

## N-channel 650 V, 0.35 $\Omega$ typ., 12 A MDmesh™ II Power MOSFETs in TO-220FP and I<sup>2</sup>PAKFP packages

Datasheet - production data

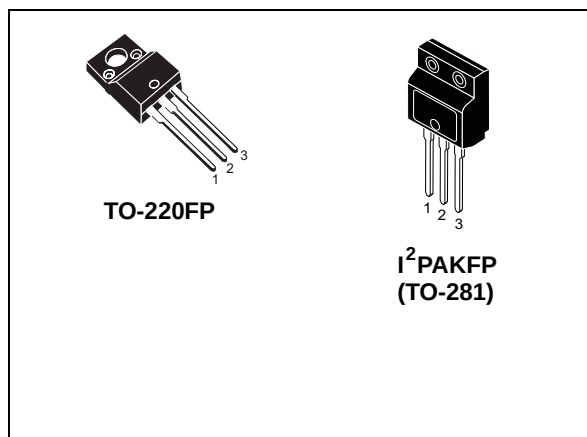
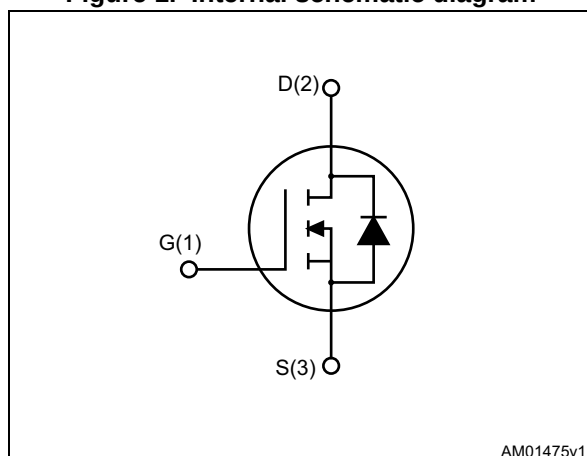


Figure 1. Internal schematic diagram



### Features

| Order code  | V <sub>DSS</sub> @T <sub>jmax</sub> | R <sub>DS(on)</sub> max. | I <sub>D</sub> |
|-------------|-------------------------------------|--------------------------|----------------|
| STF15NM65N  | 710 V                               | 0.38 $\Omega$            | 12 A           |
| STFI15NM65N |                                     |                          |                |

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

### Applications

- Switching applications

### Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFETs associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order code  | Marking | Packages                      | Packing |
|-------------|---------|-------------------------------|---------|
| STF15NM65N  | 15NM65N | TO-220FP                      | Tube    |
| STFI15NM65N |         | I <sup>2</sup> PAKFP (TO-281) |         |

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# 1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol                         | Parameter                                                                                                     | Value             |                      | Unit |
|--------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------|----------------------|------|
|                                |                                                                                                               | TO-220FP          | I <sup>2</sup> PAKFP |      |
| V <sub>DS</sub>                | Drain source voltage                                                                                          | 650               |                      | V    |
| V <sub>GS</sub>                | Gate source voltage                                                                                           | ± 25              |                      | V    |
| I <sub>D</sub>                 | Drain current continuous T <sub>c</sub> = 25 °C                                                               | 12 <sup>(1)</sup> |                      | A    |
| I <sub>D</sub>                 | Drain current continuous T <sub>c</sub> = 100 °C                                                              | 7.56              |                      | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current pulsed                                                                                          | 48                |                      | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>c</sub> = 25 °C                                                                   | 30                |                      | W    |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope                                                                             | 15                |                      | V/ns |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS from all three leads to external heatsink (t = 1 s; T <sub>C</sub> = 25 °C) | 2500              |                      | V    |
| T <sub>J</sub>                 | Operating junction temperature range                                                                          | -55 to 150        |                      | °C   |
| T <sub>stg</sub>               | Storage temperature range                                                                                     |                   |                      |      |

1. Limited by maximum junction temperature.

2. Pulse width limited by safe operating area.

3. I<sub>SD</sub> ≤ 12 A, di/dt ≤ 400 A/μs, V<sub>DSpeak</sub> ≤ V<sub>(BR)DSS</sub>, V<sub>DD</sub> = 80 % V<sub>(BR)DSS</sub>

Table 3. Thermal data

| Symbol               | Parameters                          | Value    |                      | Unit |
|----------------------|-------------------------------------|----------|----------------------|------|
|                      |                                     | TO-220FP | I <sup>2</sup> PAKFP |      |
| R <sub>thjc</sub>    | Thermal resistance junction-case    | 4.17     |                      | °C/W |
| R <sub>thj-amb</sub> | Thermal resistance junction-ambient | 62.5     |                      | °C/W |

Table 4. Avalanche characteristics

| Symbol          | Parameters                                                                                                                 | Value | Unit |
|-----------------|----------------------------------------------------------------------------------------------------------------------------|-------|------|
| I <sub>AS</sub> | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>jmax</sub> )                                | 3     | A    |
| E <sub>AS</sub> | Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 187   | mJ   |

## 2 Electrical characteristics

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

**Table 5. On/off states**

| Symbol        | Parameter                         | Test conditions                                                    | Min. | Typ. | Max.      | Unit          |
|---------------|-----------------------------------|--------------------------------------------------------------------|------|------|-----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage    | $V_{GS} = 0, I_D = 1\text{ mA}$                                    | 650  |      |           | V             |
| $I_{DSS}$     | Zero gate voltage drain current   | $V_{DD} = 650\text{ V}, V_{GS} = 0$                                |      |      | 1         | $\mu\text{A}$ |
|               |                                   | $V_{DD} = 650\text{ V}, V_{GS} = 0$<br>$T_C = 125\text{ °C}^{(1)}$ |      |      | 100       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate body leakage                 | $V_{GS} = \pm 25\text{ V}, V_{DS} = 0\text{ V}$                    |      |      | $\pm 100$ | nA            |
| $V_{GS(th)}$  | Gate threshold voltage            | $I_D = 250\text{ }\mu\text{A}, V_{GS} = V_{DS}$                    | 2    | 3    | 4         | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance | $I_D = 6\text{ A}, V_{GS} = 10\text{ V}$                           |      | 0.35 | 0.38      | $\Omega$      |

1. Defined by design, not subject to production test

**Table 6. Dynamic**

| Symbol            | Parameter                     | Test conditions                                                                                                                  | Min. | Typ. | Ma. | Unit     |
|-------------------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------|------|------|-----|----------|
| $C_{iss}$         | Input capacitance             | $V_{DS} = 50\text{ V}, f = 1\text{ MHz},$<br>$V_{GS} = 0\text{ V}$                                                               | -    | 983  | -   | pF       |
| $C_{oss}$         | Output capacitance            |                                                                                                                                  | -    | 57   | -   | pF       |
| $C_{rss}$         | Reverse capacitance           |                                                                                                                                  | -    | 4.5  | -   | pF       |
| $C_{osseq}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ V to } 520\text{ V}, V_{GS} = 0\text{ V}$                                                                      | -    | 146  | -   | pF       |
| $R_g$             | Intrinsic gate resistance     | $f = 1\text{ MHz } I_D = 0\text{ A}$                                                                                             | -    | 4.6  | -   | $\Omega$ |
| $Q_g$             | Total gate charge             | $V_{DD} = 520\text{ V}, I_D = 12\text{ A},$<br>$V_{GS} = 10\text{ V}$ (see <a href="#">Figure 13: Gate charge test circuit</a> ) | -    | 33.3 | -   | nC       |
| $Q_{gs}$          | Gate source charge            |                                                                                                                                  | -    | 5.7  | -   | nC       |
| $Q_{gd}$          | Gate-drain charge             |                                                                                                                                  | -    | 17   | -   | nC       |

1. Cross eq: 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  | $V_{DD} = 325\text{ V}, I_D = 6\text{ A}$<br>$R_g = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see <a href="#">Figure 12: Switching times test circuit for resistive load</a> and <a href="#">Figure 17: Switching time waveform</a> ) | -    | 55.5 | -    | ns   |
| $t_r$        | Rise time           |                                                                                                                                                                                                                                       | -    | 8.5  | -    | ns   |
| $t_{d(off)}$ | Turn-off-delay time |                                                                                                                                                                                                                                       | -    | 14   | -    | ns   |
| $t_f$        | Fall time           |                                                                                                                                                                                                                                       | -    | 11.4 | -    | ns   |

Table 8. Source drain diode

| Symbol          | Parameter                     | Test conditions                                                                                                                                                                                                                   | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $I_{SD}$        | Source drain current          |                                                                                                                                                                                                                                   | -    |      | 12   | A             |
| $I_{SDM}^{(1)}$ | Source drain current (pulsed) |                                                                                                                                                                                                                                   | -    |      | 48   | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 12\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                                                                                                                                    | -    |      | 1.6  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ (see <a href="#">Figure 14: Test circuit for inductive load switching and diode recovery times</a> )                                        | -    | 428  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                   | -    | 4.7  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                   | -    | 21.5 |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 14: Test circuit for inductive load switching and diode recovery times</a> ) | -    | 570  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |                                                                                                                                                                                                                                   | -    | 6.2  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |                                                                                                                                                                                                                                   | -    | 22   |      | A             |

1. Pulse width limited by safe operating area.

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

2.1 Electrical characteristics (curves)

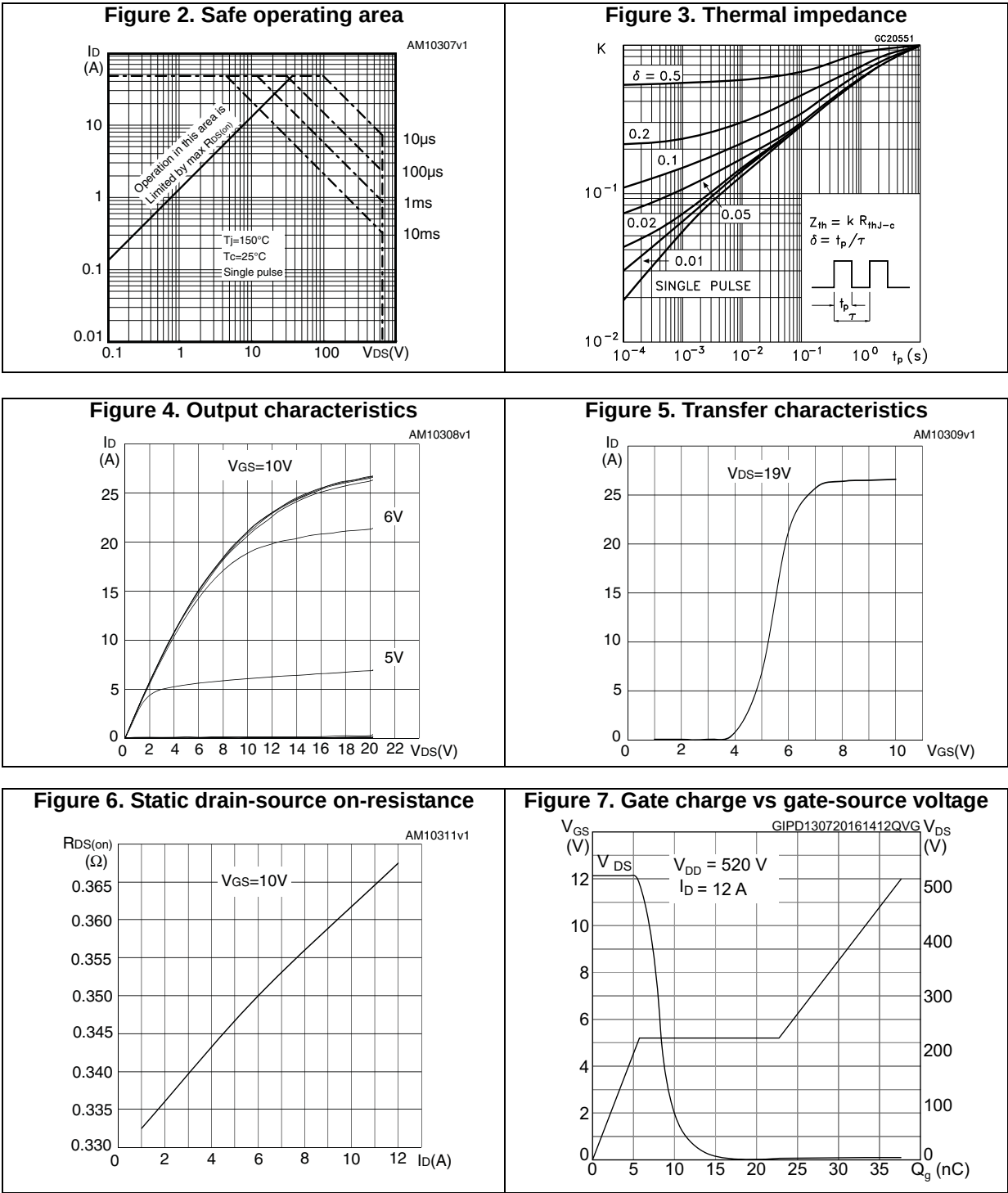


Figure 8. Capacitance variations

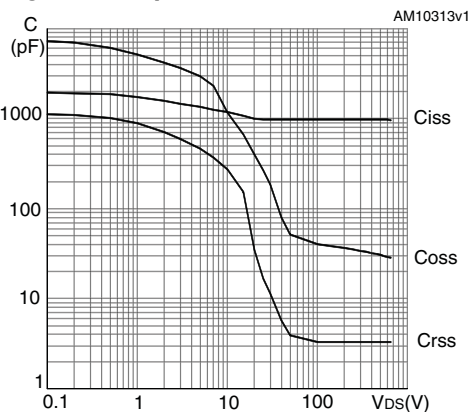


Figure 9. Normalized gate threshold voltage vs temperature

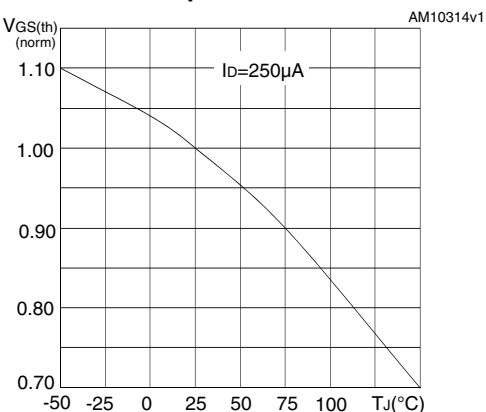
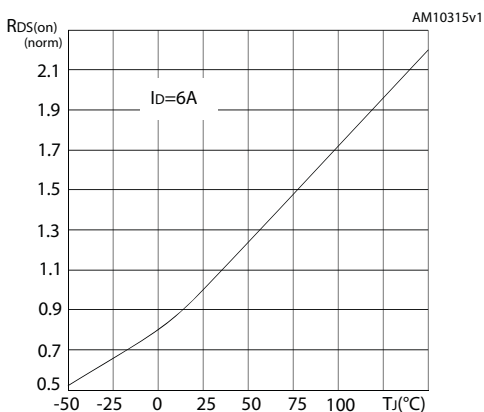


Figure 10. Normalized on-resistance vs temp.



Source-drain diode forward characteristics

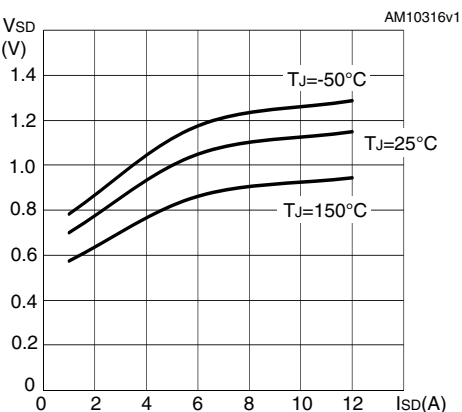
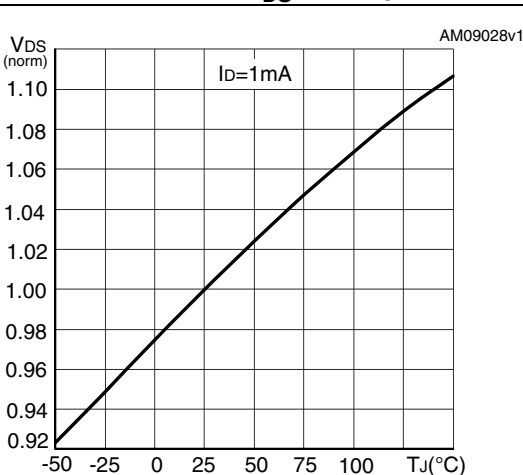
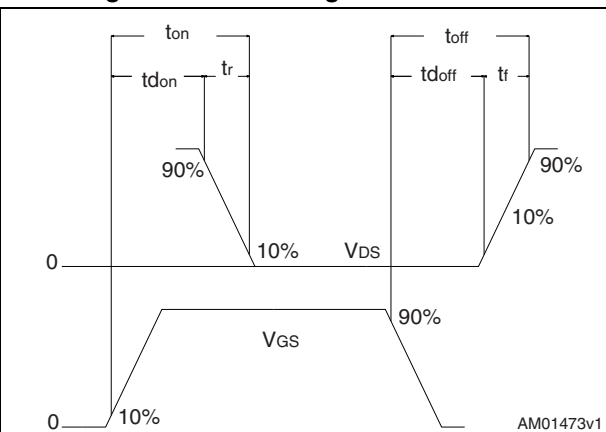
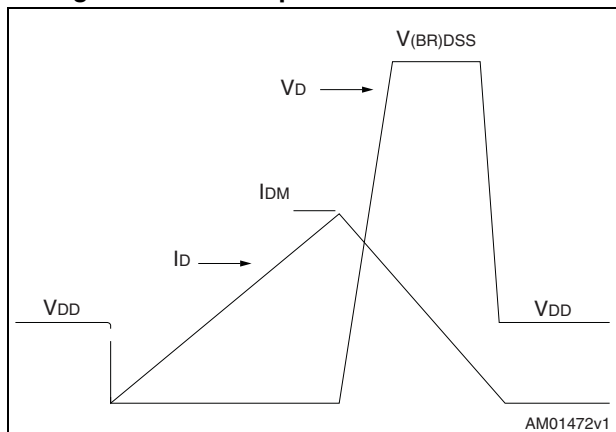
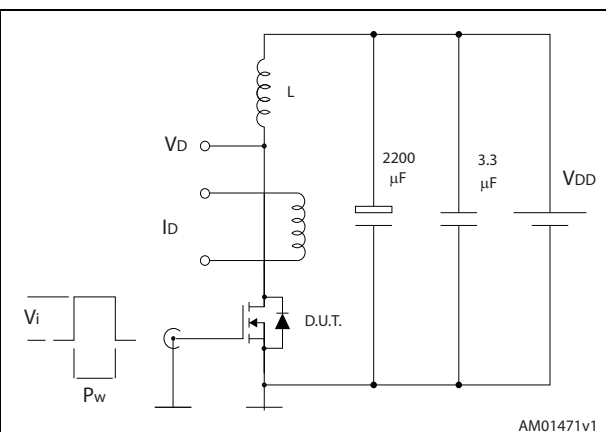
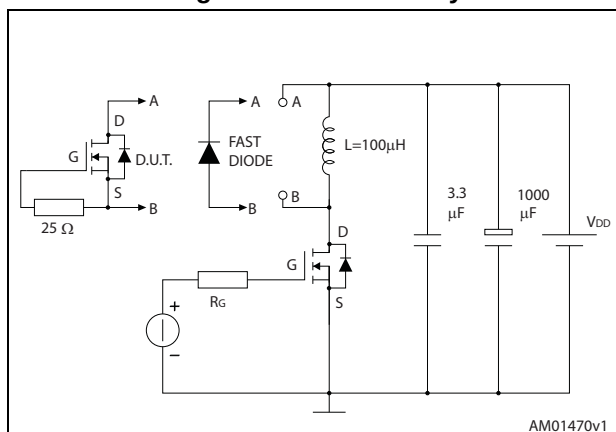
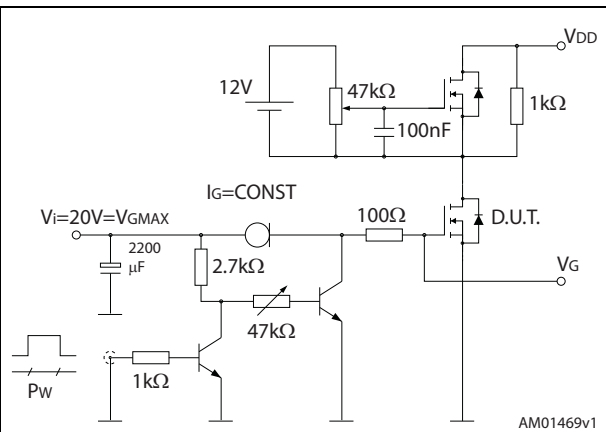
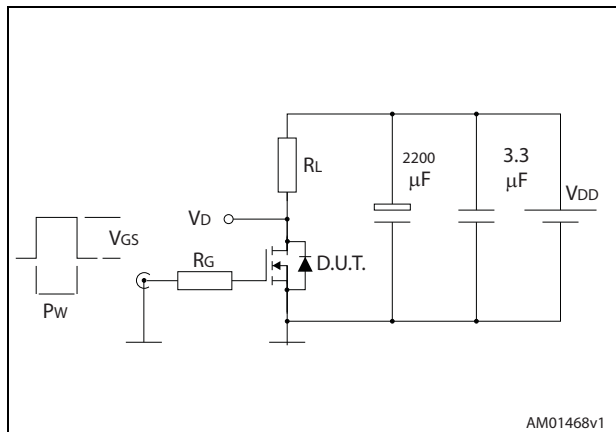


Figure 11. Normalized  $V_{DS}$  vs temperature







## 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 18. TO-220FP package outline

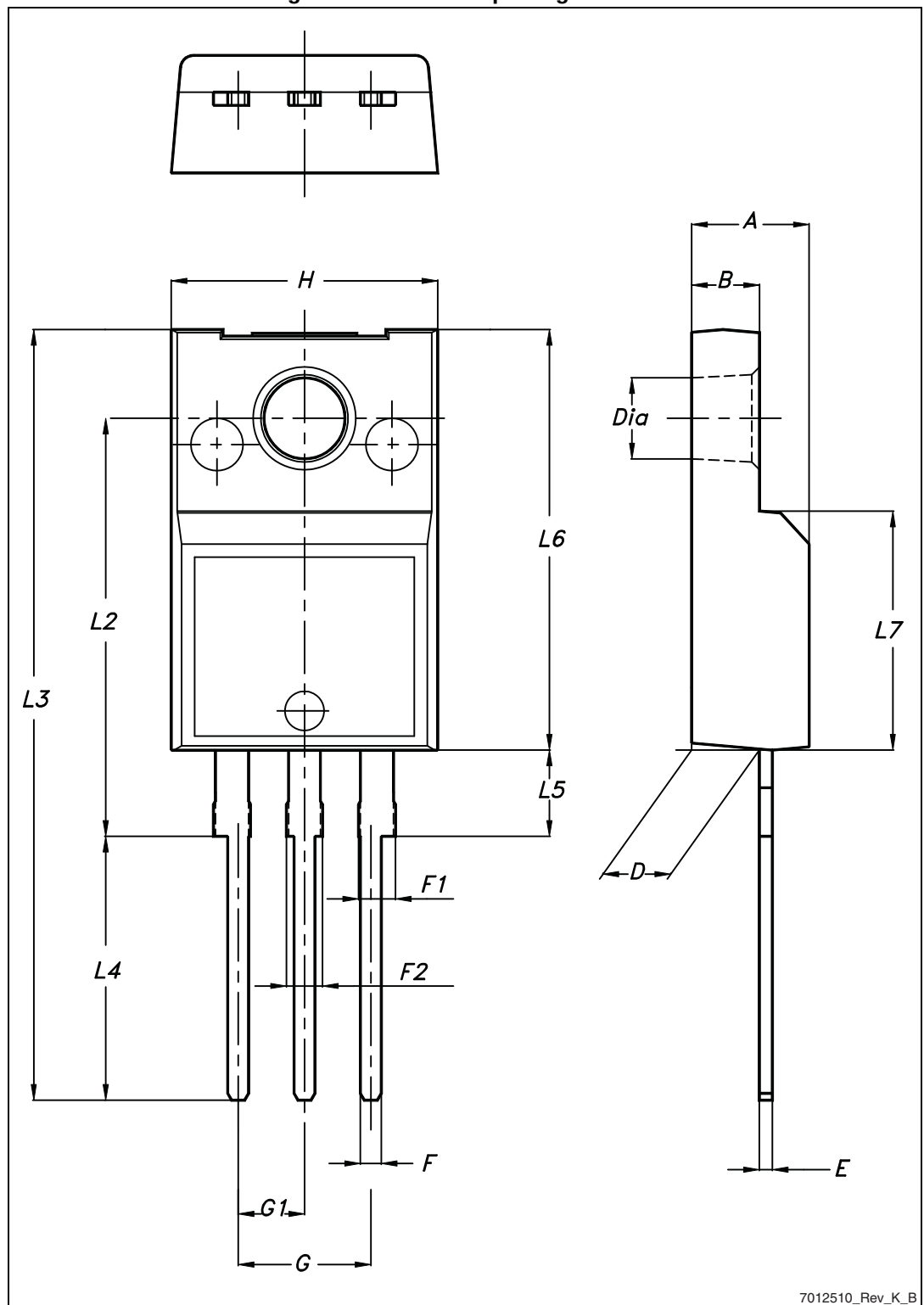


Table 9. TO-220FP package mechanical data

| 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 19. I<sup>2</sup>PAKFP (TO-281) package outline

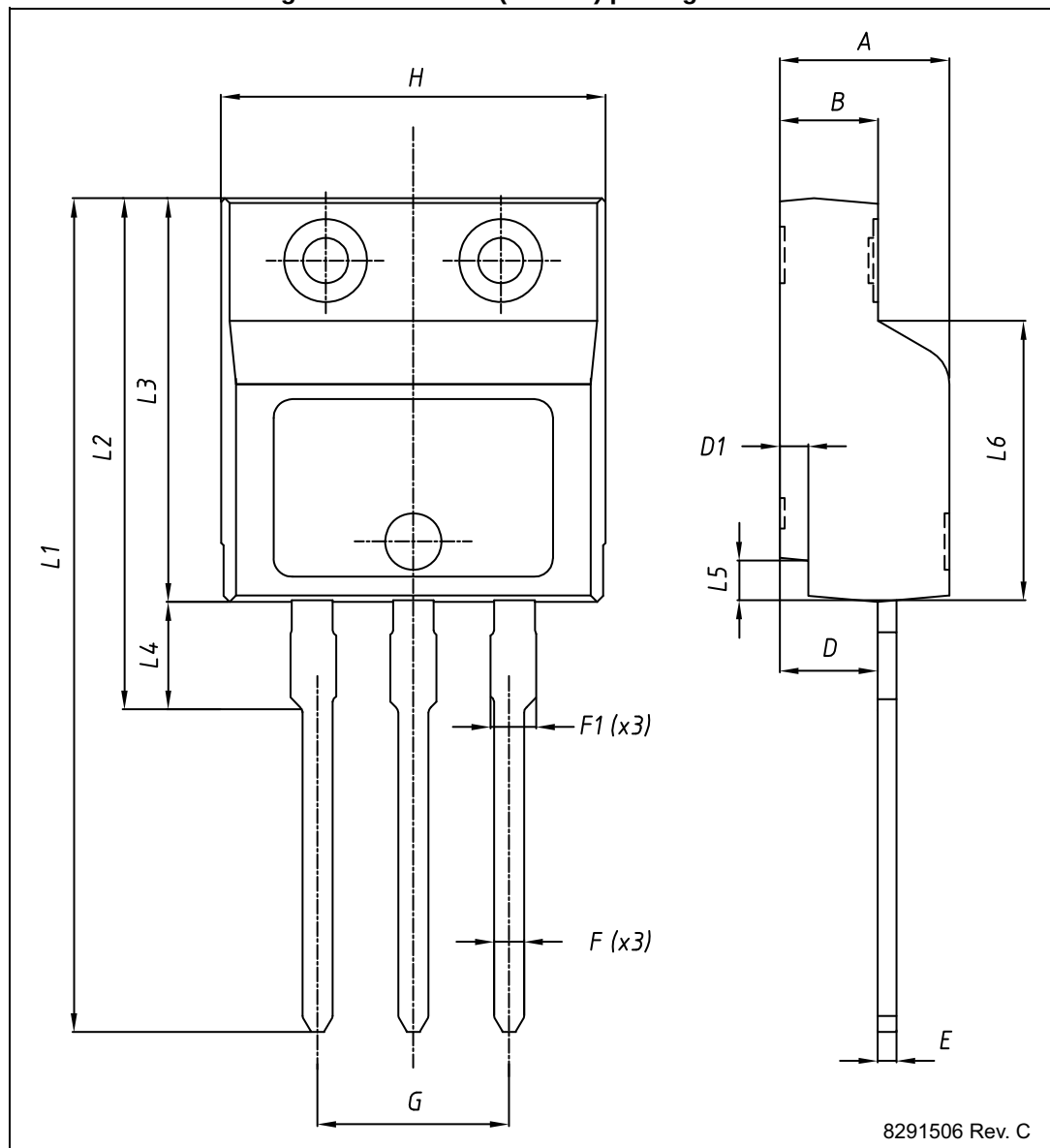


Table 10. I<sup>2</sup>PAKFP (TO-281) package mechanical data

| 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                                                                                                                                                                                                                          |
|-------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11-May-2011 | 1        | Initial release.                                                                                                                                                                                                                 |
| 21-Jun-2011 | 2        | Document status promoted from preliminary data to datasheet, added Section 2.1: Electrical characteristics (curves).                                                                                                             |
| 17-Jul-2013 | 3        | <ul style="list-style-type: none"><li>– Added: I<sup>2</sup>PAKFP package</li><li>– Added: <i>Table 10</i> and <i>Figure 22</i></li><li>– Updated: <i>Section 4: Package information</i></li><li>– Minor text changes.</li></ul> |
| 25-Jul-2016 | 4        | <p>The part number STF15NM65N has been moved to a separate datasheet.</p> <p>Minor text changes.</p>                                                                                                                             |

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