

## N-channel 800 V, 0.95 $\Omega$ typ., 6 A Zener-protected SuperMESH™ 5 Power MOSFETs in TO-220FP and I<sup>2</sup>PAKFP packages

Datasheet - production data

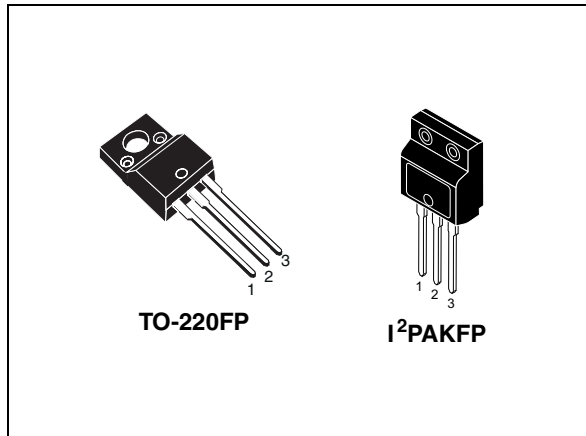
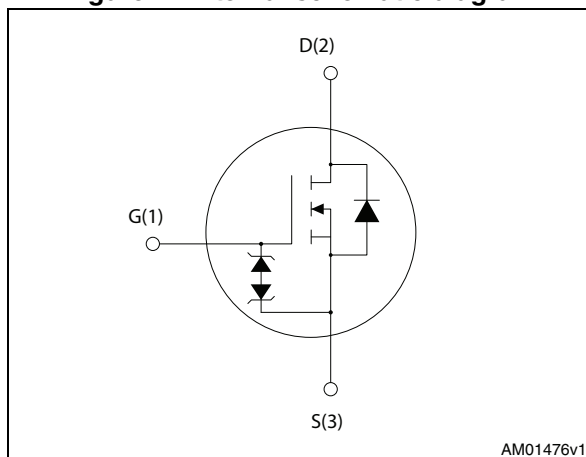


Figure 1. Internal schematic diagram



### Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub> max | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|-----------------|-------------------------|----------------|------------------|
| STF7N80K5   | 800 V           | 1.2 $\Omega$            | 6 A            | 25 W             |
| STFI7N80K5  |                 |                         |                |                  |

- Worldwide best FOM (figure of merit)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

These N-channel Zener-protected Power MOSFETs are designed using ST's revolutionary avalanche-rugged very high voltage SuperMESH™ 5 technology, based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance, and ultra-low gate charge for applications which require superior power density and high efficiency.

Table 1. Device summary

| Order codes | Marking | Package              | Packaging |
|-------------|---------|----------------------|-----------|
| STF7N80K5   | 7N80K5  | TO-220FP             | Tube      |
| STFI7N80K5  |         | I <sup>2</sup> PAKFP |           |

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter   | Value              | Unit             |
|----------------|---|--------------------|------------------|
| $V_{GS}$       | Gate- source voltage  | $\pm 30$           | V                |
| $I_D$          | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$  | 6 <sup>(1)</sup>   | A                |
| $I_D$          | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$   | 3.8 <sup>(1)</sup> | A                |
| $I_{DM}^{(2)}$ | Drain current (pulsed)  | 24 <sup>(1)</sup>  | A                |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$   | 25                 | W                |
| $I_{AR}$       | Max current during repetitive or single pulse avalanche (pulse width limited by $T_{jmax}$ )                                      | 2                  | A                |
| $E_{AS}$       | Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ )              | 88                 | mJ               |
| $V_{ISO}$      | 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                |
| $dv/dt^{(3)}$  | Peak diode recovery voltage slope   | 4.5                | V/ns             |
| $T_j$          | Operating junction temperature  | -55 to 150         | $^\circ\text{C}$ |
| $T_{stg}$      | Storage temperature   |                    | $^\circ\text{C}$ |

- Limited by package
- Pulse width limited by safe operating area.
- $I_{SD} \leq 6\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DS(peak)} \leq V_{(BR)DSS}$

**Table 3. Thermal data**

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

## 2 Electrical characteristics

( $T_{CASE} = 25\text{ °C}$  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 ( $V_{GS} = 0$ ) | $V_{DS} = 800\text{ V}$<br>$V_{DS} = 800\text{ V}, T_c = 125\text{ °C}$ |      |      | 1<br>50  | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{GSS}$     | 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                | $V_{GS} = 10\text{ V}, I_D = 3\text{ A}$                                |      | 0.95 | 1.2      | $\Omega$                       |

**Table 5. Dynamic**

| Symbol            | Parameter                             | Test conditions   | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|---|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{DS} = 100\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$   | -    | 360  | -    | pF       |
| $C_{oss}$         | Output capacitance                    |   | -    | 30   | -    | pF       |
| $C_{rss}$         | Reverse transfer capacitance          |   | -    | 1    | -    | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{GS} = 0, V_{DS} = 0\text{ to }640\text{ V}$   | -    | 47   | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related |   | -    | 20   | -    | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz}, I_D = 0$   | -    | 6    | -    | $\Omega$ |
| $Q_g$             | Total gate charge                     | $V_{DD} = 640\text{ V}, I_D = 6\text{ A}$<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 15</a> ) | -    | 13.4 | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    |   | -    | 3.7  | -    | nC       |
| $Q_{gd}$          | Gate-drain charge                     |   | -    | 7.5  | -    | 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  | $V_{DD} = 400\text{ V}$ , $I_D = 3\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see Figure 17) | -    | 11.3 | -    | ns   |
| $t_r$        | Rise time           |   |      | 8.3  |      | ns   |
| $t_{d(off)}$ | Turn-off delay time |   |      |      | 23.7 | ns   |
| $t_f$        | Fall time           |   |      |      | 20.2 | ns   |

Table 7. Source drain diode

| Symbol         | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|----------------|-------------------------------|--|------|------|------|---------------|
| $I_{SD}$       | Source-drain current          |  | -    |      | 6    | A             |
| $I_{SDM}$      | Source-drain current (pulsed) |  | -    |      | 24   | A             |
| $V_{SD}^{(1)}$ | Forward on voltage            | $I_{SD} = 6\text{ A}$ , $V_{GS} = 0$   | -    |      | 1.5  | V             |
| $t_{rr}$       | Reverse recovery time         | $I_{SD} = 6\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>(see Figure 16)                                      | -    | 315  |      | ns            |
| $Q_{rr}$       | Reverse recovery charge       |  | -    | 2.8  |      | $\mu\text{C}$ |
| $I_{RRM}$      | Reverse recovery current      |  | -    | 17.5 |      | A             |
| $t_{rr}$       | Reverse recovery time         | $I_{SD} = 6\text{ A}$ , $V_{DD} = 60\text{ V}$<br>$di/dt = 100\text{ A}/\mu\text{s}$ ,<br>$T_J = 150\text{ }^\circ\text{C}$<br>(see Figure 16) | -    | 480  |      | ns            |
| $Q_{rr}$       | Reverse recovery charge       |  | -    | 3.8  |      | $\mu\text{C}$ |
| $I_{RRM}$      | Reverse recovery current      |  | -    | 16   |      | A             |

1. 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 have been specifically designed to enhance not only the device's ESD capability, but also to make them capable of safely absorbing any voltage transients that may occasionally be applied from gate to source. In this respect, the Zener voltage is appropriate to achieve efficient and cost-effective protection of device integrity. The integrated Zener diodes thus eliminate the need for external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

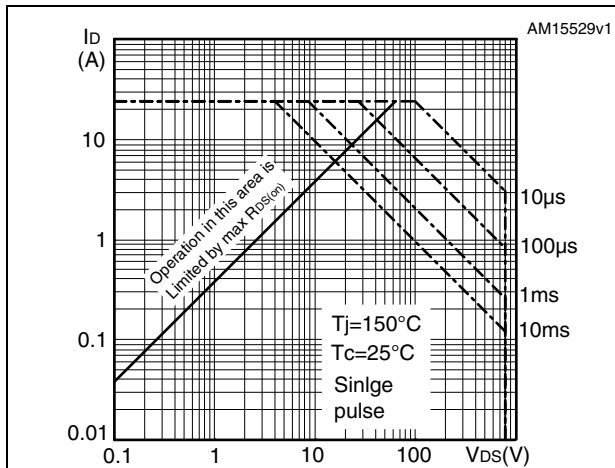


Figure 3. Thermal impedance

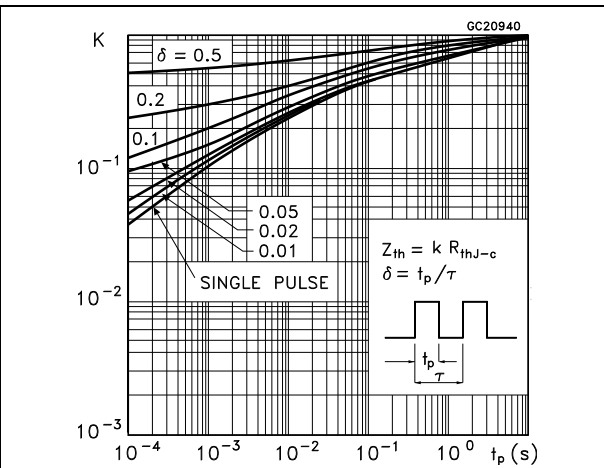


Figure 4. Output characteristics

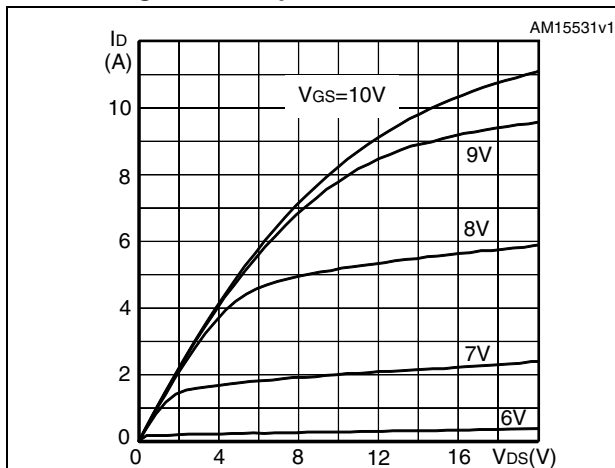


Figure 5. Transfer characteristics

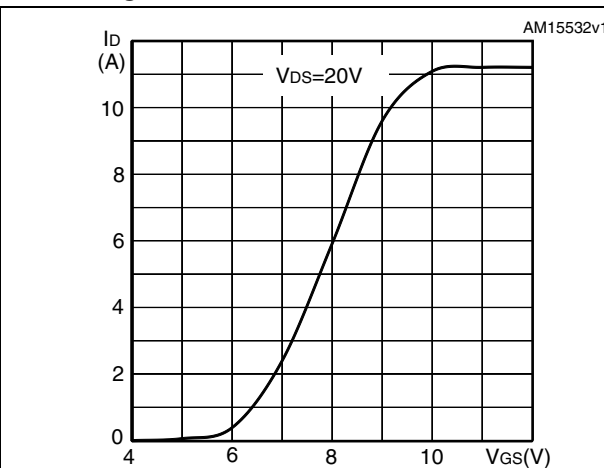


Figure 6. Gate charge vs gate-source voltage

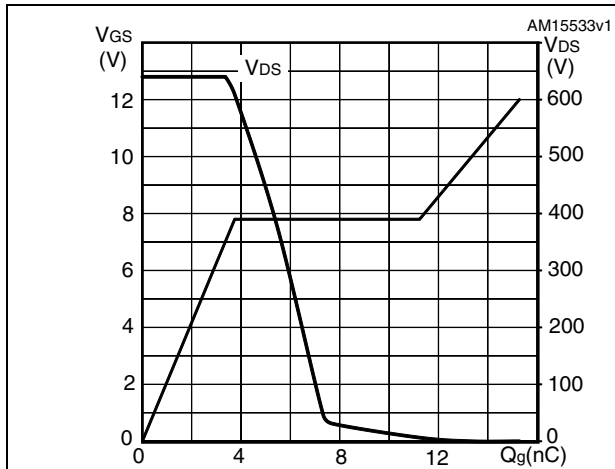


Figure 7. Static drain-source on-resistance

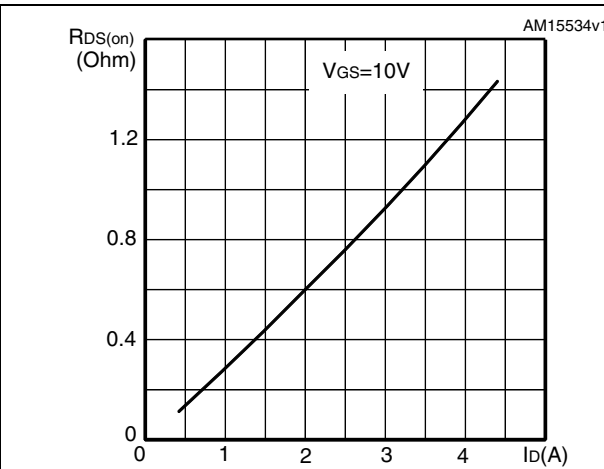


Figure 8. Capacitance variations

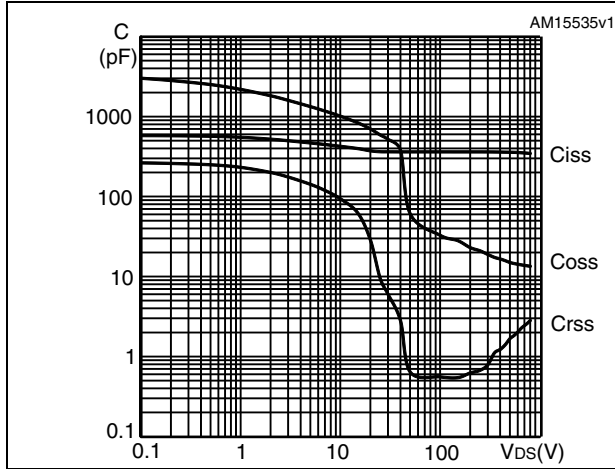


Figure 9. Source-drain diode forward characteristics

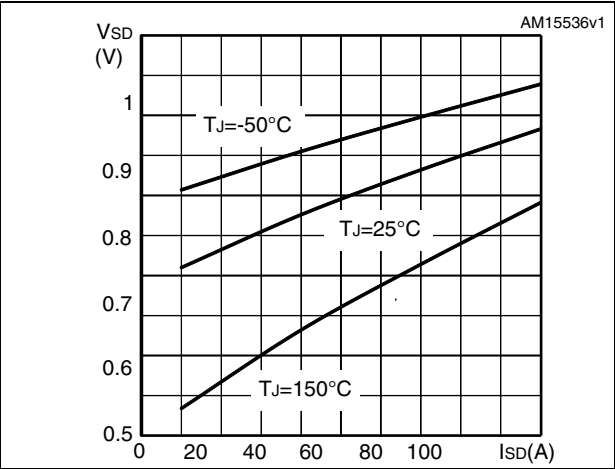


Figure 10. Normalized gate threshold voltage vs temperature

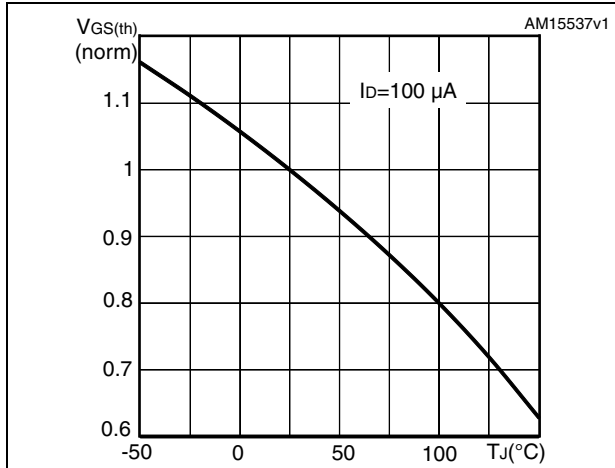


Figure 11. Normalized on-resistance vs temperature

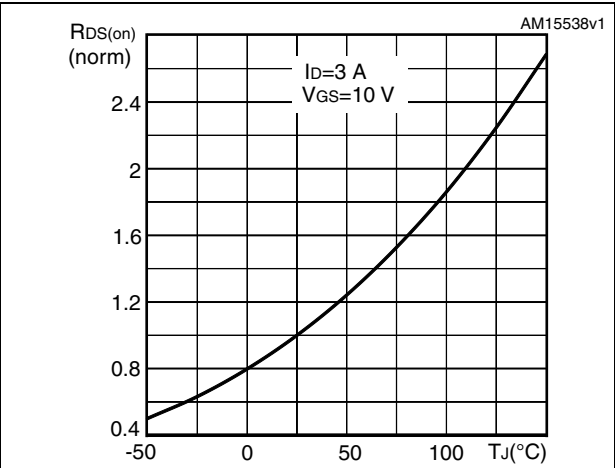


Figure 12. Normalized  $V_{(BR)DSS}$  vs temperature

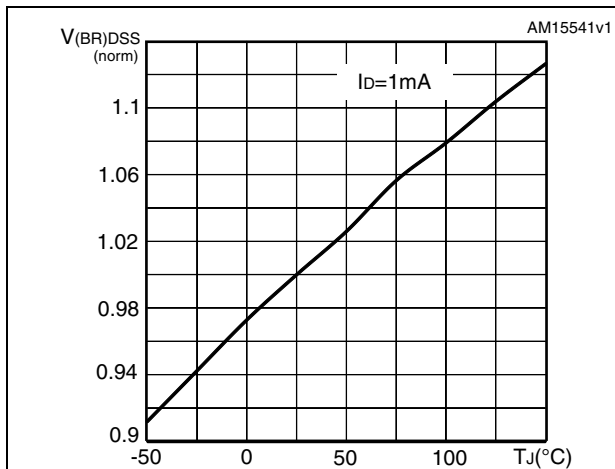
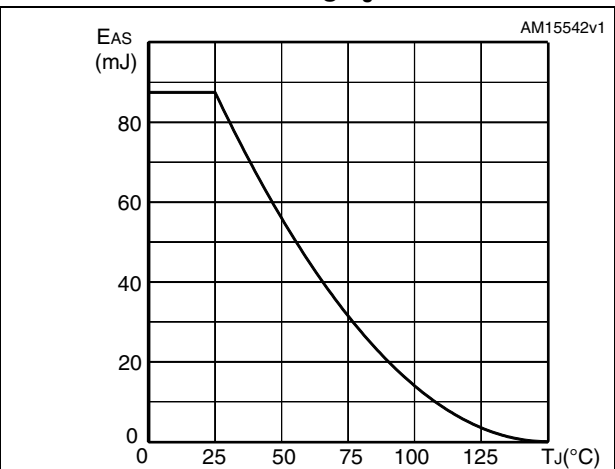


Figure 13. Maximum avalanche energy vs starting  $T_J$



### 3 Test circuits

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



**Figure 15. Gate charge test circuit**



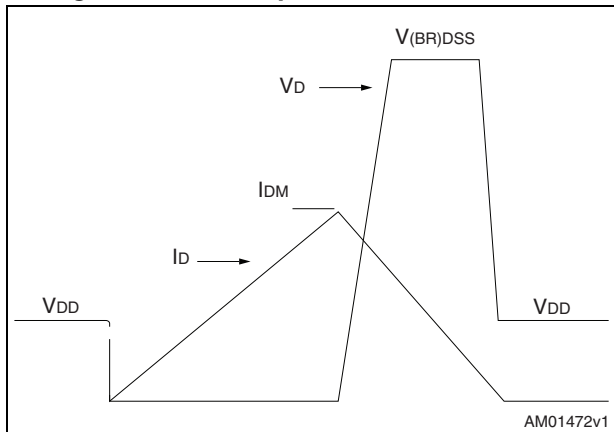
**Figure 16. Test circuit for inductive load switching and diode recovery times**



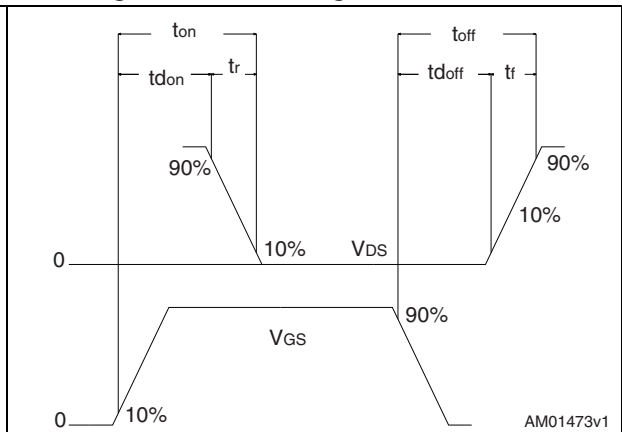
**Figure 17. Unclamped inductive load test circuit**



**Figure 18. Unclamped inductive waveform**



**Figure 19. Switching time waveform**





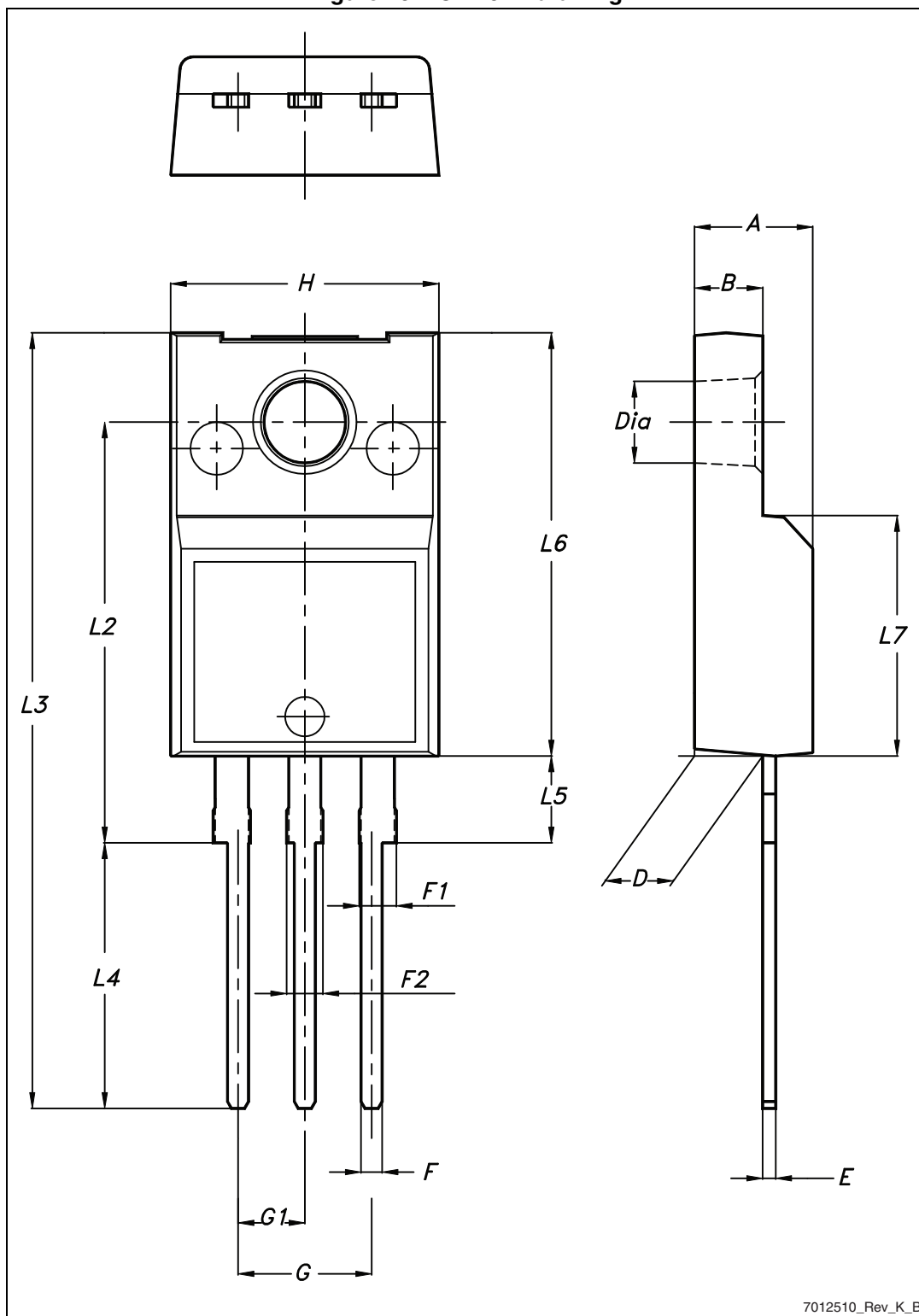
## 4 Package mechanical data

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.

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  |

Figure 20. TO-220FP drawing

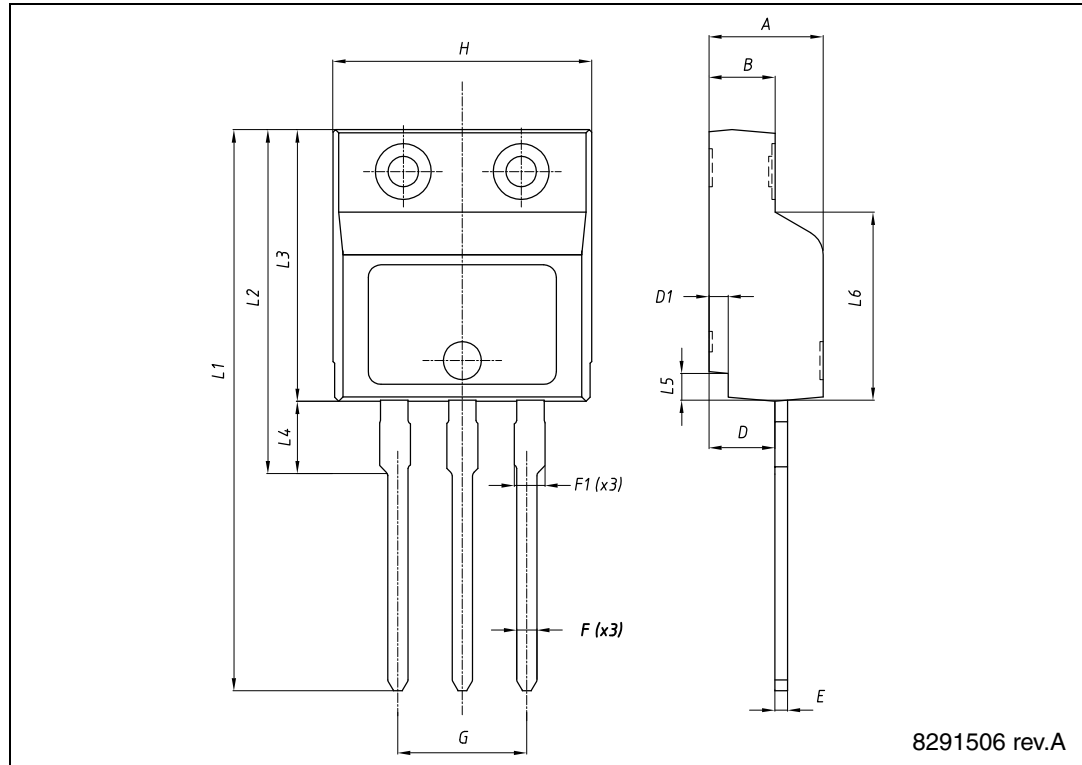


7012510\_Rev\_K\_B

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   | 7.30  |      | 7.50  |

Figure 21. I<sup>2</sup>PAKFP (TO-281) drawing



## 5 Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 11-Oct-2013 | 1        | First release. Part numbers previously included in datasheet DocID023448 |

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