



**THE DATASHEET OF  
STFW38N65M5**



## N-channel 650 V, 0.073 $\Omega$ typ., 30 A MDmesh™ V Power MOSFETs in TO-220FP and TO-3PF packages

Datasheet - production data

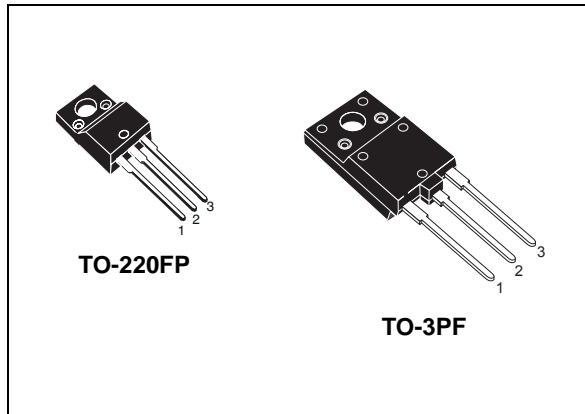
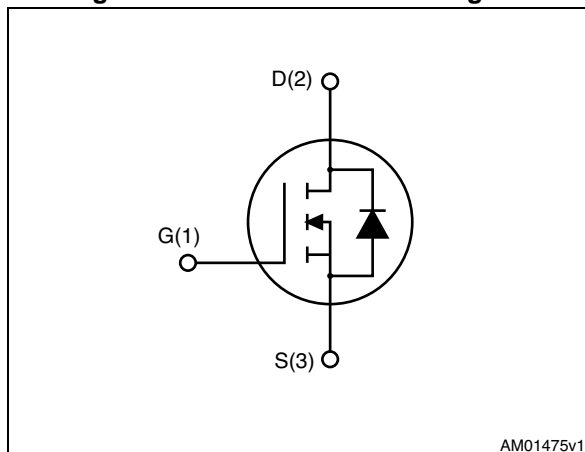


Figure 1. Internal schematic diagram



### Features

| Order codes | $V_{DS@T_{Jmax}}$ | $R_{DS(on)max}$ | $I_D$ |
|-------------|-------------------|-----------------|-------|
| STF38N65M5  | 710 V             | 0.095 $\Omega$  | 30 A  |
| STFW38N65M5 |                   |                 |       |

- Higher  $V_{DSS}$  rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

### Applications

- Switching applications

### Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

Table 1. Device summary

| Order codes | Marking | Package  | Packaging |
|-------------|---------|----------|-----------|
| STF38N65M5  | 38N65M5 | TO-220FP | Tube      |
| STFW38N65M5 |         | TO-3PF   |           |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol              | Parameter   | Value      |        | Unit |
|---------------------|---|------------|--------|------|
|                     |   | TO-220FP   | TO-3PF |      |
| $V_{GS}$            | Gate-source voltage   | ± 25       |        | V    |
| $I_D^{(1)}$         | Drain current (continuous) at $T_C = 25\text{ °C}$  | 30         |        | A    |
| $I_D^{(1)}$         | Drain current (continuous) at $T_C = 100\text{ °C}$   | 19         |        | A    |
| $I_{DM}^{(1), (2)}$ | Drain current (pulsed)  | 120        |        | A    |
| $P_{TOT}$           | Total dissipation at $T_C = 25\text{ °C}$   | 35         | 57     | W    |
| $dv/dt^{(3)}$       | Peak diode recovery voltage slope   | 15         |        | 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       | 3500   | V    |
| $T_{stg}$           | Storage temperature   | -55 to 150 |        | °C   |
| $T_j$               | Max. operating junction temperature   | 150        |        | °C   |

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area.
3.  $I_{SD} \leq 30\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{Peak} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$
4.  $V_{DS} \leq 520\text{ V}$

**Table 3. Thermal data**

| Symbol         | Parameter                               | Value    |        | Unit |
|----------------|---|----------|--------|------|
|                |   | TO-220FP | TO-3PF |      |
| $R_{thj-case}$ | Thermal resistance junction-case max    | 3.6      | 2.2    | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-ambient max | 62.5     | 50     | °C/W |

**Table 4. Avalanche characteristics**

| Symbol   | Parameter  | Value | Unit |
|----------|--|-------|------|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )                     | 8     | A    |
| $E_{AS}$ | Single pulse avalanche energy (starting $t_j = 25\text{ °C}$ , $I_d = I_{AR}$ ; $V_{dd} = 50\text{ V}$ ) | 660   | mJ   |

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  unless otherwise specified)

**Table 5. On /off states**

| Symbol        | Parameter  | Test conditions                                    | Min. | Typ.  | Max.      | Unit          |
|---------------|--|--|------|-------|-----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1\text{ mA}$ , $V_{GS} = 0$                 | 650  |       |           | V             |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = 650\text{ V}$                            |      |       | 1         | $\mu\text{A}$ |
|               |  | $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$    |      |       | 100       | $\mu\text{A}$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 25\text{ V}$                         |      |       | $\pm 100$ | nA            |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$ | 3    | 4     | 5         | V             |
| $R_{DS(on)}$  | Static drain-source on-resistance                | $V_{GS} = 10\text{ V}$ , $I_D = 15\text{ A}$       |      | 0.073 | 0.095     | $\Omega$      |

**Table 6. Dynamic**

| Symbol            | Parameter                             | Test conditions   | Min. | Typ. | Max. | Unit     |
|-------------------|---------------------------------------|---|------|------|------|----------|
| $C_{iss}$         | Input capacitance                     | $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GS} = 0$  | -    | 3000 | -    | pF       |
| $C_{oss}$         | Output capacitance                    |   | -    | 74   | -    | pF       |
| $C_{riss}$        | Reverse transfer capacitance          |   | -    | 5.8  | -    | pF       |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related   | $V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0$  | -    | 244  | -    | pF       |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related |   | -    | 70   | -    | pF       |
| $R_G$             | Intrinsic gate resistance             | $f = 1\text{ MHz}$ open drain   | -    | 2.4  | -    | $\Omega$ |
| $Q_g$             | Total gate charge                     | $V_{DD} = 520\text{ V}$ , $I_D = 15\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 18</a> ) | -    | 71   | -    | nC       |
| $Q_{gs}$          | Gate-source charge                    |   | -    | 18   | -    | nC       |
| $Q_{gd}$          | Gate-drain charge                     |   | -    | 30   | -    | 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 7. Switching times

| Symbol       | Parameter          | Test conditions  | Min. | Typ. | Max. | Unit |
|--------------|--------------------|--|------|------|------|------|
| $t_{d(v)}$   | Voltage delay time | $V_{DD} = 400\text{ V}$ , $I_D = 20\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$<br>(see <a href="#">Figure 19</a> and<br><a href="#">Figure 22</a> ) | -    | 66   | -    | ns   |
| $t_{r(v)}$   | Voltage rise time  |  | -    | 9    | -    | ns   |
| $t_{f(i)}$   | Current fall time  |  | -    | 9    | -    | ns   |
| $t_{c(off)}$ | Crossing time      |  | -    | 13   | -    | ns   |

Table 8. Source drain diode

| Symbol          | Parameter                     | Test conditions  | Min. | Typ. | Max. | Unit          |
|-----------------|-------------------------------|--|------|------|------|---------------|
| $I_{SD}$        | Source-drain current          |  | -    |      | 30   | A             |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) |  | -    |      | 120  | A             |
| $V_{SD}^{(2)}$  | Forward on voltage            | $I_{SD} = 30\text{ A}$ , $V_{GS} = 0$  | -    |      | 1.5  | V             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 30\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ (see <a href="#">Figure 22</a> )  | -    | 382  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 6.6  |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 35   |      | A             |
| $t_{rr}$        | Reverse recovery time         | $I_{SD} = 30\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$<br>$V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 22</a> ) | -    | 522  |      | ns            |
| $Q_{rr}$        | Reverse recovery charge       |  | -    | 10.3 |      | $\mu\text{C}$ |
| $I_{RRM}$       | Reverse recovery current      |  | -    | 40   |      | 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 2. Safe operating area for TO-220FP

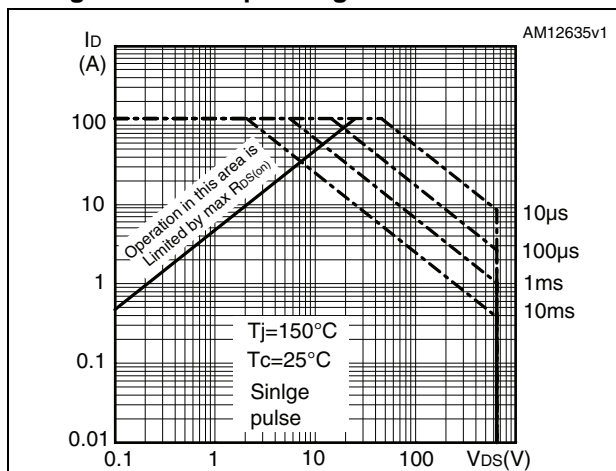


Figure 3. Thermal impedance for TO-220FP

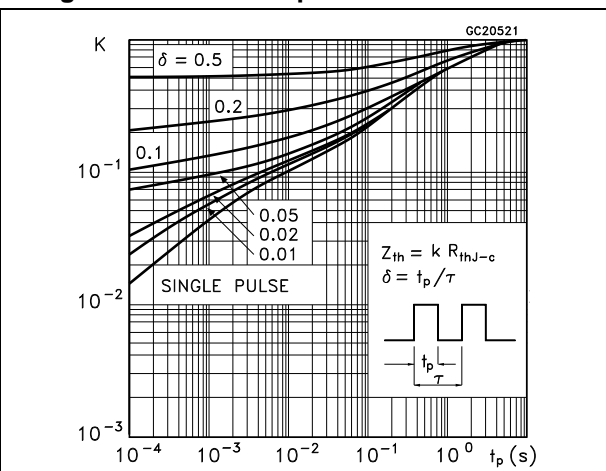


Figure 4. Safe operating area for TO-3PF

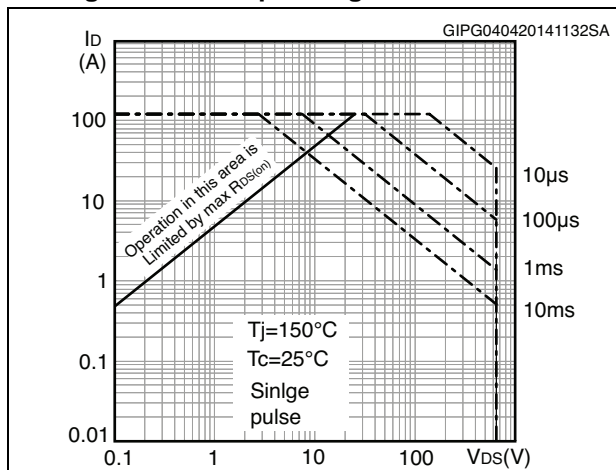


Figure 5. Thermal impedance for TO-3PF

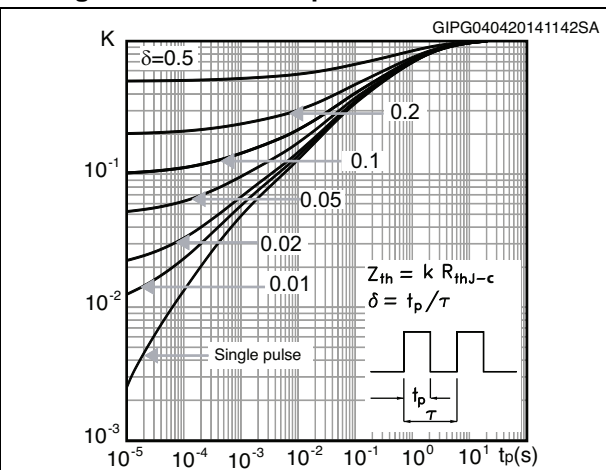


Figure 6. Output characteristics

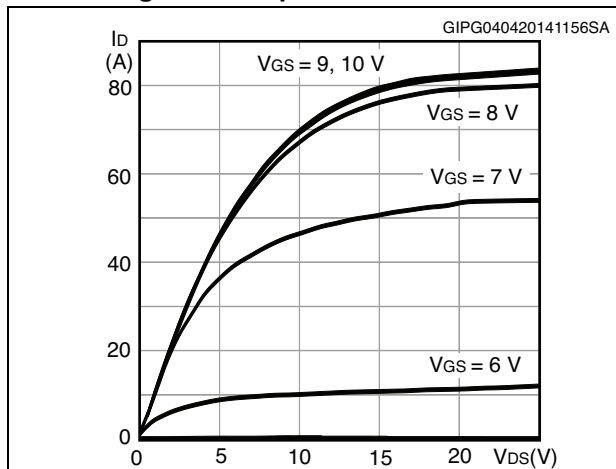


Figure 7. Transfer characteristics

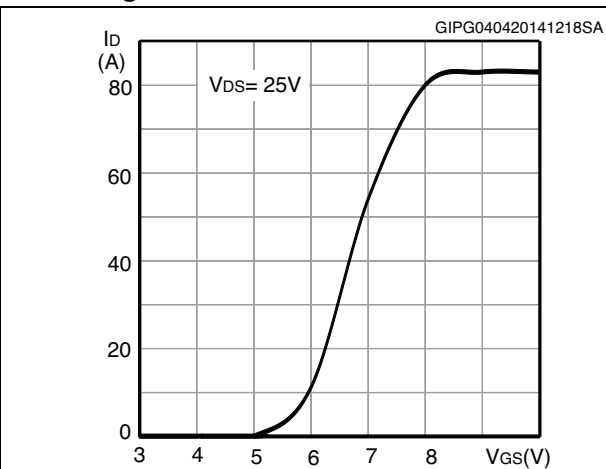


Figure 8. Gate charge vs gate-source voltage

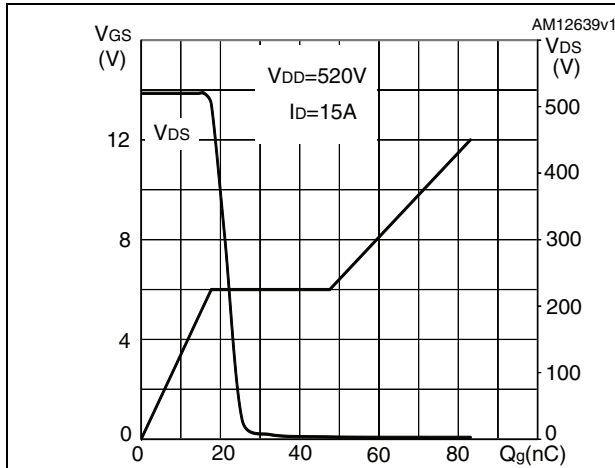


Figure 9. Static drain-source on-resistance

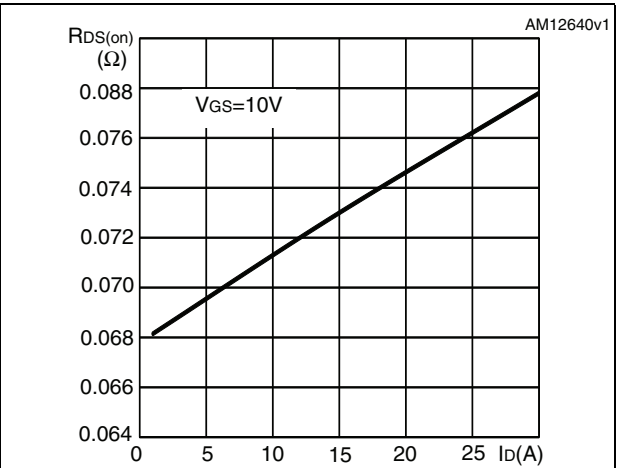


Figure 10. Capacitance variations

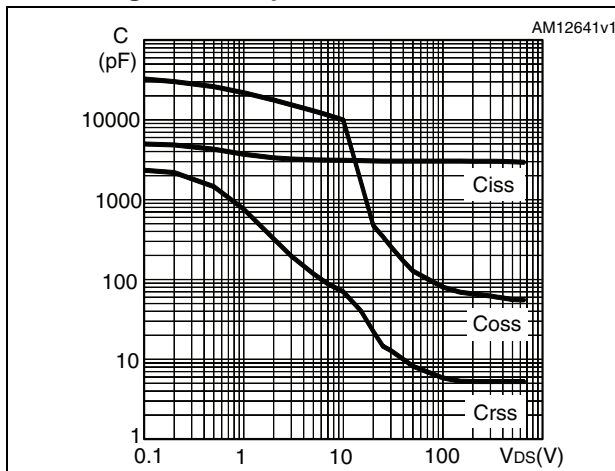


Figure 11. Output capacitance stored energy

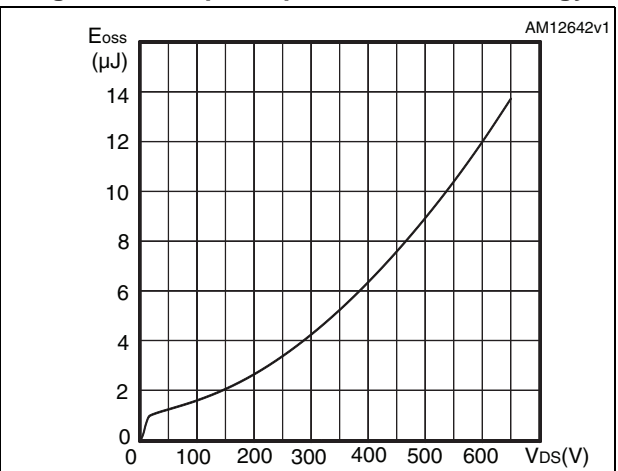


Figure 12. Normalized gate threshold voltage vs temperature

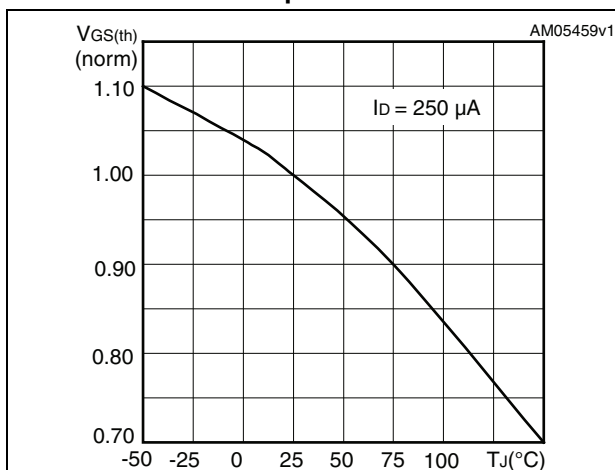


Figure 13. Normalized on-resistance vs temperature

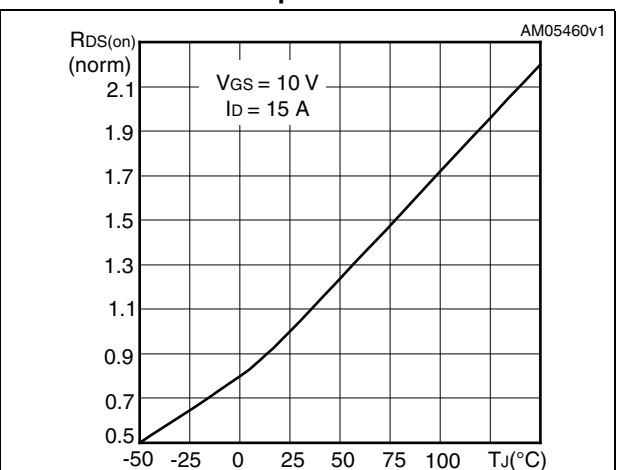


Figure 14. Source-drain diode forward characteristics

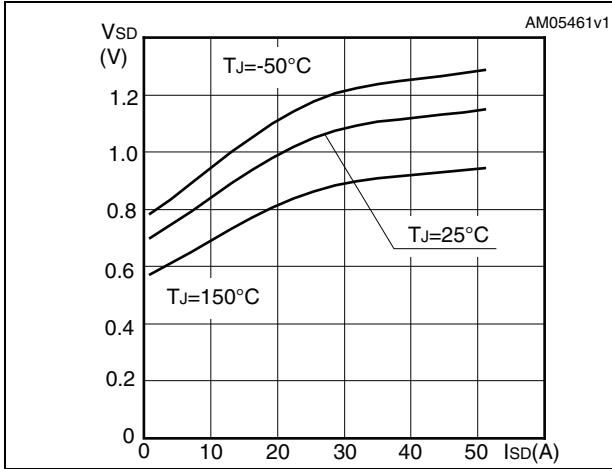


Figure 15. Normalized  $V_{(BR)DSS}$  vs temperature

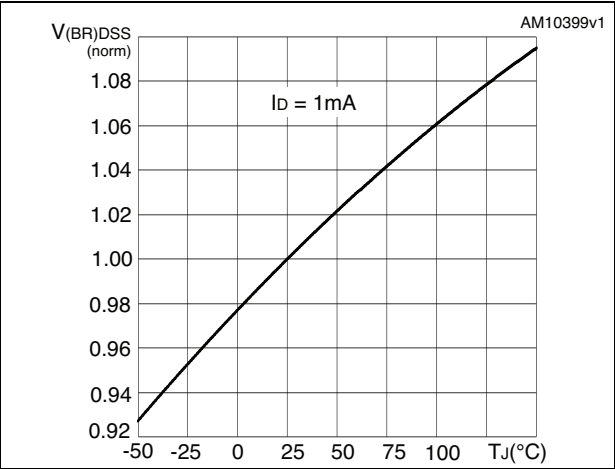
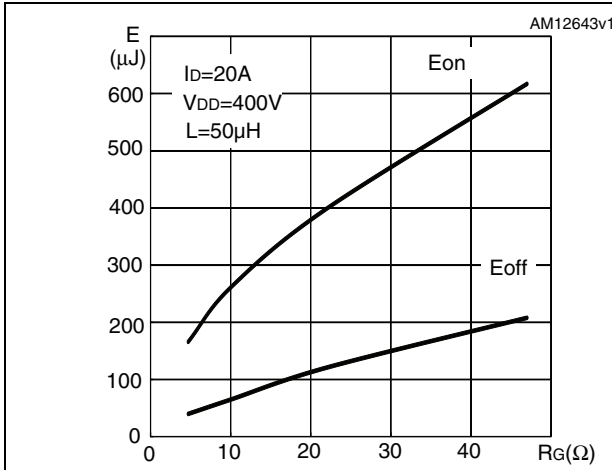


Figure 16. Switching losses vs gate resistance (1)



1.  $E_{on}$  including reverse recovery of a SiC diode.

### 3 Test circuits

Figure 17. Switching times test circuit for resistive load

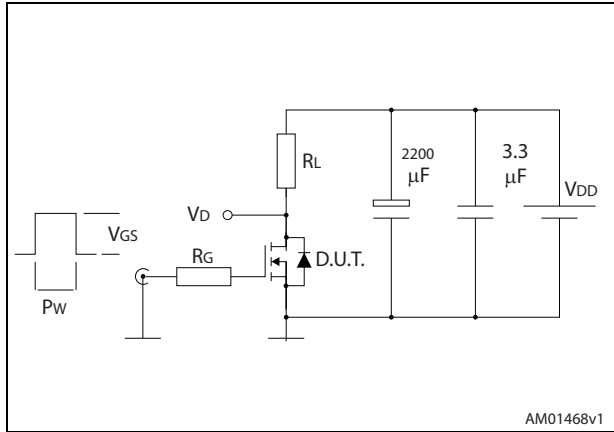


Figure 18. Gate charge test circuit

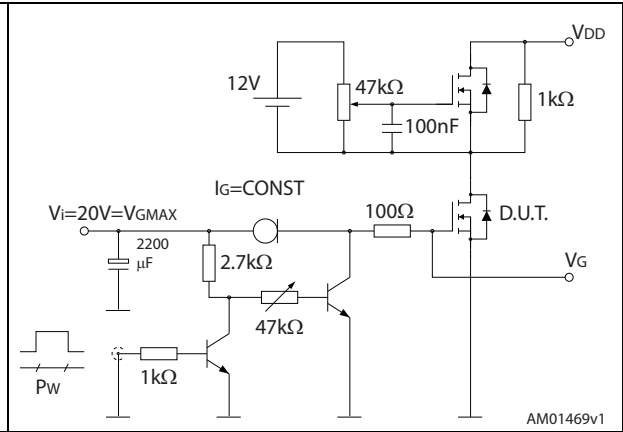


Figure 19. Test circuit for inductive load switching and diode recovery times

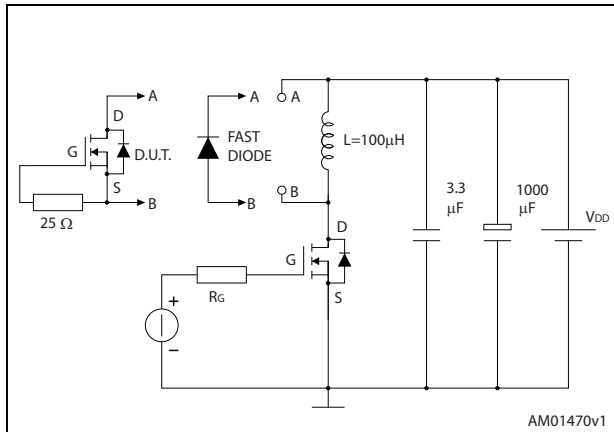


Figure 20. Unclamped inductive load test circuit

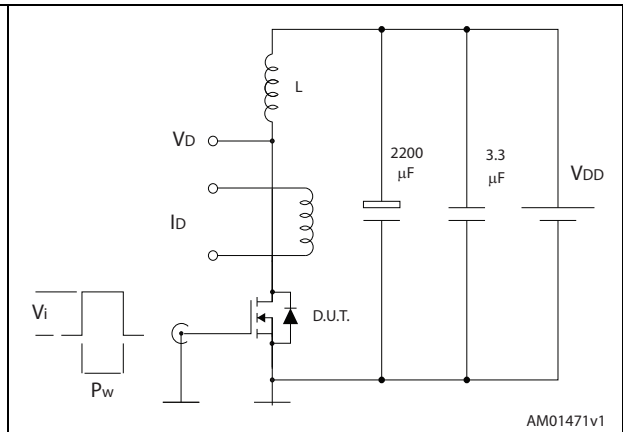


Figure 21. Unclamped inductive waveform

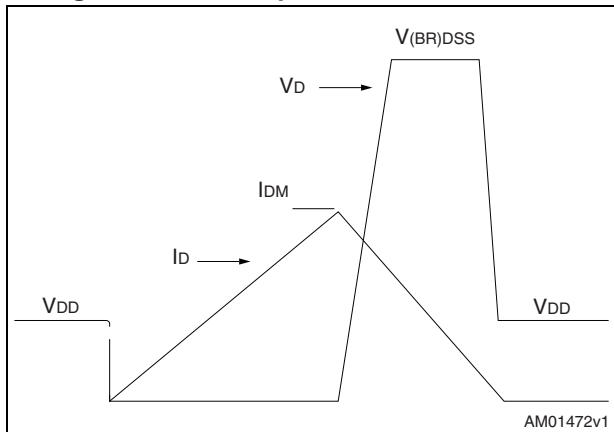
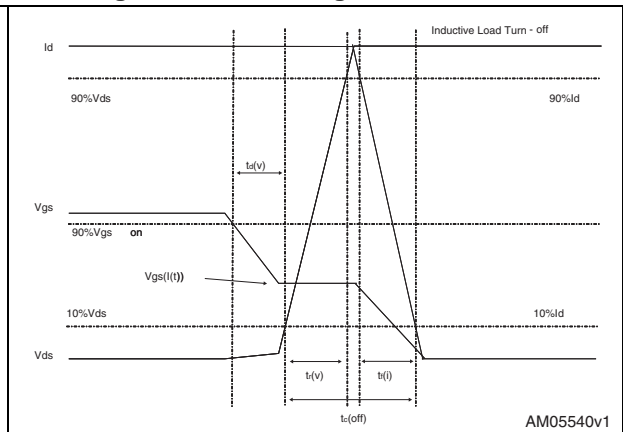


Figure 22. Switching time waveform

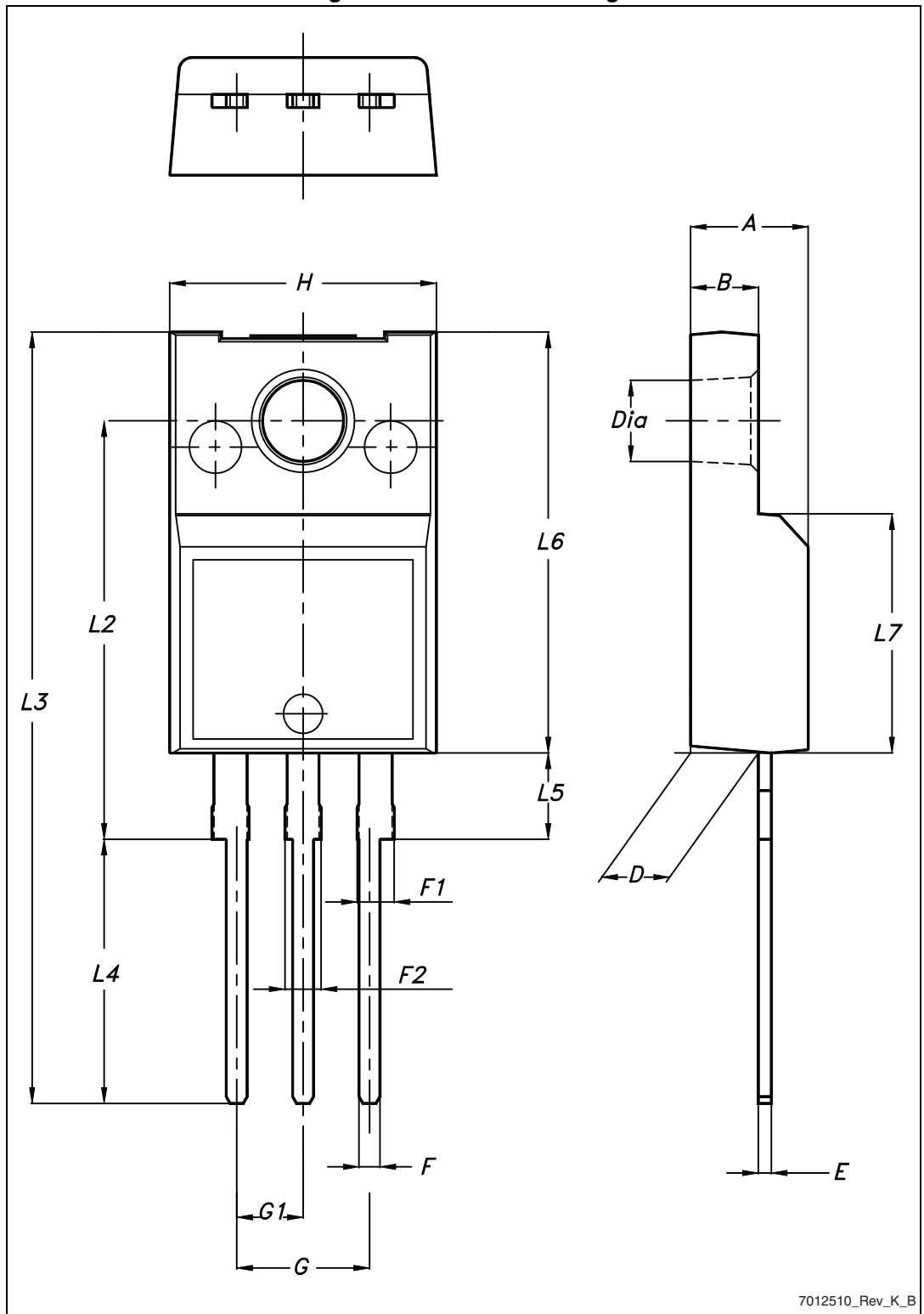


## 4 Package mechanical data

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.

### 4.1 TO-220FP, STF38N65M5

Figure 23. 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  |

### 4.2 TO-3PF, STFW38N65M5

Figure 24. TO-3PF drawing

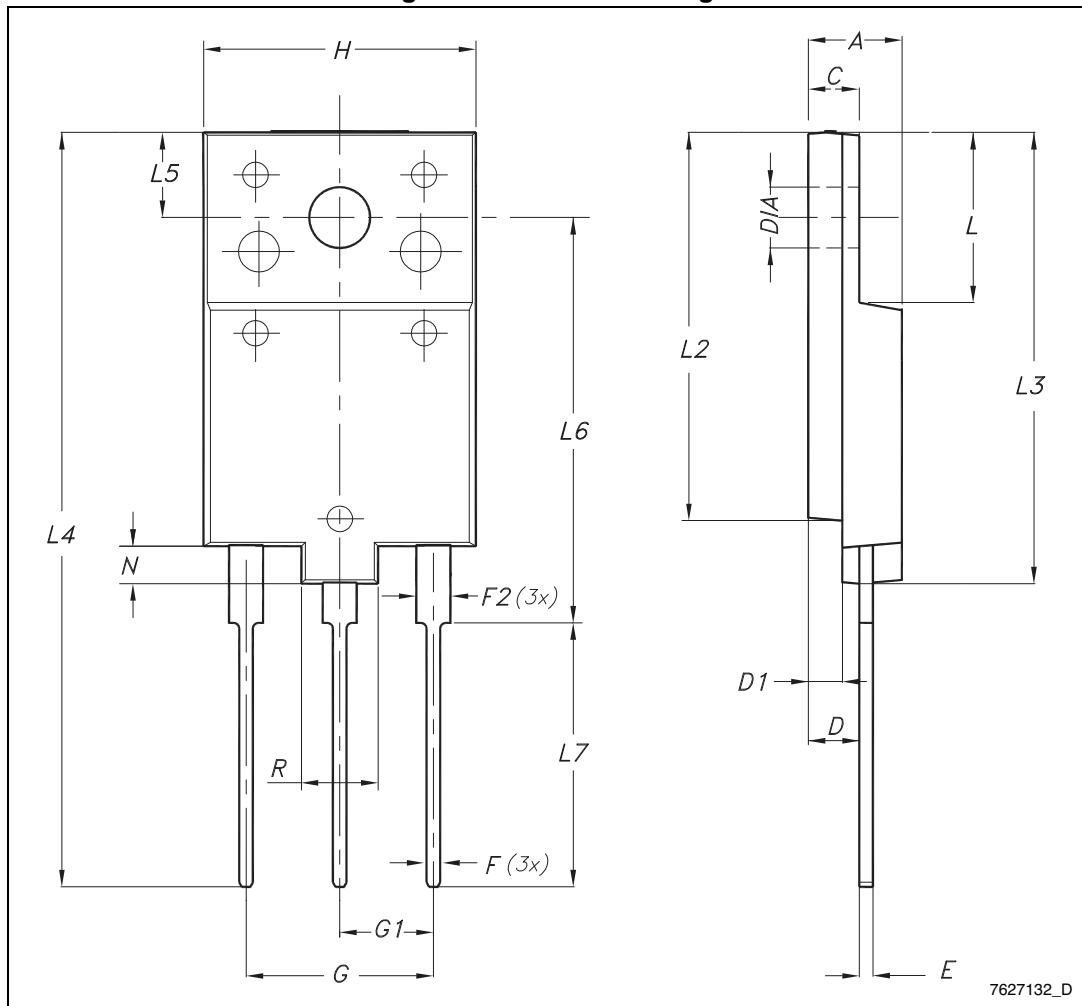


Table 10. TO-3PF mechanical data

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 5.30  |      | 5.70  |
| C    | 2.80  |      | 3.20  |
| D    | 3.10  |      | 3.50  |
| D1   | 1.80  |      | 2.20  |
| E    | 0.80  |      | 1.10  |
| F    | 0.65  |      | 0.95  |
| F2   | 1.80  |      | 2.20  |
| G    | 10.30 |      | 11.50 |
| G1   |       | 5.45 |       |
| H    | 15.30 |      | 15.70 |
| L    | 9.80  | 10   | 10.20 |
| L2   | 22.80 |      | 23.20 |
| L3   | 26.30 |      | 26.70 |
| L4   | 43.20 |      | 44.40 |
| L5   | 4.30  |      | 4.70  |
| L6   | 24.30 |      | 24.70 |
| L7   | 14.60 |      | 15    |
| N    | 1.80  |      | 2.20  |
| R    | 3.80  |      | 4.20  |
| Dia  | 3.40  |      | 3.80  |

## 5 Revision history

Table 11. Document revision history

| Date        | Revision | Changes  |
|-------------|----------|--|
| 14-Apr-2014 | 1        | First release. Part numbers previously included in datasheet DocID022851 |

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