# STF1N105K3, STFW1N105K3, STP1N105K3

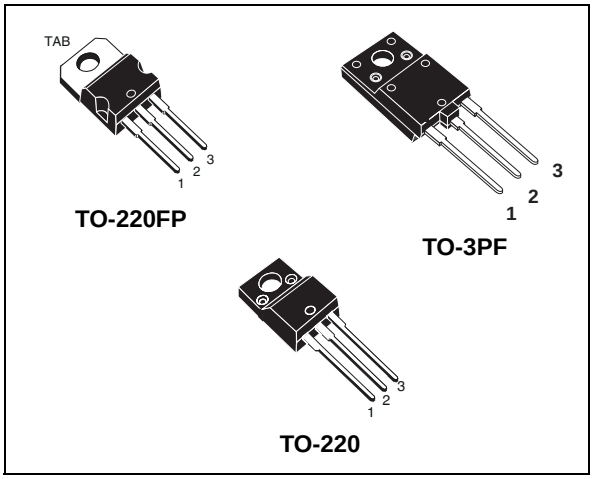
## N-channel 1050 V, 8 Ω typ., 1.4 A SuperMESH3™ Power MOSFET in TO-220FP, TO-3PF and TO-220 packages

**Datasheet — production data**

## Features

| Order codes | $V_{DS}$ | $R_{DS(on)}$ max | $I_D$ | $P_{TOT}$ |
|---|---|---|---|---|
| STF1N105K3 | 1050 V | 11 Ω | 1.4 A | 20 W |
| STFW1N105K3 | | | | |
| STP1N105K3 | | | | 60 W |

- Gate charge minimized
- Extremely large avalanche performance
- 100% avalanche tested
- Very low intrinsic capacitance




## Applications

- Switching applications

## Description

These SuperMESH3™ Power MOSFETs are the result of improvements applied to STMicroelectronics' SuperMESH™ technology, combined with a new optimized vertical structure. These devices boast an extremely low on-resistance, superior dynamic performance and high avalanche capability, rendering them suitable for the most demanding applications.

**Figure 1. Internal schematic diagram**

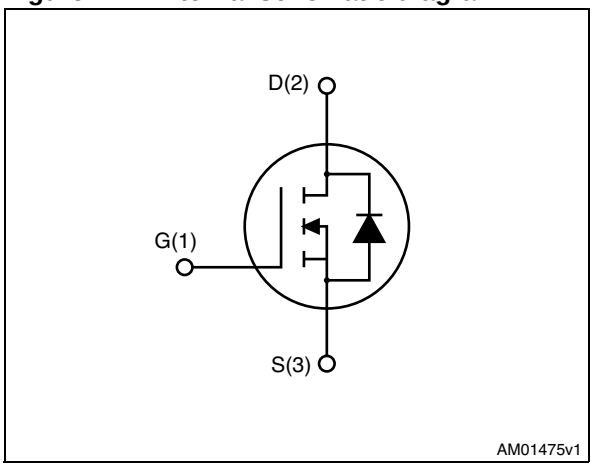



**Table 1. Device summary**

| Order codes | Marking | Package | Packaging |
|---|---|---|---|
| STF1N105K3 | 1N105K3 | TO-220FP | Tube |
| STFW1N105K3 | | TO-3PF | |
| STP1N105K3 | | TO-220 | |

# Contents

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# 1 Electrical ratings

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**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | | | Unit |
|---|---|---|---|---|---|
| | | TO-220FP | TO-3PF | TO-220 | |
| $V_{DS}$ | Drain source voltage | 1050 | | | V |
| $V_{GS}$ | Gate- source voltage | ± 30 | | | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 1.4(1) | | 1.4 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 0.9(1) | | 0.9 | A |
| $I_{DM}$ (2) | Drain current (pulsed) | 5.6(1) | | 5.6 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 20 | | 60 | W |
| $I_{AR}$ | Max current during repetitive or single pulse avalanche (pulse width limited by $T_{jmax}$ ) | 1.2 | | | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_J$ = 25 °C, $I_D$=$I_{AR}$, $V_{DD}$= 50 V) | 130 | | | mJ |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; TC = 25 °C) | 2500 | 3500 | | V |
| dv/dt (3) | Peak diode recovery voltage slope | 6 | | | V/ns |
| $T_j$<br>$T_{stg}$ | Operating junction temperature<br>Storage temperature | - 55 to 150 | | | °C |

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. $I_{SD} \leq 1.4$ A, di/dt $\leq$ 100 A/$\mu$s, $V_{DD}$ = 80% $V_{(BR)DSS}$, $V_{DS}$ peak $\leq V_{(BR)DSS}$.

**Table 3. Thermal data**

| Symbol | Parameter | Value | | | Unit |
|---|---|---|---|---|---|
| | | TO-220FP | TO-3PF | TO-220 | |
| Rthj-case | Thermal resistance junction-case max | 6.25 | | 2.08 | °C/W |
| Rthj-amb | Thermal resistance junction-amb max | 62.50 | 50 | 62.50 | °C/W |

# 2 Electrical characteristics

($T_{CASE}$ = 25 °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 mA, $V_{GS}$= 0 | 1050 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = 1050 V,<br>$V_{DS}$ = 1050 V, Tc=125 °C | | | 1<br>50 | µA<br>µA |
| $I_{GSS}$ | Gate body leakage current ($V_{DS}$ = 0) | $V_{GS}$ = ± 20 V | | | ±50 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 50 µA | 2 | 3 | 4.5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$= 0.6 A | | 8 | 11 | Ω |

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$ =100 V, f=1 MHz, $V_{GS}$=0 | - | 180 | - | pF |
| $C_{oss}$ | Output capacitance | | | 15 | | pF |
| $C_{rss}$ | Reverse transfer capacitance | | | 1 | | pF |
| $C_{o(tr)}$(1) | Equivalent capacitance time related | $V_{GS}$ = 0, $V_{DS}$ = 0 to 840 V | - | 11 | - | pF |
| $C_{o(er)}$(2) | Equivalent capacitance energy related | | - | 7 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz open drain | - | 18 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 840 V, $I_D$ = 1.2 A | - | 13 | - | nC |
| $Q_{gs}$ | Gate-source charge | $V_{GS}$ =10 V | | 1.6 | | nC |
| $Q_{gd}$ | Gate-drain charge | *(see Figure 18)* | | 8 | | 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 | $V_{DD}$ = 525 V, $I_D$ = 0.6 A, $R_G$=4.7 Ω, $V_{GS}$=10 V *(see Figure 20)* | - | 6 | - | ns |
| $t_r$ | Rise time | | | 7 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 27 | | ns |
| $t_f$ | Fall time | | | 50 | | ns |

**Table 7. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 1.4 | mA |
| $I_{SDM}$ | Source-drain current (pulsed) | | | | 5.6 | A |
| $V_{SD}$ (1) | Forward on voltage | $I_{SD}$= 1.2 A, $V_{GS}$=0 | - | | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$= 1.2 A, $V_{DD}$= 60 V di/dt = 100 A/µs, *(see Figure 19)* | - | | 244 | ns |
| $Q_{rr}$ | Reverse recovery charge | | | | 1 | µC |
| $I_{RRM}$ | Reverse recovery current | | | | 9 | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$= 1.2 A,$V_{DD}$= 60 V di/dt=100 A/µs, Tj=25 °C*(see Figure 19)* | - | | 330 | ns |
| $Q_{rr}$ | Reverse recovery charge | | | | 1.3 | µC |
| $I_{RRM}$ | Reverse recovery current | | | | 8 | A |

1. Pulsed: pulse duration = 300 µs, duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area for TO-220FP and TO-3PF**

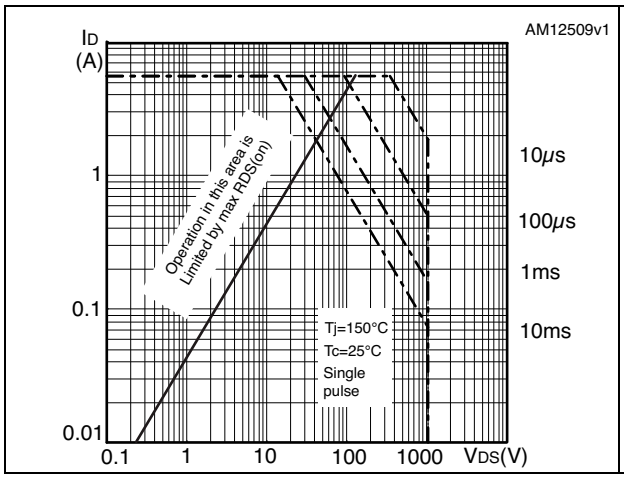



**Figure 3. Thermal impedance for TO-220FP and TO-3PF**

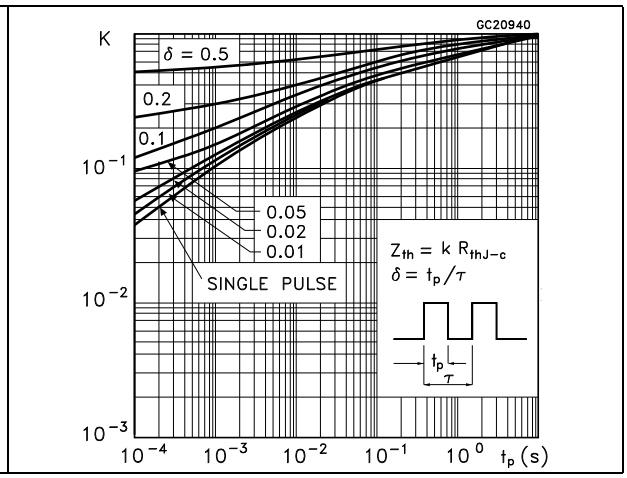



**Figure 4. Safe operating area for TO-220**

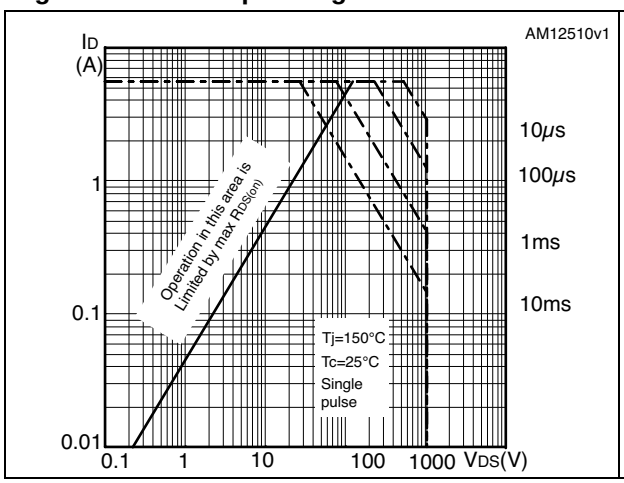



**Figure 5. Thermal impedance for TO-220**

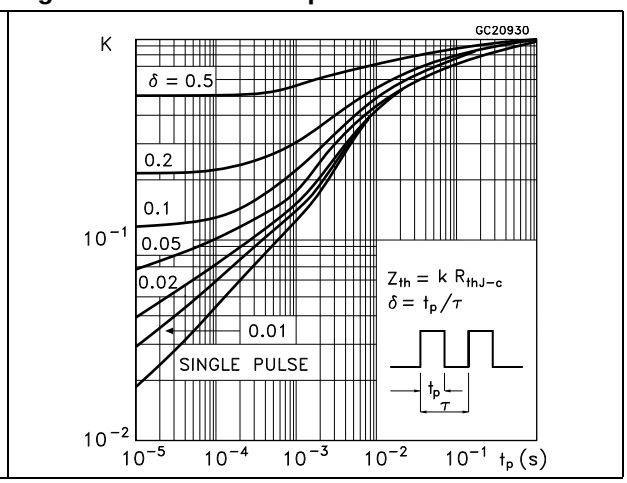



**Figure 6. Output characteristics**

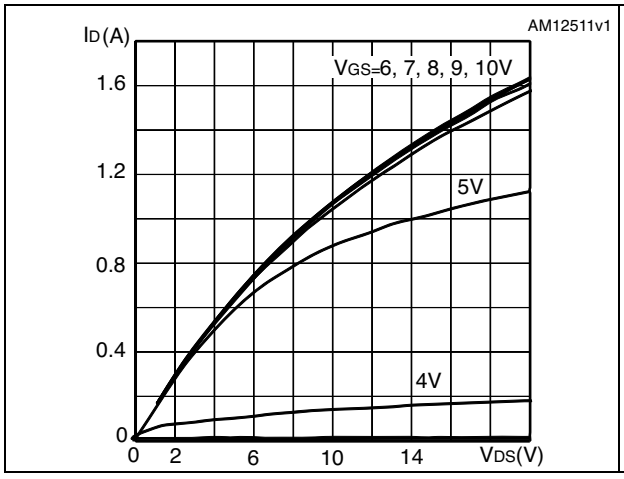



**Figure 7. Transfer characteristics**

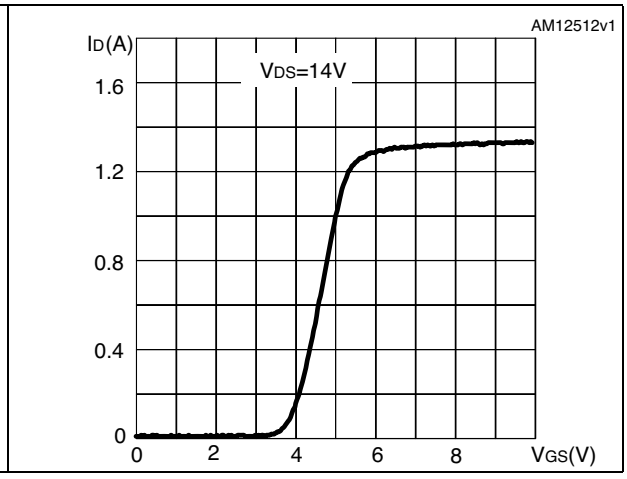


**Figure 8. Gate charge vs gate-source voltage**

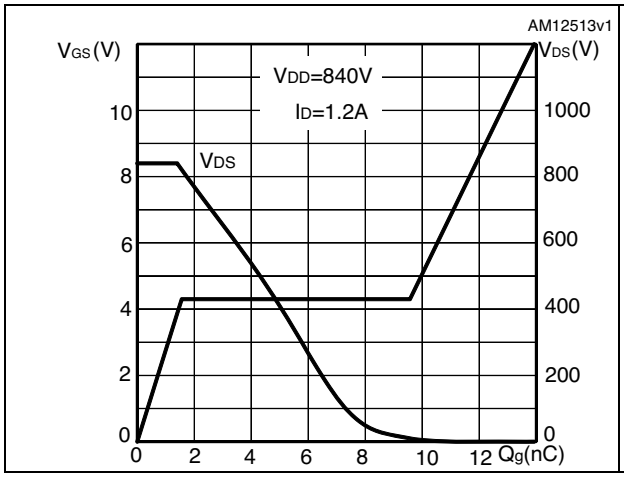



**Figure 9. Static drain-source on-resistance**

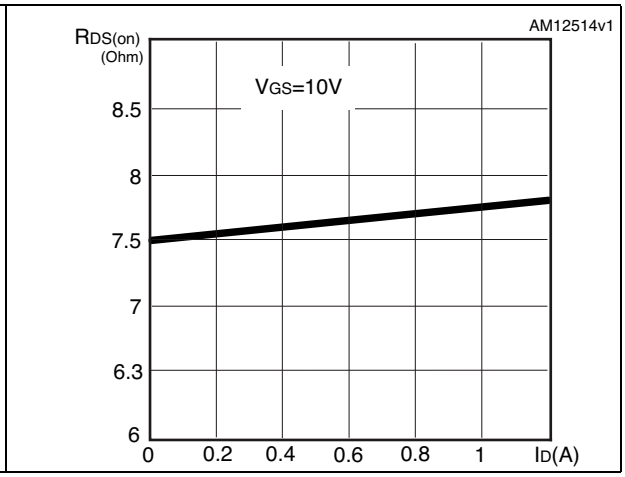



**Figure 10. Capacitance variations**

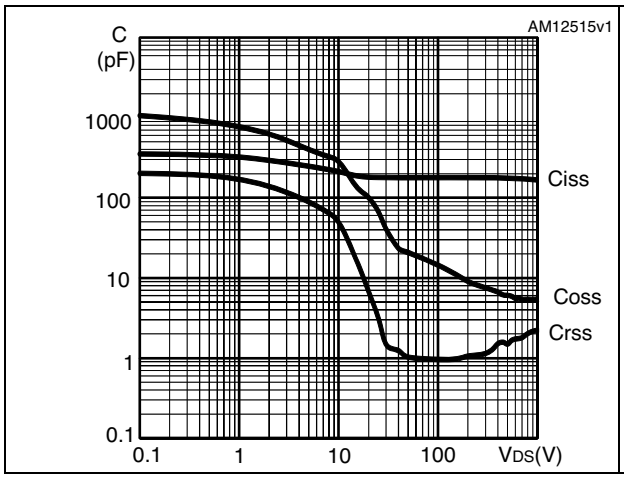



**Figure 11. Output capacitance stored energy**

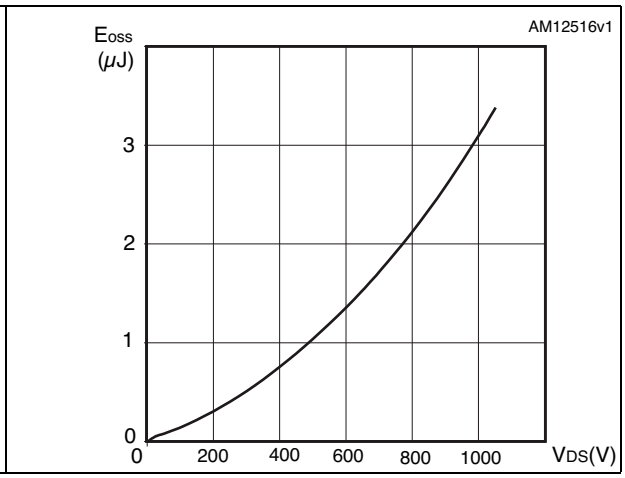



**Figure 12. Normalized gate threshold voltage vs temperature**

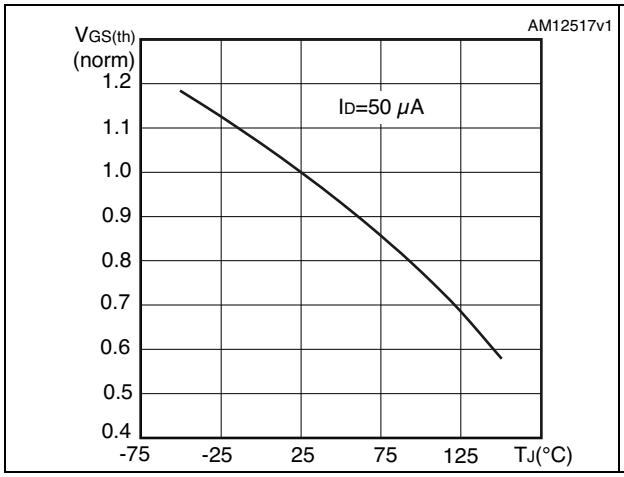



**Figure 13. Normalized on-resistance vs temperature**

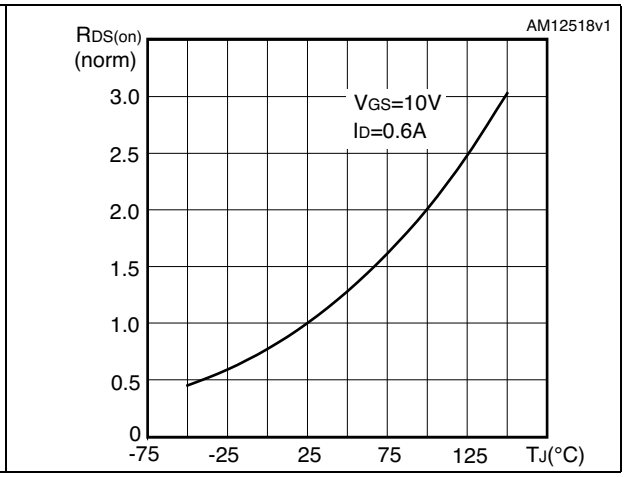


**Figure 14. Source-drain diode forward characteristics**

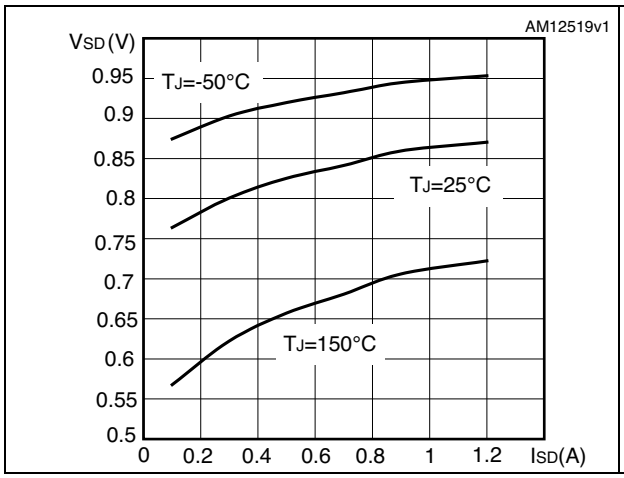



**Figure 15. Normalized $B_{VDSS}$ vs temperature**

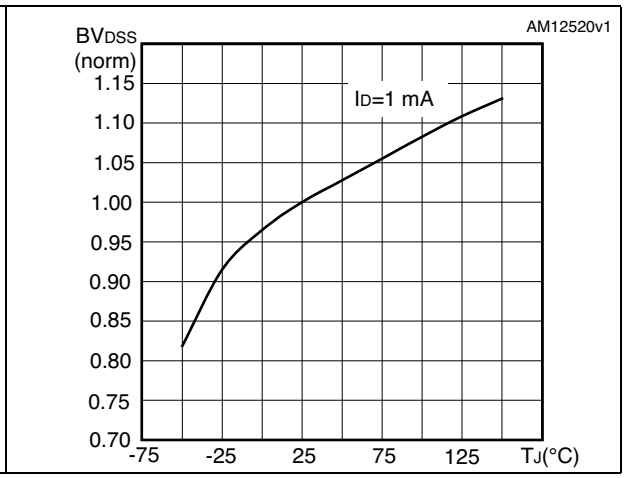
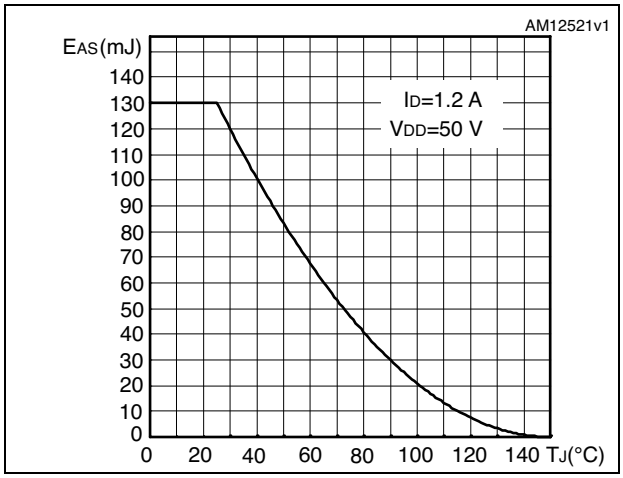



**Figure 16. Maximum avalanche energy vs starting Tj**



# 3 Test circuits

**Figure 17. Switching times test circuit for resistive load**

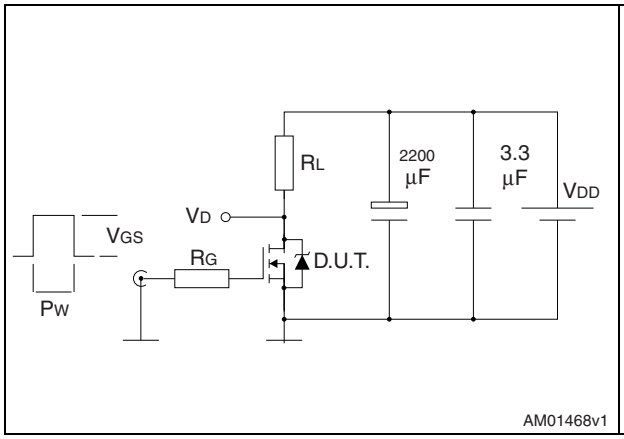



**Figure 18. Gate charge test circuit**

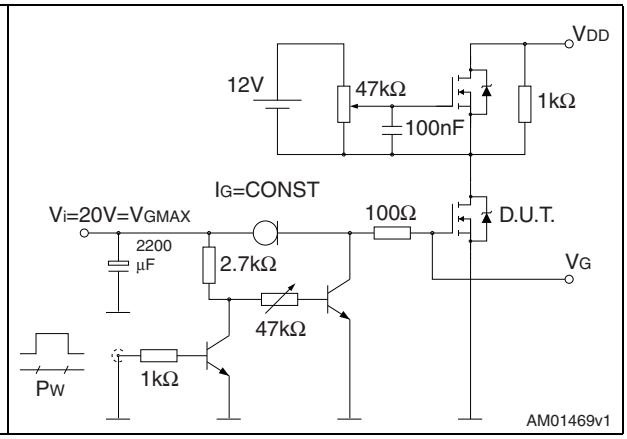



**Figure 19. Test circuit for inductive load switching and diode recovery times**

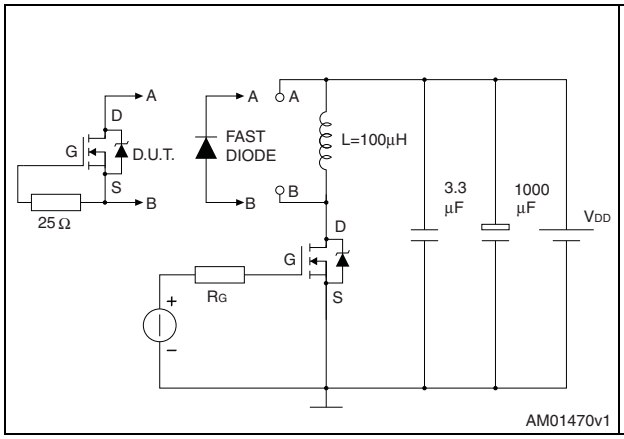



**Figure 20. Unclamped inductive load test circuit**

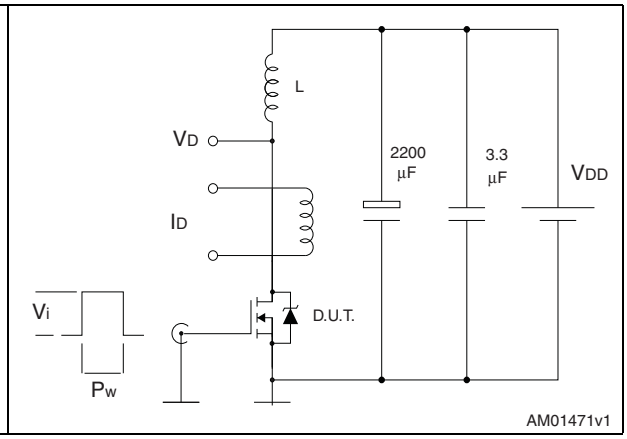



**Figure 21. Unclamped inductive waveform**

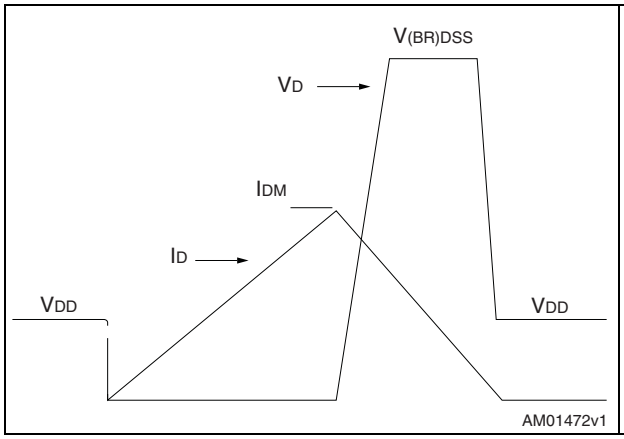
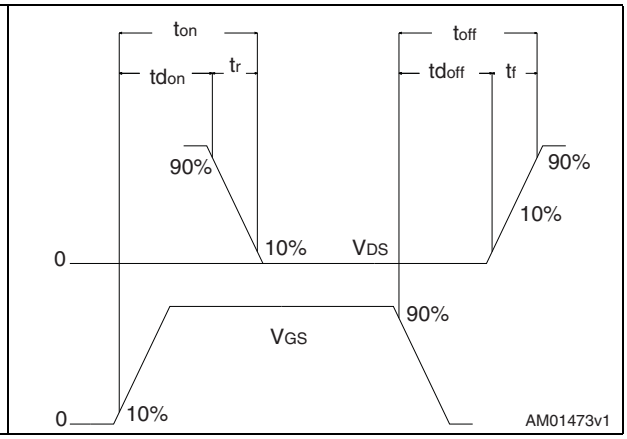



**Figure 22. Switching time waveform**



# 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

**Table 8. 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 23. TO-220FP drawing**

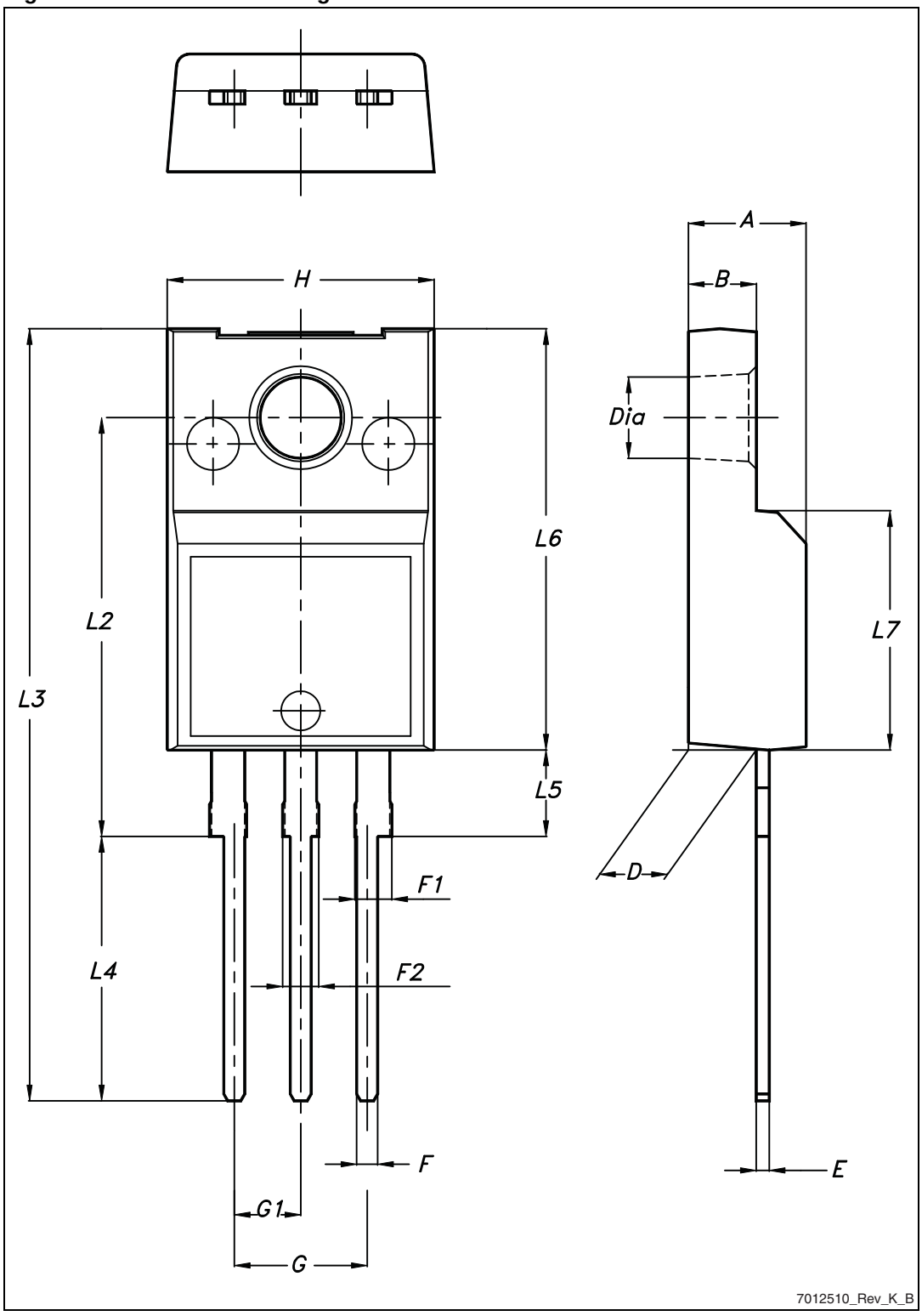


**Table 9. TO-3PF mechanical data**

| 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 |

**Figure 24. TO-3PF drawing**

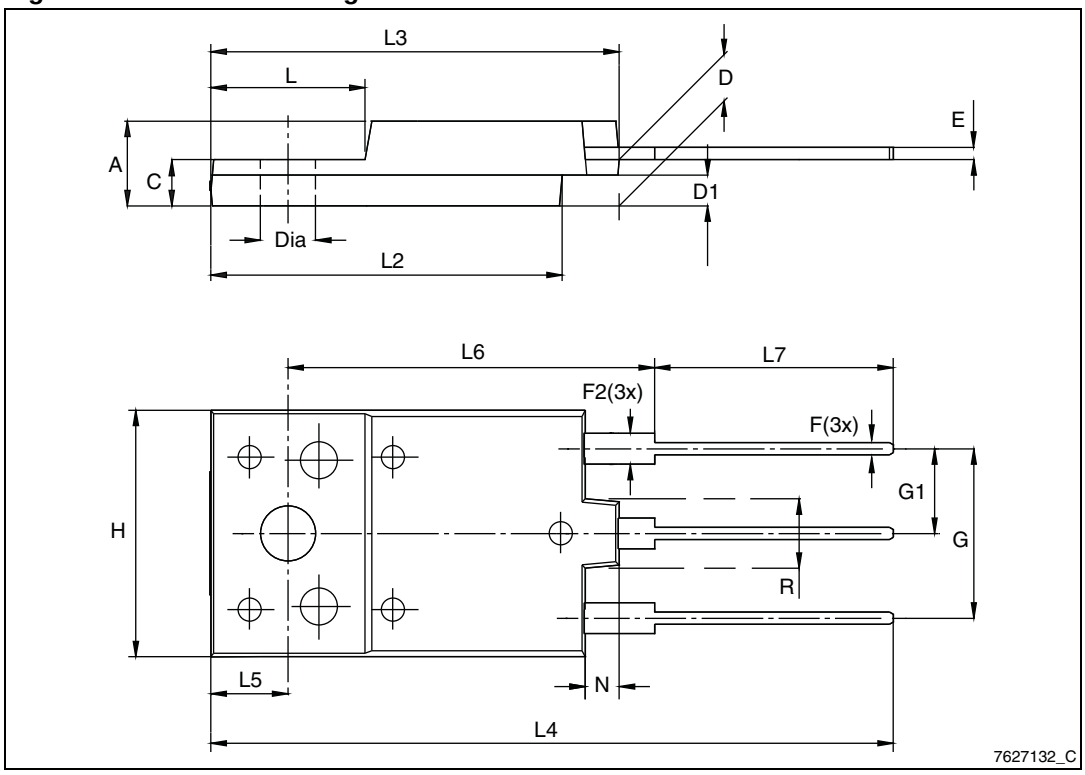
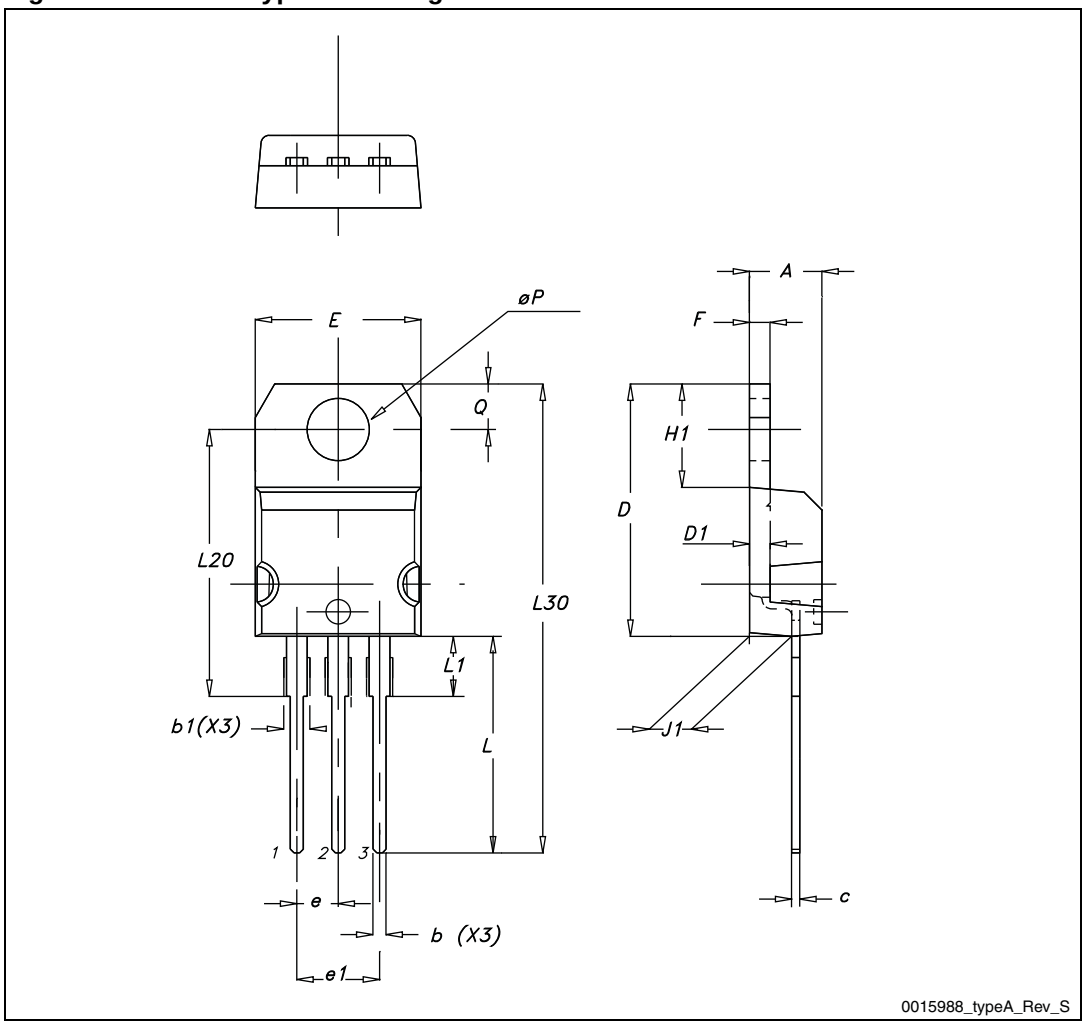


Table 10. TO-220 type A mechanical data

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.70 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 6.20 | | 6.60 |
| J1 | 2.40 | | 2.72 |
| L | 13 | | 14 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| ∅P | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

**Figure 25. TO-220 type A drawing**



# 5 Revision history

Table 11. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 13-Aug-2012 | 1 | First release. |
| 23-Jan-2013 | 2 | Added device in TO-3PF. |