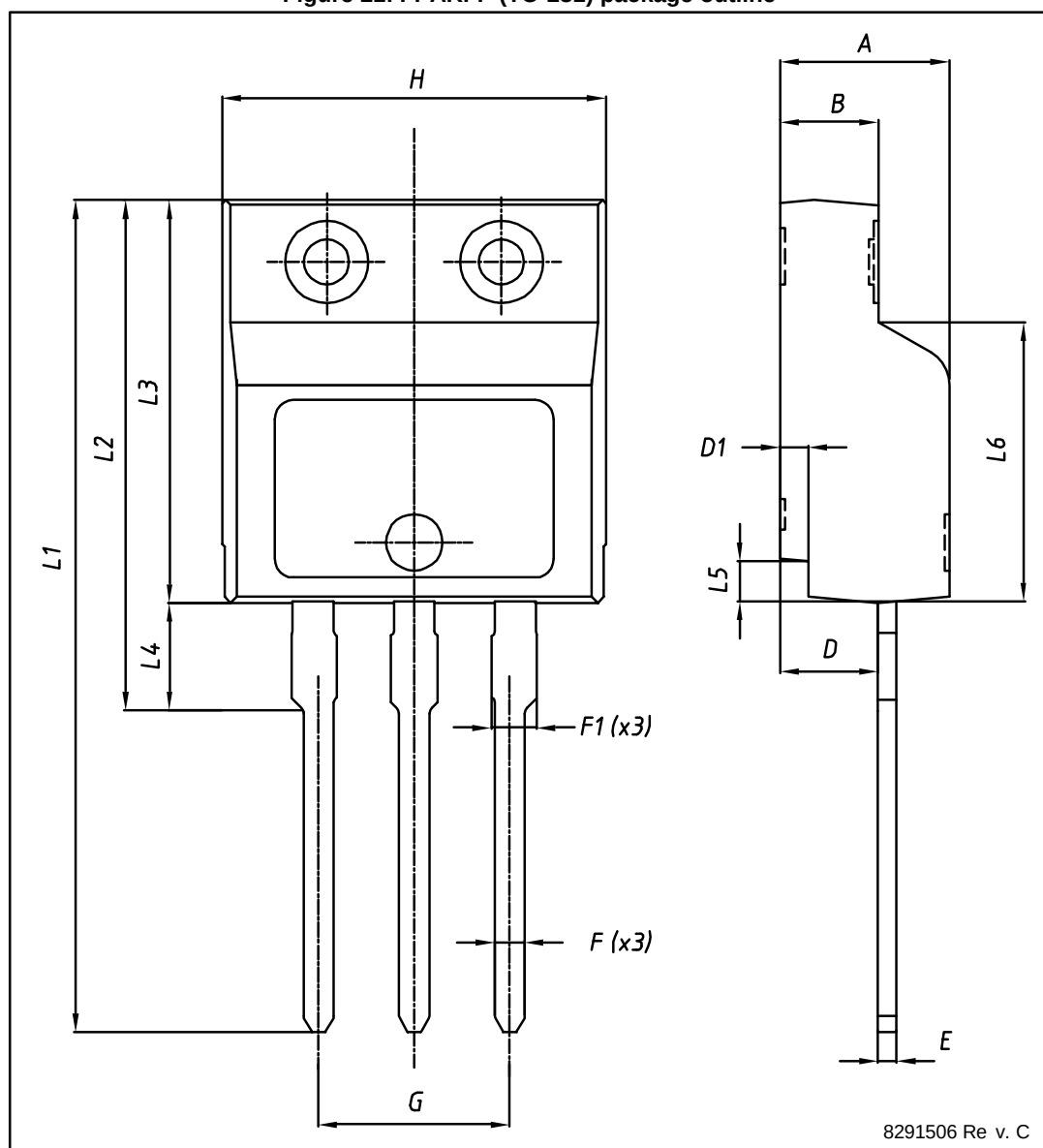
Figure 21: I<sup>2</sup>PAKFP (TO-281) package outline

Table 10: I<sup>2</sup>PAKFP (TO-281) mechanical data

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.40  | -    | 4.60  |
| B    | 2.50  |      | 2.70  |
| D    | 2.50  |      | 2.75  |
| D1   | 0.65  |      | 0.85  |
| E    | 0.45  |      | 0.70  |
| F    | 0.75  |      | 1.00  |
| F1   |       |      | 1.20  |
| G    | 4.95  |      | 5.20  |
| H    | 10.00 |      | 10.40 |
| L1   | 21.00 |      | 23.00 |
| L2   | 13.20 |      | 14.10 |
| L3   | 10.55 |      | 10.85 |
| L4   | 2.70  |      | 3.20  |
| L5   | 0.85  |      | 1.25  |
| L6   | 7.50  | 7.60 | 7.70  |

## 5 Revision history

**Table 11: Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 09-May-2014 | 1        | First release.                                                                                                                                                                                                                                                                                                                                                                             |
| 08-Sep-2015 | 2        | Text and formatting changes throughout document.<br>On cover page:<br>- updated <i>Title</i> and <i>Features</i><br>In section <i>Electrical characteristics</i> :<br>- updated and renamed table <i>Static</i> (was On /off states)<br>Updated section <i>Electrical characteristics (curves)</i><br>Updated and renamed section <i>Package information</i> (was Package mechanical data) |

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