

## N-channel 800 V, 1.3 $\Omega$ typ., 4.5 A MDmesh™ K5 Power MOSFETs in TO-220FP and I<sup>2</sup>PAKFP packages

Datasheet - production data

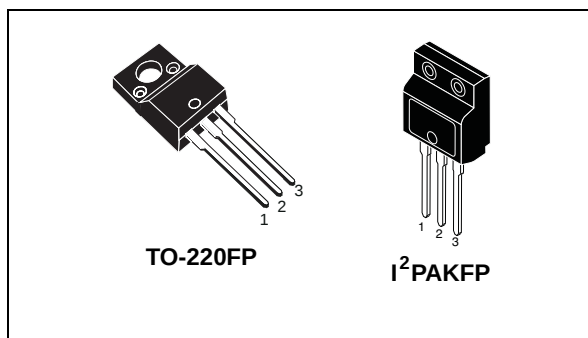
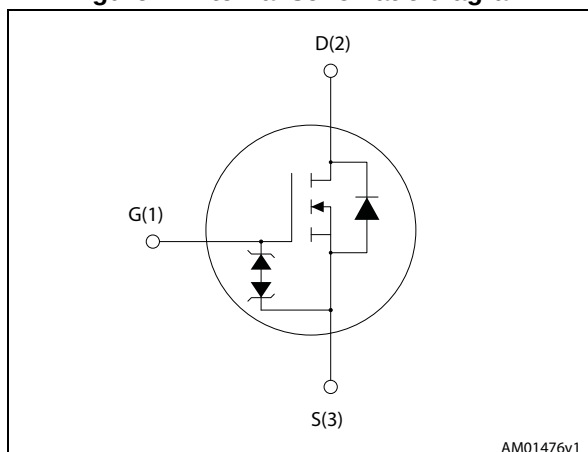


Figure 1. Internal schematic diagram



### Features

| Order code | V <sub>DS</sub> | R <sub>DS(on)</sub> max | I <sub>D</sub> | P <sub>TOT</sub> |
|------------|-----------------|-------------------------|----------------|------------------|
| STF6N80K5  | 800 V           | 1.6 $\Omega$            | 4.5 A          | 25 W             |
| STFI6N80K5 |                 |                         |                |                  |

- Industry's lowest R<sub>DS(on)</sub>
- Industry's best figure of merit (FoM)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1. Device summary

| Order code | Marking | Package              | Packing |
|------------|---------|----------------------|---------|
| STF6N80K5  | 6N80K5  | TO-220FP             | Tube    |
| STFI6N80K5 |         | I <sup>2</sup> PAKFP |         |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter                                                                                                                 | Value              | Unit |
|----------------|---------------------------------------------------------------------------------------------------------------------------|--------------------|------|
| $V_{GS}$       | Gate- source voltage                                                                                                      | 30                 | V    |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ °C}$                                                                        | 4.5 <sup>(1)</sup> | A    |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ °C}$                                                                       | 2.8                | A    |
| $I_{DM}^{(2)}$ | Drain current (pulsed)                                                                                                    | 18                 | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$                                                                                 | 25                 | W    |
| $I_{AR}$       | Max current during repetitive or single pulse avalanche (pulse width limited by $T_{jmax}$ )                              | 1.5                | A    |
| $E_{AS}$       | Single pulse avalanche energy (starting $T_J = 25\text{ °C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ )                  | 85                 | mJ   |
| $dv/dt^{(3)}$  | Peak diode recovery voltage slope                                                                                         | 4.5                | 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 ( $t = 1\text{ s}$ , $T_C = 25\text{ °C}$ ) | 2500               | V    |
| $T_J$          | Operating junction temperature range                                                                                      | -55 to 150         | °C   |
| $T_{stg}$      | Storage temperature range                                                                                                 |                    |      |

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3.  $I_{SD} \leq 4.5\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ , peak  $V_{DS} \leq V_{(BR)DSS}$
4.  $V_{DS} \leq 640\text{ V}$

**Table 3. Thermal data**

| Symbol         | Parameter                        | Value | Unit |
|----------------|----------------------------------|-------|------|
| $R_{thj-case}$ | Thermal resistance junction-case | 5     | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-amb  | 62.5  |      |

## 2 Electrical characteristics

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

**Table 4. On/off states**

| Symbol        | Parameter                                        | Test conditions                                                     | Min. | Typ. | Max.     | Unit          |
|---------------|--------------------------------------------------|---------------------------------------------------------------------|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage ( $V_{GS} = 0$ )  | $I_D = 1\text{ mA}$                                                 | 800  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 800\text{ V}$                                             |      |      | 1        | $\mu\text{A}$ |
|               |                                                  | $V_{DS} = 800\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}^{(1)}$ |      |      | 50       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20\text{ V}$                                          |      |      | $\pm 10$ | $\mu\text{A}$ |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$                  | 3    | 4    | 5        | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 2\text{ A}$                         |      | 1.3  | 1.6      | $\Omega$      |

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

**Table 5. Dynamic**

| Symbol            | Parameter                             | Test conditions                                                   | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|-------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$ | -    | 270  | -    | pF       |
| $C_{oss}$         | Output capacitance                    |                                                                   | -    | 25   | -    | pF       |
| $C_{rss}$         | Reverse transfer capacitance          |                                                                   | -    | 0.7  | -    | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{GS} = 0$ , $V_{DS} = \text{from } 0 \text{ to } 640\text{ V}$ | -    | 38   | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related |                                                                   | -    | 16   | -    | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz}$ , $I_D = 0$                                    | -    | 7.5  | -    | $\Omega$ |
| $Q_g$             | Total gate charge                     | $V_{DD} = 640\text{ V}$ , $I_D = 4.5\text{ A}$                    | -    | 13   | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    | $V_{GS} = 10\text{ V}$                                            | -    | 2.1  | -    | nC       |
| $Q_{gd}$          | Gate-drain charge                     | (see <a href="#">Figure 15: Gate charge test circuit</a> )        | -    | 9.6  | -    | nC       |

1. Time related is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$
2. Energy related is defined as a constant equivalent capacitance giving the same stored energy 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  | $V_{DD} = 400\text{ V}$ , $I_D = 2.25\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 14: Switching times test circuit for resistive load</a> and <a href="#">Figure 19: Switching time waveform</a> ) | -    | 16   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                               | -    | 7.5  | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                                                                                                                               | -    | 28.5 | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                               | -    | 16   | -    | ns   |

Table 7. Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                                       | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |                                                                                                                                                                                                                                       | -    |      | 4.5  | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |                                                                                                                                                                                                                                       | -    |      | 18   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 4.5\text{ A}$ , $V_{GS} = 0$                                                                                                                                                                                                | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 4.5\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>(see <a href="#">Figure 16: Test circuit for inductive load switching and diode recovery times</a> )                                      | -    | 280  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                       | -    | 2.2  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                       | -    | 15.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 4.5\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 16: Test circuit for inductive load switching and diode recovery times</a> ) | -    | 450  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                       | -    | 3.15 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                       | -    | 14   |      | A             |

1. Pulse width limited by safe operating area

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

Table 8. Gate-source Zener diode

| Symbol        | Parameter                     | Test conditions                        | Min. | Typ. | Max. | Unit |
|---------------|-------------------------------|----------------------------------------|------|------|------|------|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS} = \pm 1\text{ mA}$ , $I_D = 0$ | 30   | -    | -    | V    |

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

2.1 Electrical characteristics (curves)

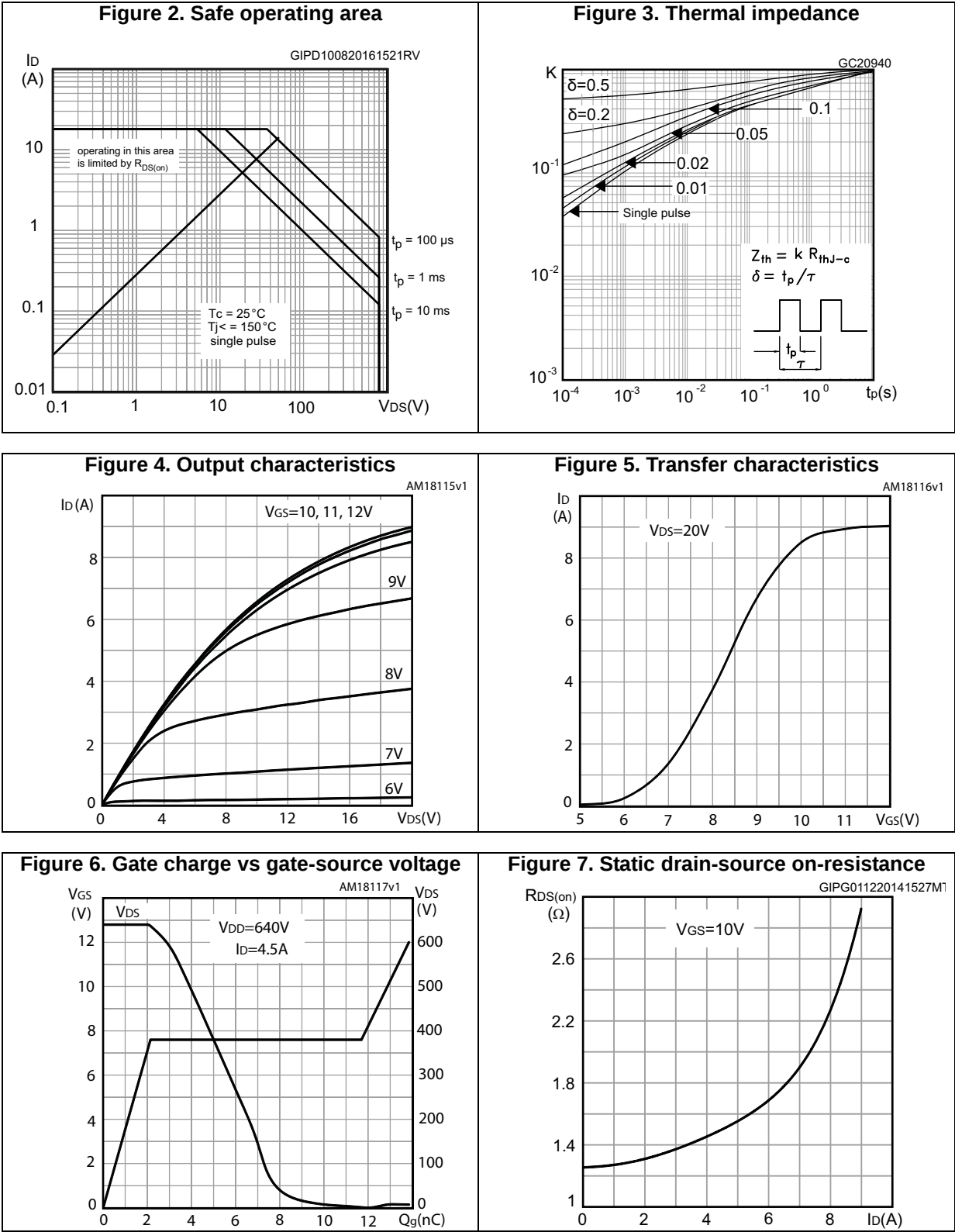


Figure 8. Capacitance variations

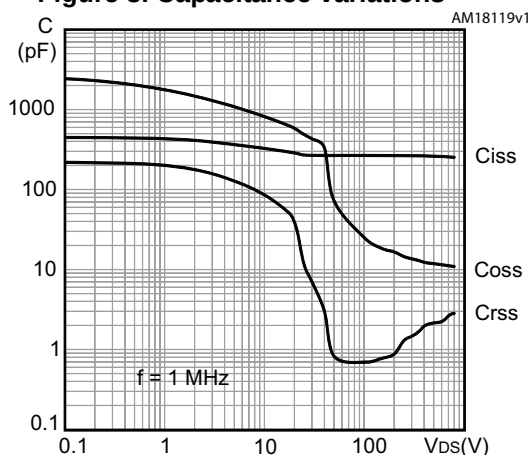


Figure 9. Output capacitance stored energy

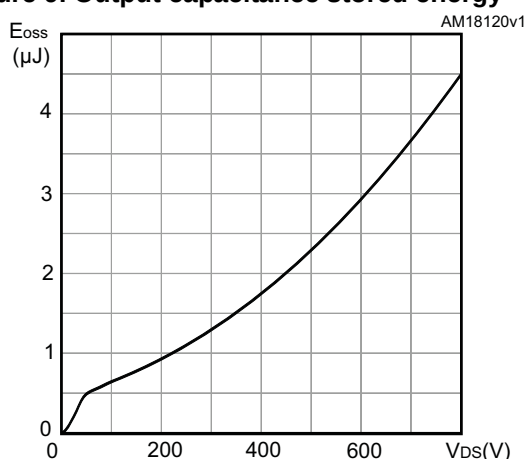


Figure 10. Normalized gate threshold voltage vs temperature

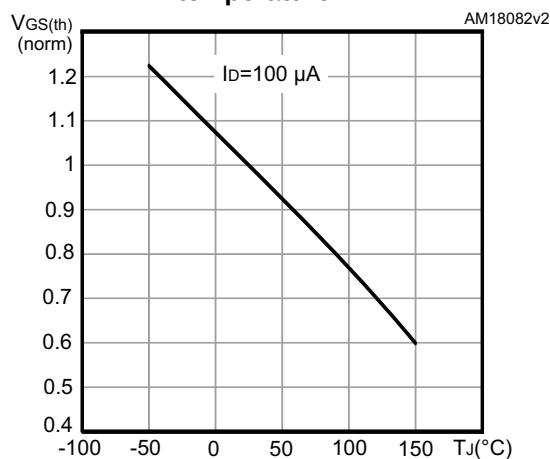


Figure 11. Normalized on-resistance vs temperature

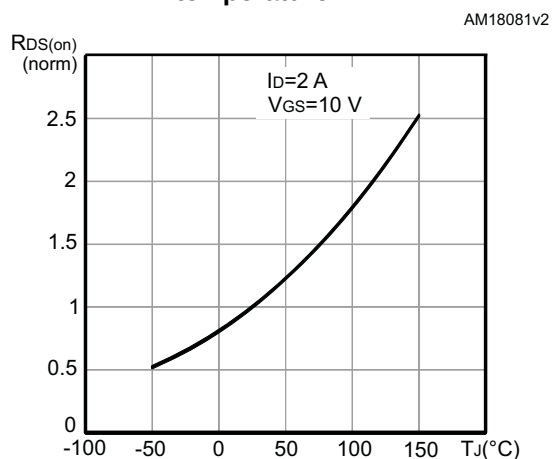
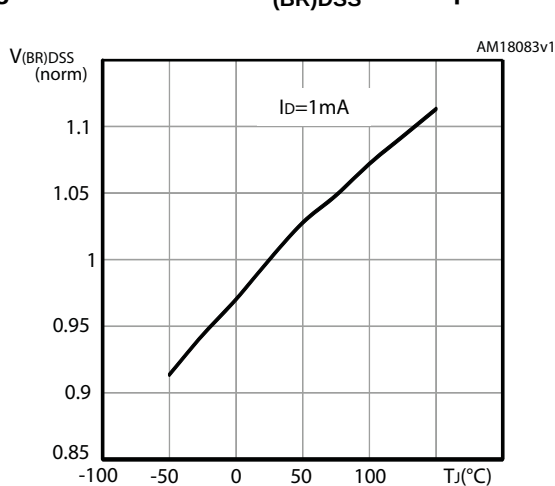
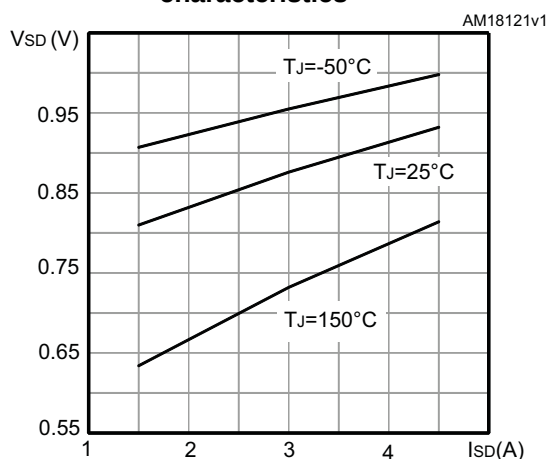
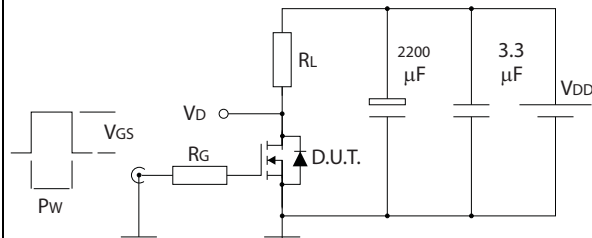
Figure 12. Normalized  $V_{(BR)DSS}$  vs temperature

Figure 13. Source-drain diode forward characteristics



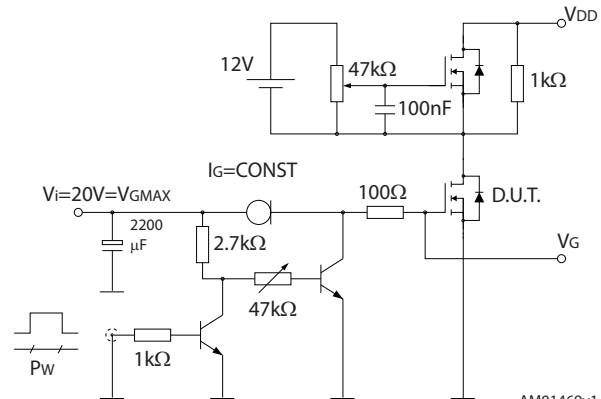
### 3 Test circuits

**Figure 14. Switching times test circuit for resistive load**



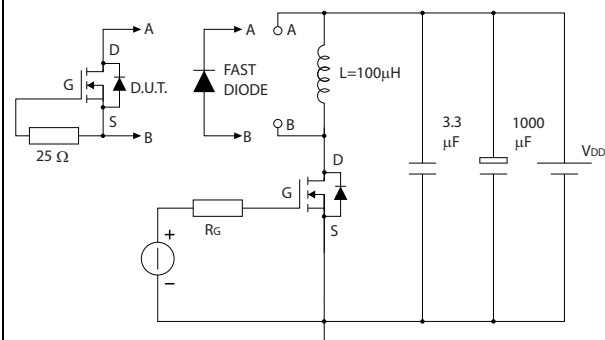
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**Figure 15. Gate charge test circuit**



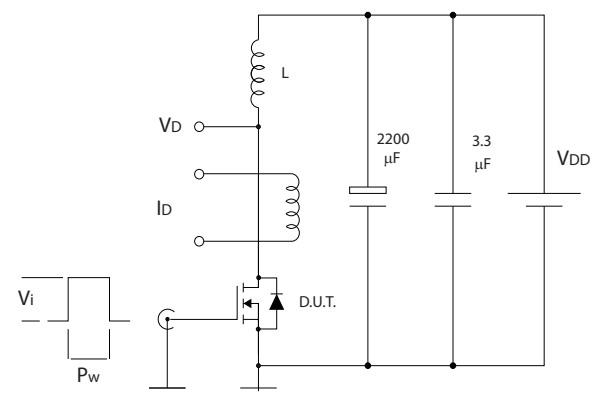
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**Figure 16. Test circuit for inductive load switching and diode recovery times**



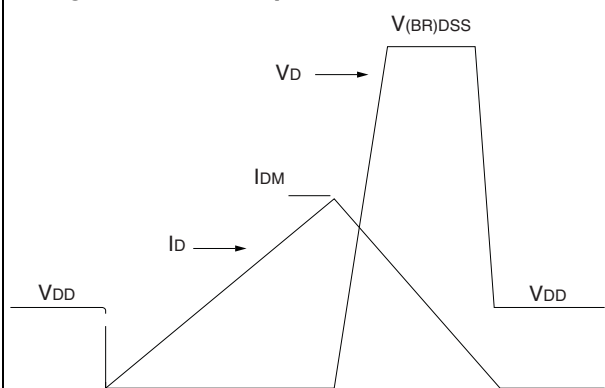
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**Figure 17. Unclamped inductive load test circuit**



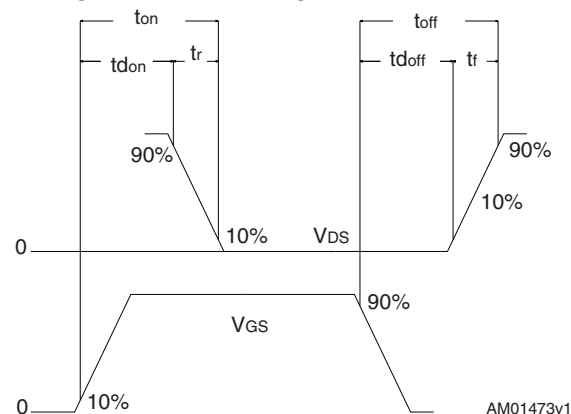
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**Figure 18. Unclamped inductive waveform**



AM01472v1

**Figure 19. Switching time waveform**



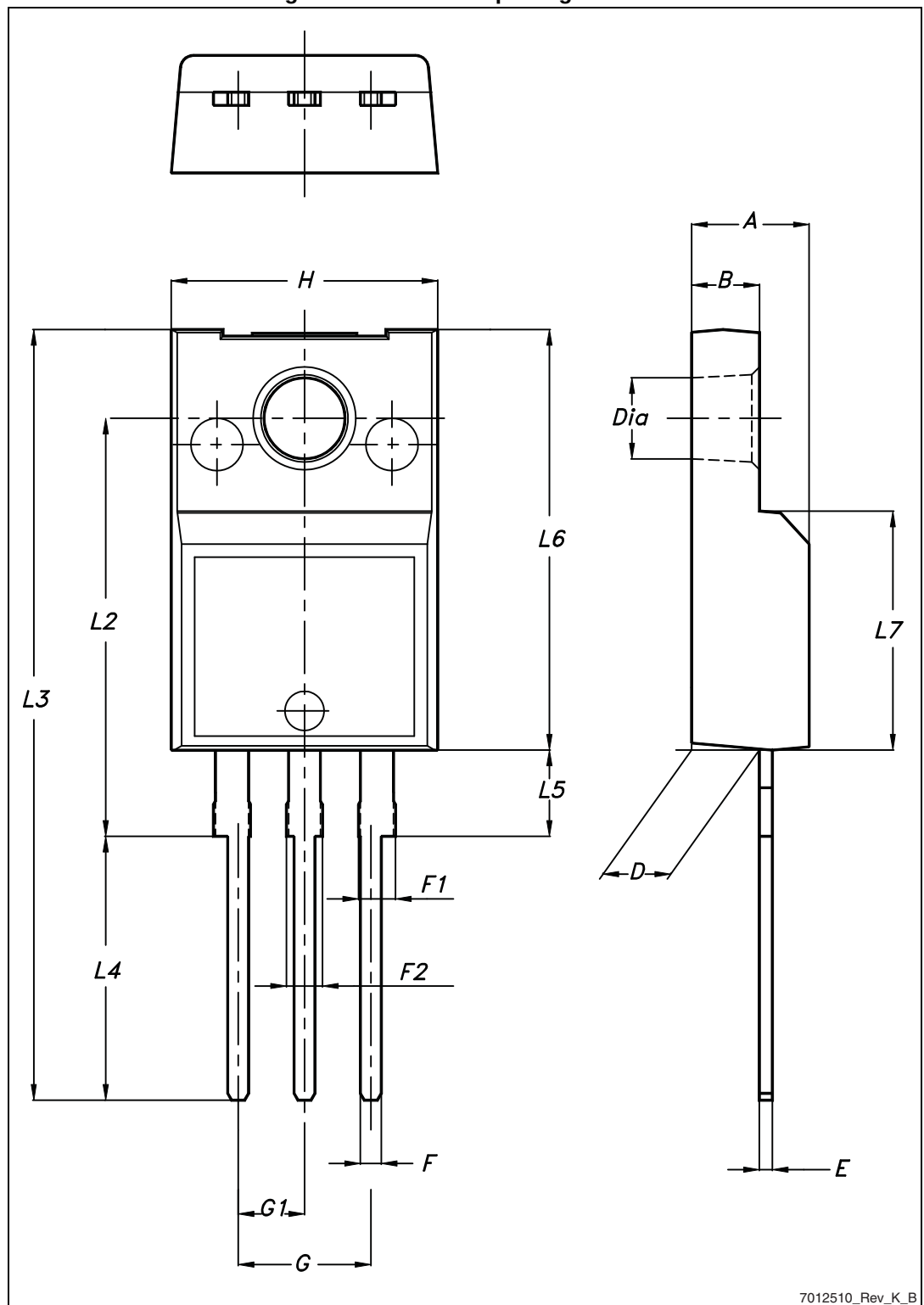
AM01473v1

## 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 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

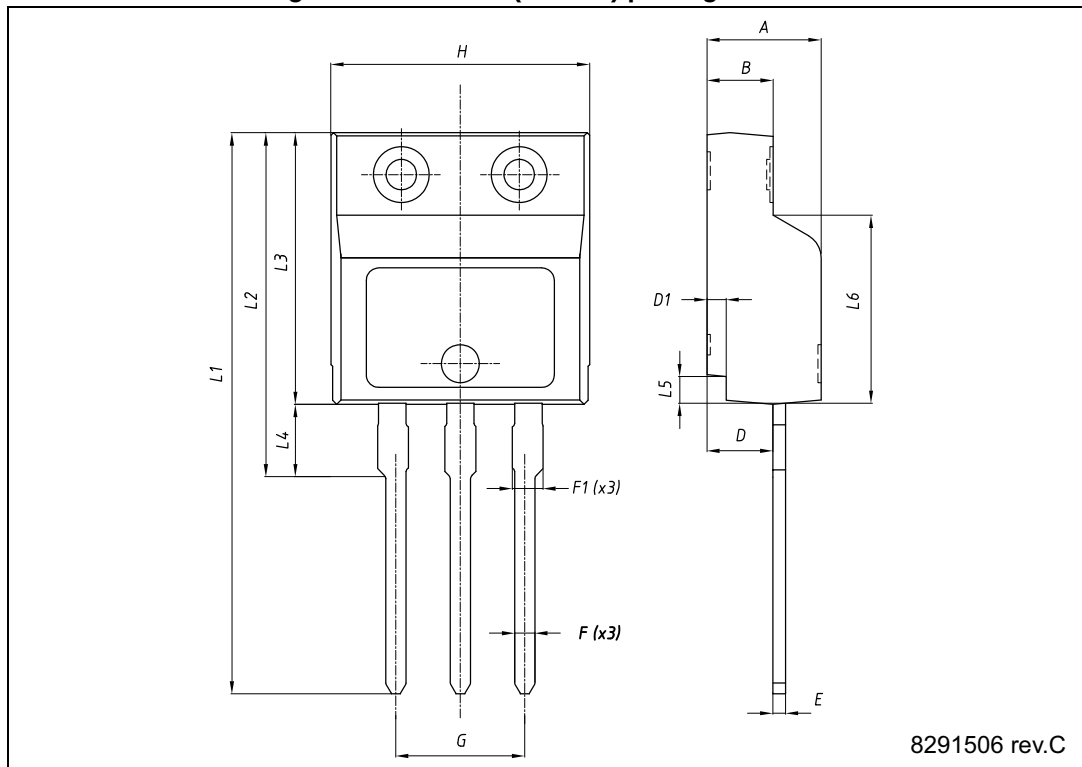


Table 10. I<sup>2</sup>PAKFP (TO-281) mechanical data

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 28-May-2013  | 1        | First release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 05-Mar-2014  | 2        | <ul style="list-style-type: none"> <li>– Datasheet status promoted from preliminary data to production data</li> <li>– Added: I<sup>2</sup>PAKFP package</li> <li>– Modified: E<sub>AS</sub> value in <i>Table 2</i></li> <li>– Added: MOSFET dv/dt ruggedness test condition and <i>note 4</i> in <i>Table 2</i></li> <li>– Modified: R<sub>G</sub> value in <i>Table 5</i></li> <li>– Modified: the entire typical values in <i>Table 5, 6 and 7</i></li> <li>– Added: <i>Section 2.1: Electrical characteristics (curves)</i></li> <li>– Minor text changes</li> </ul> |
| 05-Dec-2014  | 3        | <p>Updated title, features and description in cover page.</p> <p>Updated <i>Section 2.1: Electrical characteristics (curves)</i> and <i>Section 4: Package information</i>.</p> <p>Minor text changes.</p>                                                                                                                                                                                                                                                                                                                                                                |
| 06-Sept-2016 | 4        | <p>Updated <i>Table 2: Absolute maximum ratings</i>, <i>Table 4: On/off states</i>, <i>Table 5: Dynamic</i>, <i>Table 6: Switching times</i>, and <i>Table 7: Source drain diode</i>.</p> <p>Updated <i>Figure 2: Safe operating area</i> and <i>Figure 3: Thermal impedance</i>.</p> <p>Minor text changes.</p>                                                                                                                                                                                                                                                          |

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