

## N-channel 800 V, 0.8 $\Omega$ typ., 6 A MDmesh™ K5 Power MOSFET in TO-220FP and I<sup>2</sup>PAKFP packages

Datasheet – production data

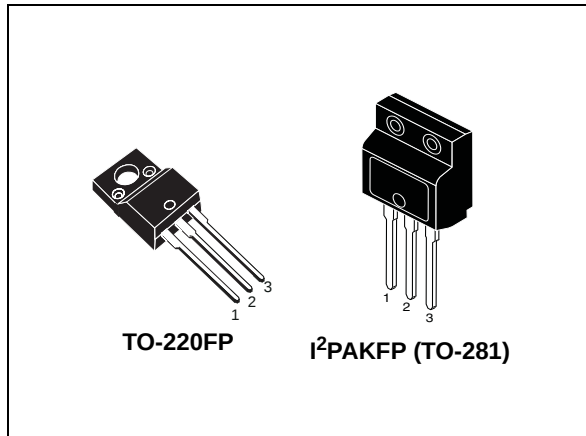
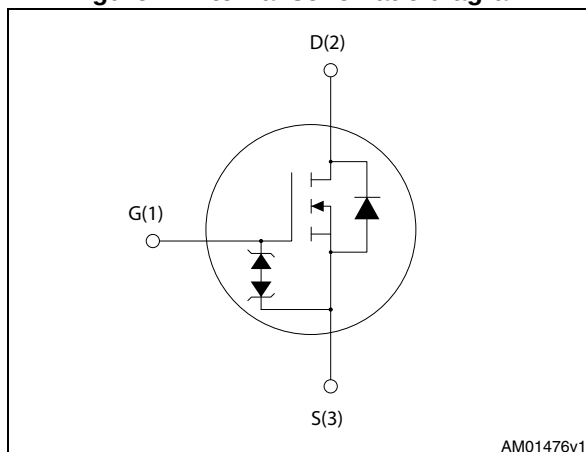


Figure 1. Internal schematic diagram



### Features

| Order codes | V <sub>DS</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> | P <sub>TOT</sub> |
|-------------|-----------------|--------------------------|----------------|------------------|
| STF8N80K5   | 800 V           | 0.95 $\Omega$            | 6 A            | 25 W             |
| STFI8N80K5  |                 |                          |                |                  |

- Industry's lowest R<sub>DS(on)</sub> x area
- 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 codes | Marking | Package                       | Packaging |
|-------------|---------|-------------------------------|-----------|
| STF8N80K5   | 8N80K5  | TO-220FP                      | Tube      |
| STFI8N80K5  |         | I <sup>2</sup> PAKFP (TO-281) |           |

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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 $T_C = 25\text{ }^{\circ}\text{C}$                                                                                    | 6 <sup>(1)</sup>  | A                  |
| $I_D$                   | Drain current $T_C = 100\text{ }^{\circ}\text{C}$                                                                                   | 4 <sup>(1)</sup>  | A                  |
| $I_{DM}$ <sup>(2)</sup> | Drain current (pulsed)                                                                                                              | 24 <sup>(1)</sup> | A                  |
| $P_{TOT}$               | Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$                                                                             | 25                | W                  |
| $I_{AR}$ <sup>(3)</sup> | Max current during repetitive or single pulse avalanche                                                                             | 2                 | A                  |
| $E_{AS}$ <sup>(4)</sup> | Single pulse avalanche energy (starting $T_J = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AS}$ , $V_{DD} = 50\text{ V}$ )              | 114               | 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                  |
| $dv/dt$ <sup>(5)</sup>  | Peak diode recovery voltage slope                                                                                                   | 4.5               | V/ns               |
| $dv/dt$ <sup>(6)</sup>  | MOSFET $dv/dt$ ruggedness                                                                                                           | 50                | V/ns               |
| $T_J$                   | Operating junction temperature                                                                                                      | -55 to 150        | $^{\circ}\text{C}$ |
| $T_{stg}$               | Storage temperature                                                                                                                 |                   | $^{\circ}\text{C}$ |

1. Limited by package.
2. Pulse width limited by safe operating area.
3. Pulse width limited by  $T_{Jmax}$ .
4. Starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $I_D = I_{AS}$ ,  $V_{DD} = 50\text{ V}$
5.  $I_{SD} \leq 6\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DS(peak)} \leq V_{(BR)DSS}$
6.  $V_{DS} \leq 640\text{ V}$

**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

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

**Table 4. On/off states**

| Symbol        | Parameter                                        | Test conditions                                               | Min. | Typ. | Max.     | Unit          |
|---------------|--------------------------------------------------|---------------------------------------------------------------|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                            | 800  |      |          | V             |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 800\text{ V}$ ,                                     |      |      | 1        | $\mu\text{A}$ |
|               |                                                  | $V_{DS} = 800\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$ |      |      | 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                | $V_{GS} = 10\text{ V}$ , $I_D = 3\text{ A}$                   |      | 0.8  | 0.95     | $\Omega$      |

**Table 5. Dynamic**

| Symbol            | Parameter                             | Test conditions                                                                                            | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|------------------------------------------------------------------------------------------------------------|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$                                                | -    | 450  | -    | pF       |
| $C_{oss}$         | Output capacitance                    |                                                                                                            | -    | 50   | -    | pF       |
| $C_{rss}$         | Reverse transfer capacitance          |                                                                                                            | -    | 1    | -    | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{GS} = 0$ , $V_{DS} = 0\text{ to }640\text{ V}$                                                         | -    | 57   | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related |                                                                                                            | -    | 24   | -    | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz}$ open drain                                                                              | -    | 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 16</a> ) | -    | 16.5 | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    |                                                                                                            | -    | 3.2  | -    | nC       |
| $Q_{gd}$          | Gate-drain charge                     |                                                                                                            | -    | 11   | -    | 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 <a href="#">Figure 18</a> ) | -    | 12   | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                    |      | 14   | -    | ns   |
| $t_{d(off)}$ | Turn-off delay time |                                                                                                                                    |      | 32   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                    |      | 20   | -    | 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 <a href="#">Figure 17</a> )                                      | -    | 300  |      | ns            |
| $Q_{rr}$       | Reverse recovery charge       |                                                                                                                                                                 |      | 3    |      | $\mu\text{C}$ |
| $I_{RRM}$      | Reverse recovery current      |                                                                                                                                                                 |      | 20   |      | 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 <a href="#">Figure 17</a> ) | -    | 415  |      | ns            |
| $Q_{rr}$       | Reverse recovery charge       |                                                                                                                                                                 | -    | 3.8  |      | $\mu\text{C}$ |
| $I_{RRM}$      | Reverse recovery current      |                                                                                                                                                                 | -    | 18   |      | 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 the ESD capability of the device. The Zener voltage is appropriate for efficient and cost-effective intervention to protect the device integrity. These integrated Zener diodes thus eliminate the need for external components.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

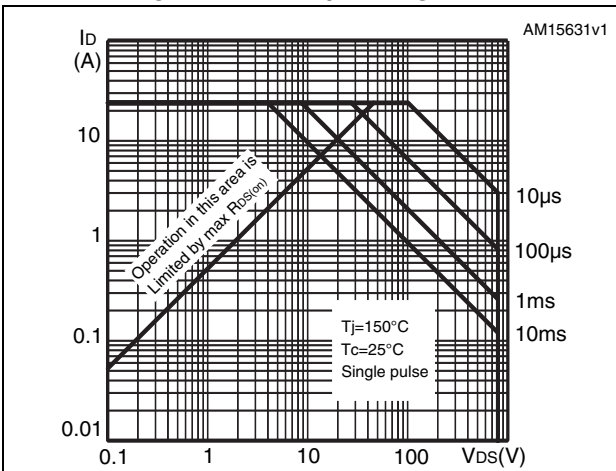


Figure 3. Thermal impedance

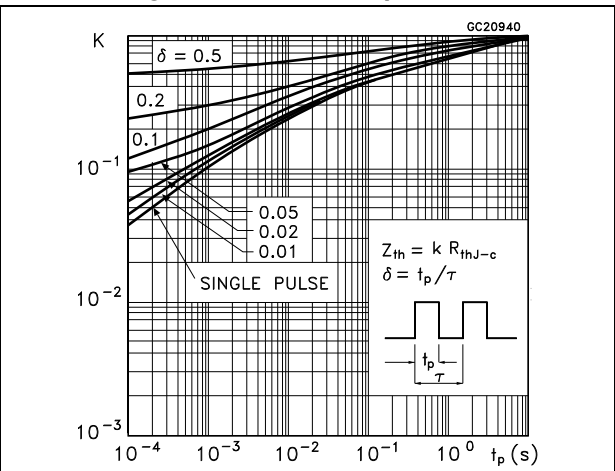


Figure 4. Output characteristics

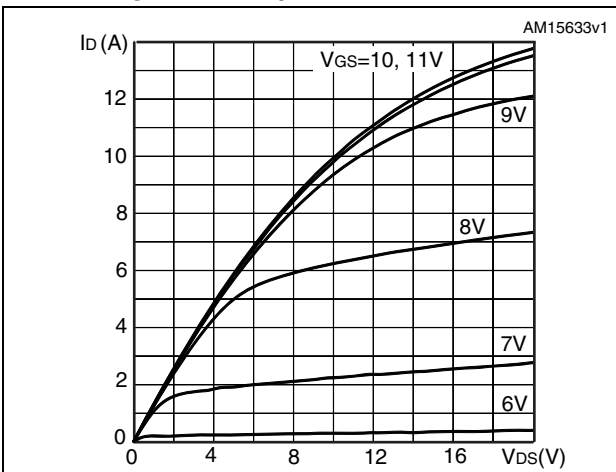


Figure 5. Transfer characteristics

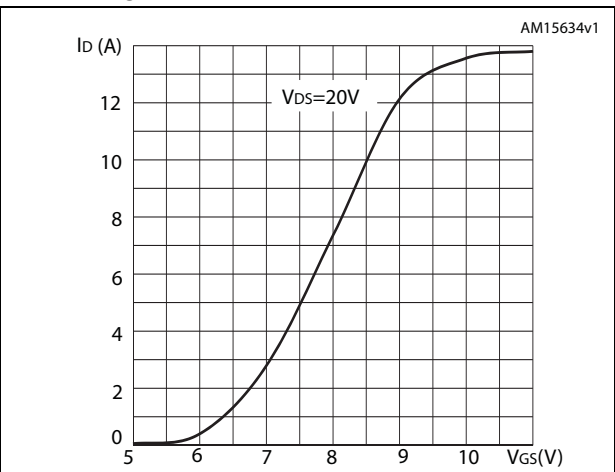


Figure 6. Gate charge vs gate-source voltage

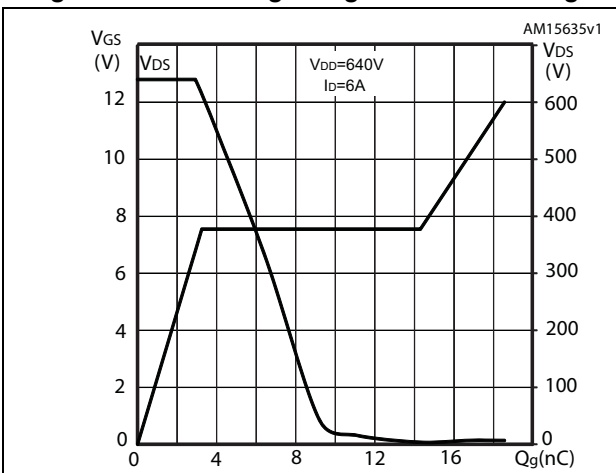


Figure 7. Static drain-source on-resistance

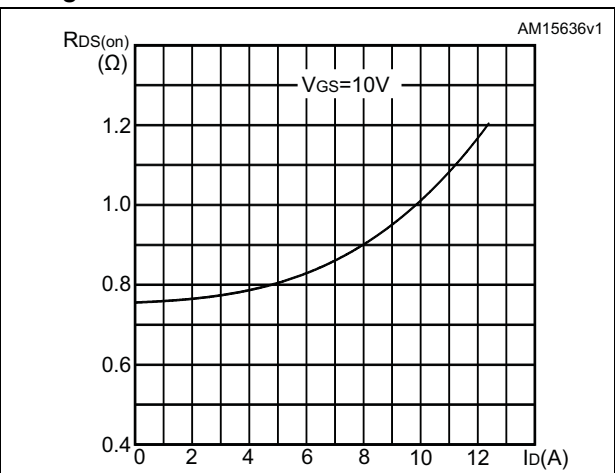


Figure 8. Capacitance variations

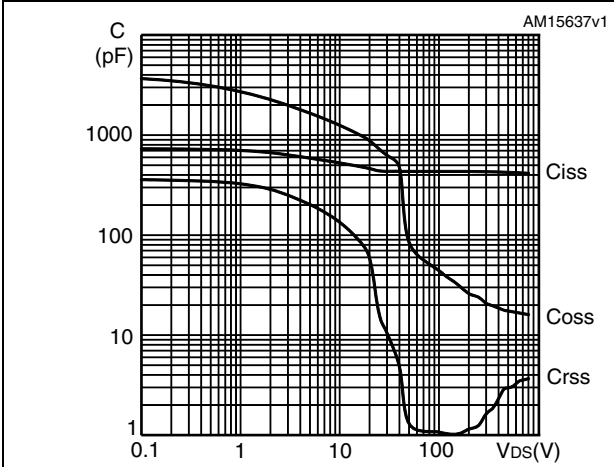


Figure 9. Output capacitance stored energy

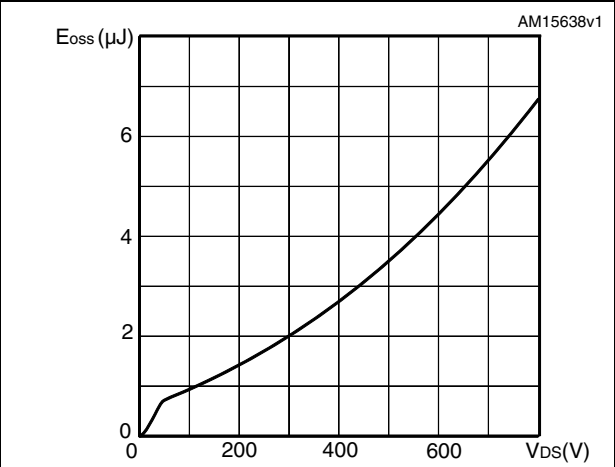


Figure 10. Normalized gate threshold voltage vs. temperature

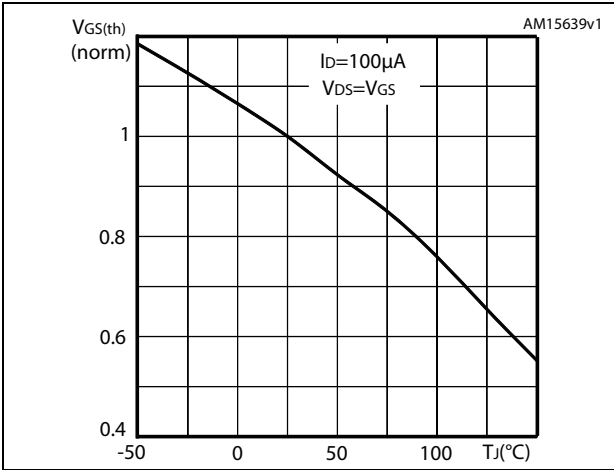


Figure 11. Normalized on-resistance vs. temperature

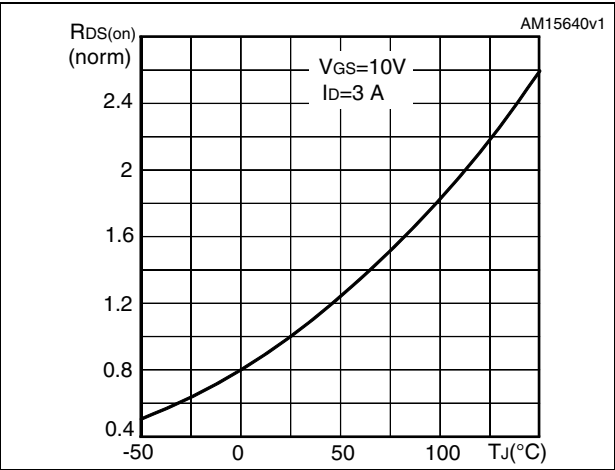


Figure 12. Drain-source diode forward characteristics

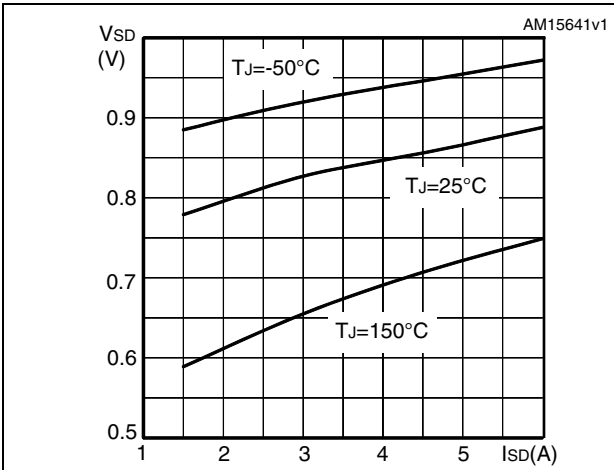


Figure 13. Normalized  $V_{DS}$  vs. temperature

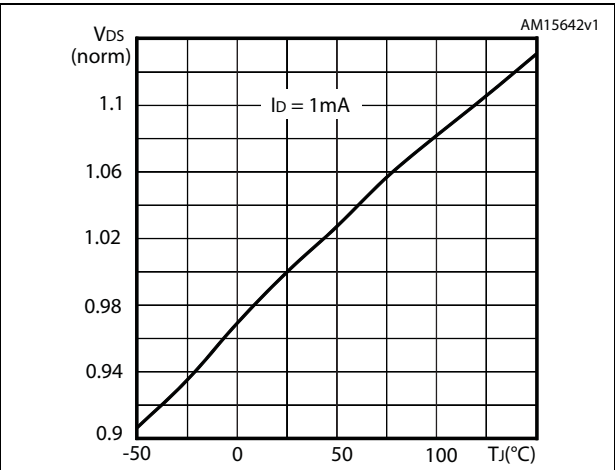
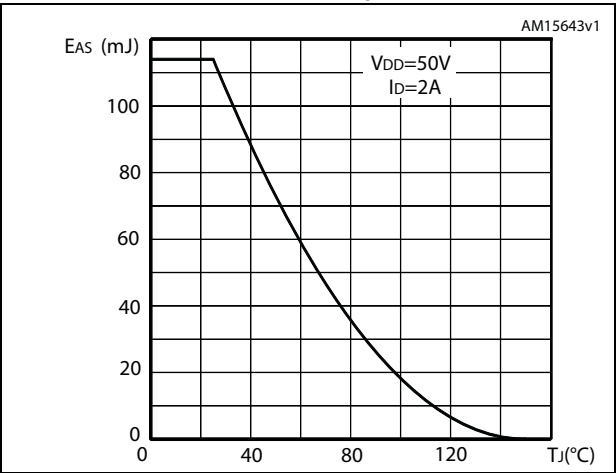


Figure 14. Maximum avalanche energy vs. starting  $T_J$



### 3 Test circuits

Figure 15. Switching times test circuit for resistive load



Figure 16. Gate charge test circuit

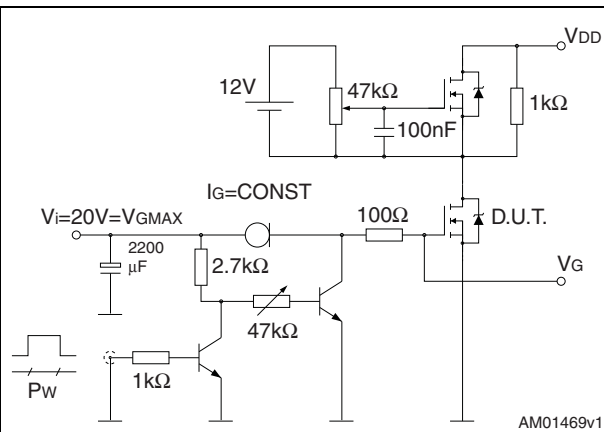


Figure 17. Test circuit for inductive load switching and diode recovery times

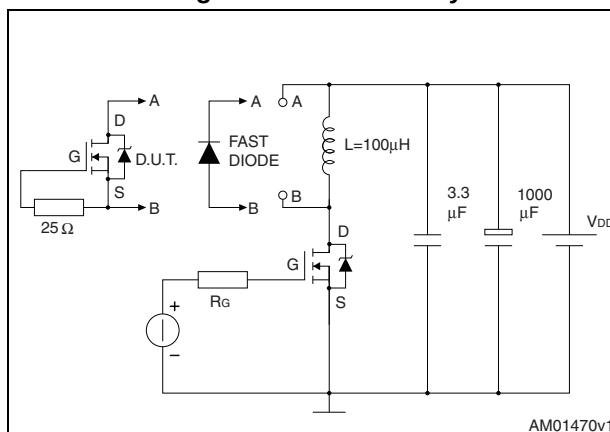


Figure 18. Unclamped inductive load test circuit

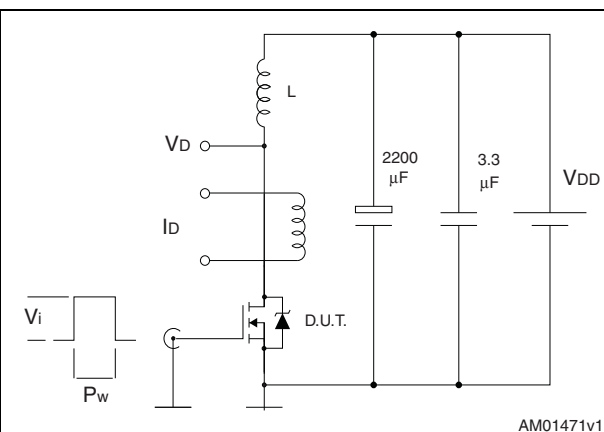


Figure 19. Unclamped inductive waveform

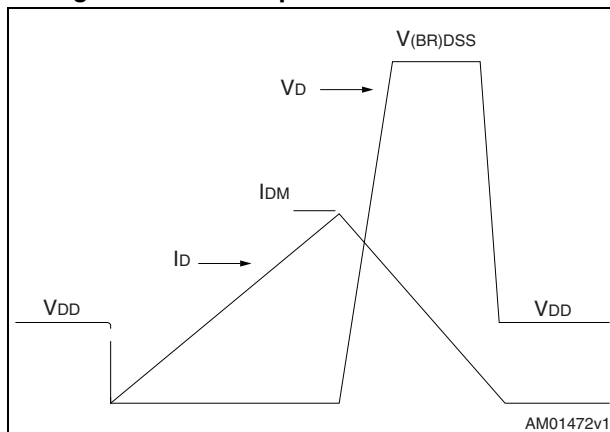


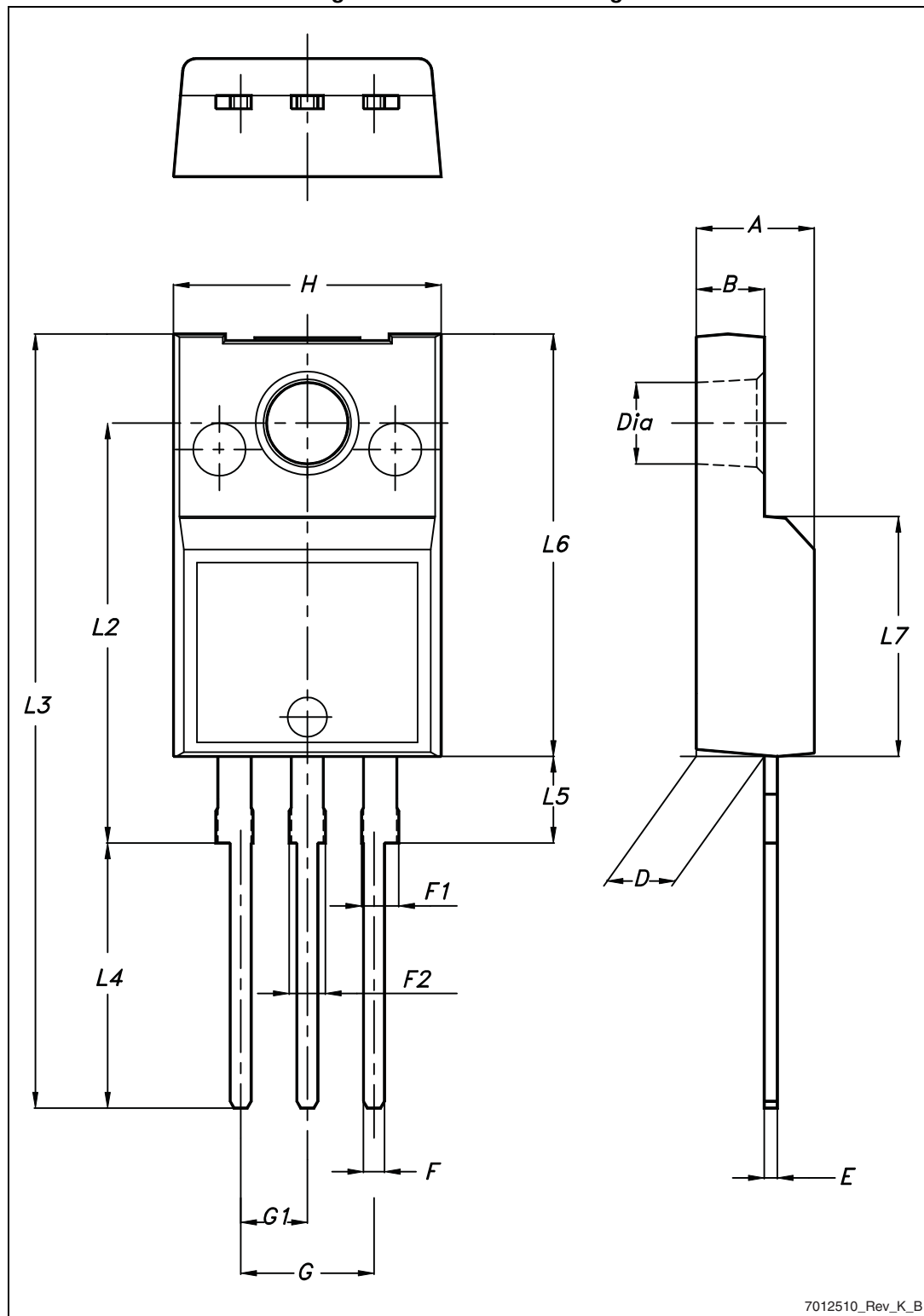
Figure 20. Switching time waveform



## 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.

Figure 21. TO-220FP drawing

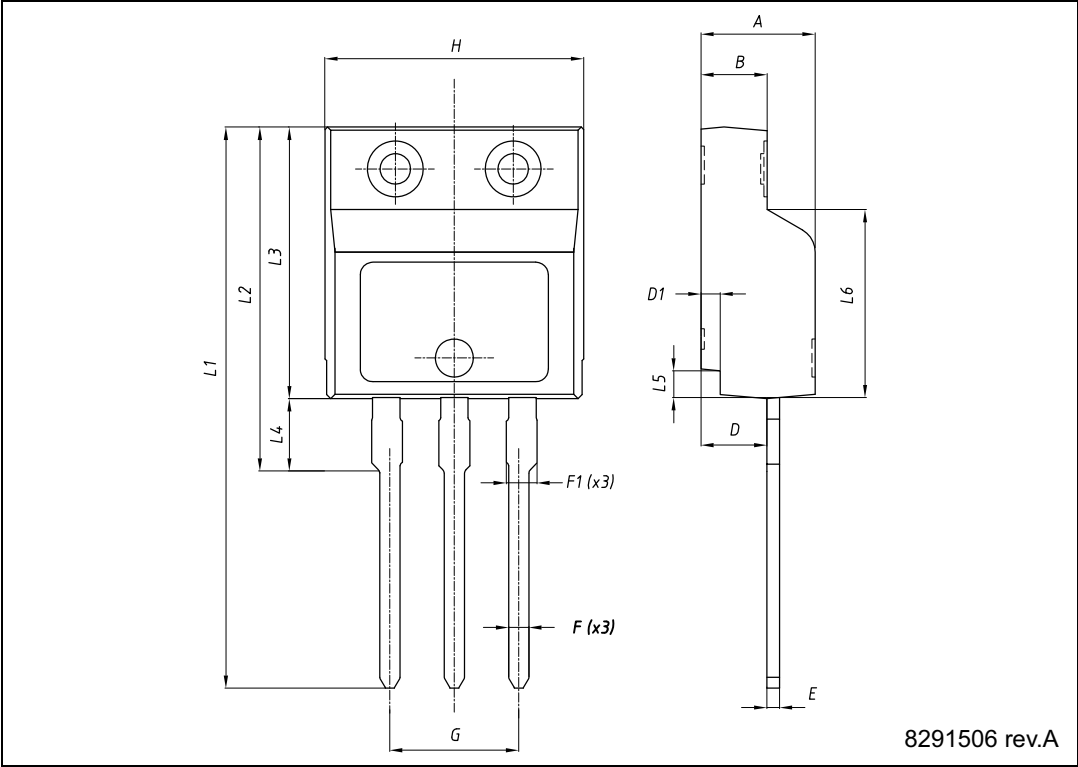


7012510\_Rev\_K\_B

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  |

Figure 22. I<sup>2</sup>PAKFP (TO-281) drawing



8291506 rev.A

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  |

## 5 Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25-Mar-2012 | 1        | First release. Part numbers previously included in datasheet DM00062075                                                                                                                                                                                                                                                                                                                                                                                                            |
| 27-Mar-2013 | 2        | Added: MOSFET dv/dt ruggedness on <a href="#">Table 2</a>                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 28-Oct-2014 | 3        | Updated title with "MDmesh™ K5" nomenclature<br>Document status promoted from preliminary data to production data<br>Updated cover page <a href="#">Features</a> list<br>Updated cover page <a href="#">Description</a><br>Updated zener diode descriptions in <a href="#">Section 2: Electrical characteristics</a><br>Updated <a href="#">Figure 7: Static drain-source on-resistance</a><br>Reordered drawings and tables in <a href="#">Section 4: Package mechanical data</a> |

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