

N-channel 600 V, 0.078 Ω typ., 34 A MDmesh M2 Power MOSFETs in TO-220FP, I²PAKFP and TO-3PF packages

Datasheet – production data

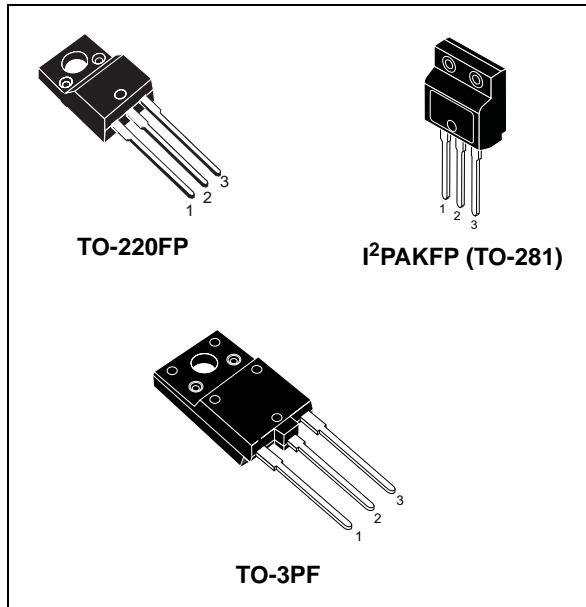
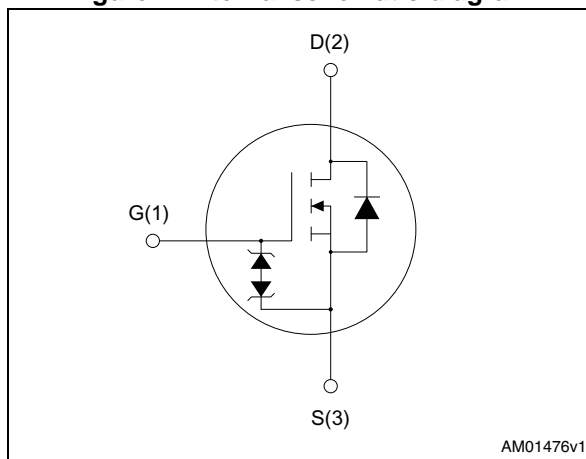


Figure 1. Internal schematic diagram



Features

| Order codes | V _{DS} @ T _{Jmax} | R _{DS(on)} max | I _D |
|-------------|-------------------------------------|-------------------------|----------------|
| STF40N60M2 | 650 V | 0.088 Ω | 34 A |
| STFI40N60M2 | | | |
| STFW40N60M2 | | | |

- Extremely low gate charge
- Excellent output capacitance (C_{oss}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications
- LLC converters, resonant converters

Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, the devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1. Device summary

| Order code | Marking | Packages | Packing |
|-------------|---------|-------------------------------|---------|
| STF40N60M2 | 40N60M2 | TO-220FP | Tube |
| STFI40N60M2 | | I ² PAKFP (TO-281) | |
| STFW40N60M2 | | TO-3PF | |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|------------------------------------|--|-----------------------------------|--------|------|
| | | TO-220FP, I ² PAKFP | TO-3PF | |
| V _{GS} | Gate-source voltage | ± 25 | | V |
| I _D ⁽¹⁾ | Drain current (continuous) at T _C = 25 °C | 34 | | A |
| I _D ⁽¹⁾ | Drain current (continuous) at T _C = 100 °C | 22 | | A |
| I _{DM} ^{(1),(2)} | Drain current (pulsed) | 136 | | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 40 | 63 | 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 s; T _C =25 °C) | 2500 | 3500 | V |
| T _{stg} | Storage temperature range | - 55 to 150 | | °C |
| T _j | Operating junction temperature range | | | °C |

- Limited by maximum junction temperature
- Pulse width limited by safe operating area.
- I_{SD} ≤ 34 A, di/dt ≤ 400 A/μs; V_{DS peak} < V_{(BR)DSS}; V_{DD}=400 V.
- V_{DS} ≤ 480 V

Table 3. Thermal data

| Symbol | Parameter | Value | | Unit |
|-----------------------|-------------------------------------|-----------------------------------|--------|------|
| | | TO-220FP, I ² PAKFP | TO-3PF | |
| R _{thj-case} | Thermal resistance junction-case | 3.13 | 2.00 | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient | 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}) | 6 | A |
| E _{AS} | Single pulse avalanche energy (starting T _j =25°C, I _D = I _{AR} ; V _{DD} =50 V) | 500 | 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 | $V_{GS} = 0, I_D = 1\text{ mA}$ | 600 | | | V |
| I_{DSS} | Zero gate voltage drain current () | $V_{GS} = 0, V_{DS} = 600\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0, V_{DS} = 600\text{ V}, T_C = 125\text{ °C}^{(1)}$ | | | 100 | μA |
| I_{GSS} | Gate-body leakage current | $V_{DS} = 0, V_{GS} = \pm 25\text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 2 | 3 | 4 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}, I_D = 17\text{ A}$ | | 0.078 | 0.088 | Ω |

1. Defined by design, not subject to production test

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|--|------|------|------|----------|
| C_{iss} | Input capacitance | $V_{GS} = 0, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$ | - | 2500 | - | pF |
| C_{oss} | Output capacitance | | - | 117 | - | pF |
| C_{rss} | Reverse transfer capacitance | | - | 2.4 | - | pF |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{GS} = 0, V_{DS} = 0\text{ to }480\text{ V}$ | - | 342 | - | pF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}, I_D = 0$ | - | 4.4 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 480\text{ V}, I_D = 34\text{ A}, V_{GS} = 10\text{ V}$ (see Figure 17: Gate charge test circuit) | - | 57 | - | nC |
| Q_{gs} | Gate-source charge | | - | 10 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 25.5 | - | nC |

1. $C_{oss\text{ eq.}}$ 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}

Table 7. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|---|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 300\text{ V}$, $I_D = 34\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 16: Switching times test circuit for resistive load and Figure 21: Switching time waveform) | - | 20.5 | - | ns |
| t_r | Rise time | | - | 13.5 | - | ns |
| $t_{d(off)}$ | Turn-off-delay time | | - | 96 | - | ns |
| t_f | Fall time | | - | 11 | - | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | 34 | | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | 136 | | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 34\text{ A}$, $V_{GS} = 0$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 34\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 18: Test circuit for inductive load switching and diode recovery times) | - | 440 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 8.2 | | μC |
| I_{RRM} | Reverse recovery current | | - | 37 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 34\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 18: Test circuit for inductive load switching and diode recovery times) | - | 568 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 11.5 | | μC |
| I_{RRM} | Reverse recovery current | | - | 40.5 | | A |

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220FP and I²PAKFP

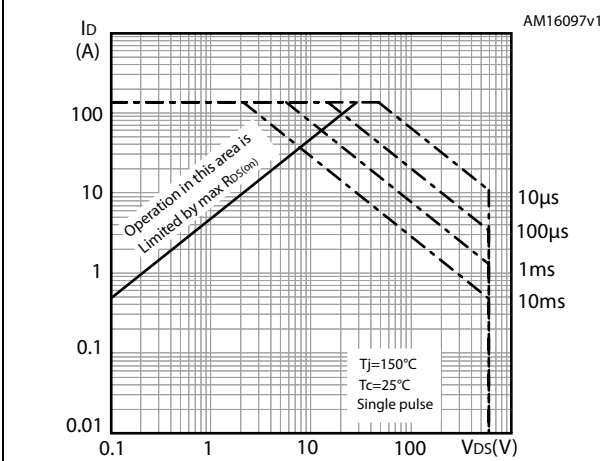


Figure 3. Thermal impedance for TO-220FP and I²PAKFP

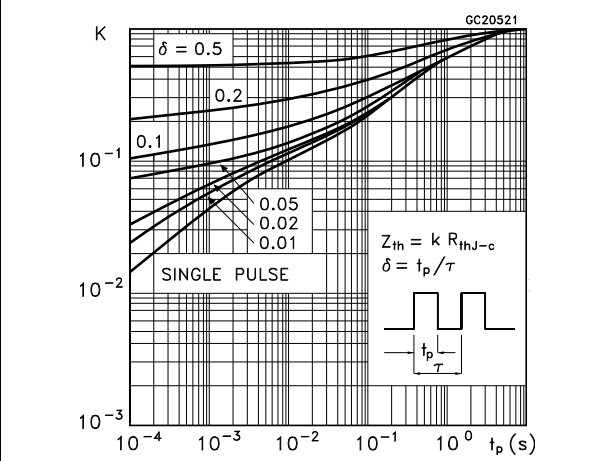


Figure 4. Safe operating area for TO-3PF

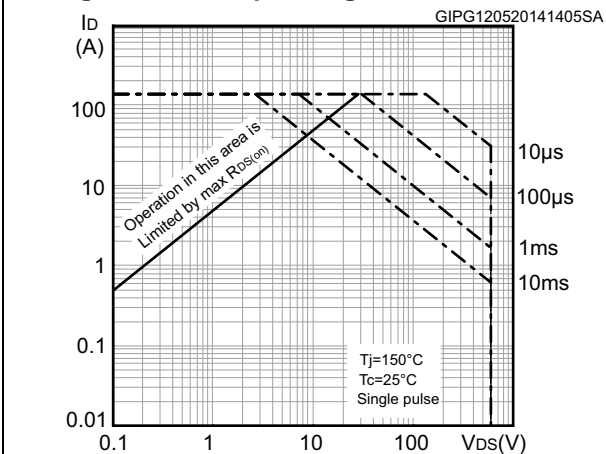


Figure 5. Thermal impedance for TO-3PF

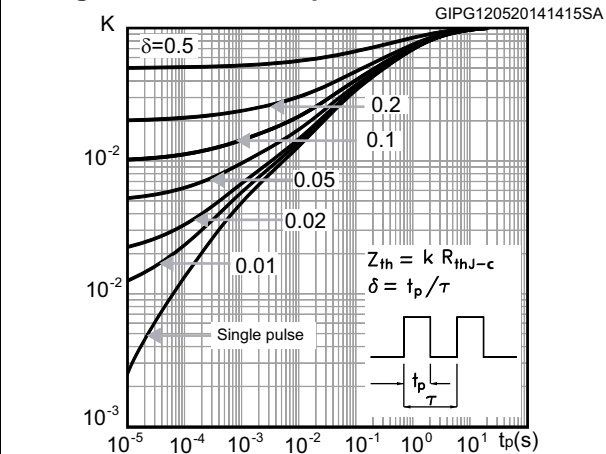


Figure 6. Output characteristics

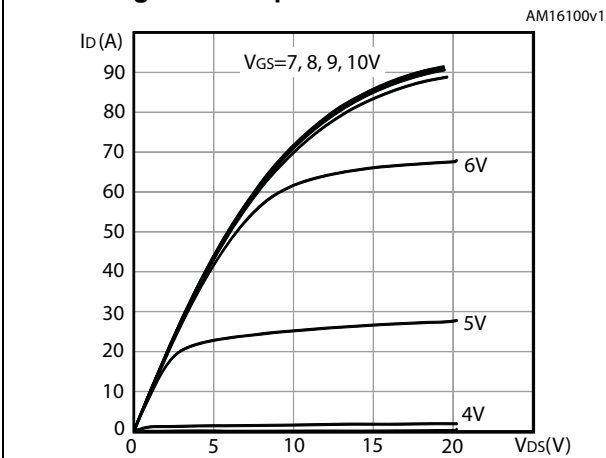
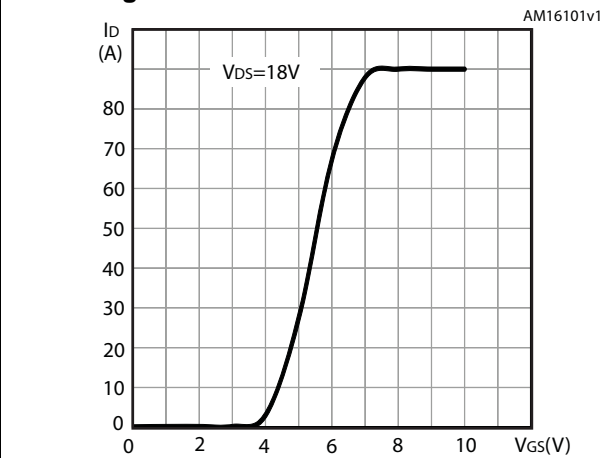


Figure 7. Transfer characteristics



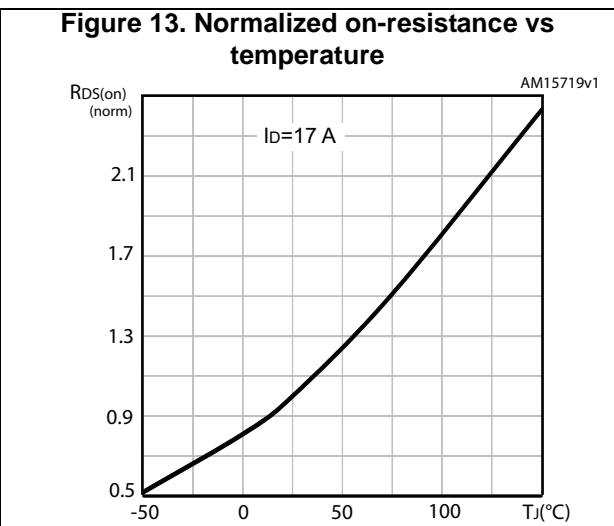
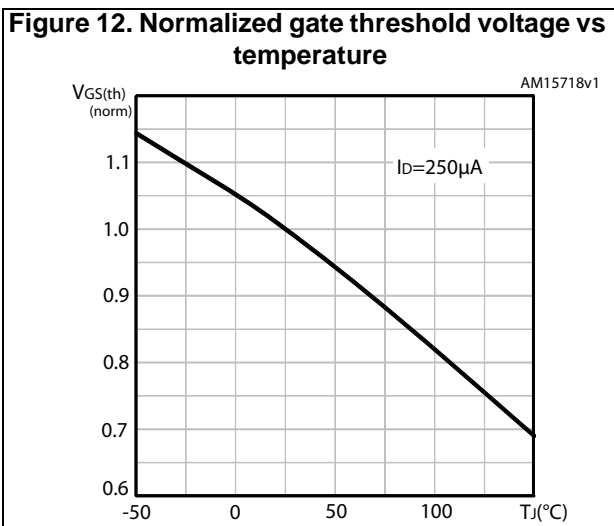
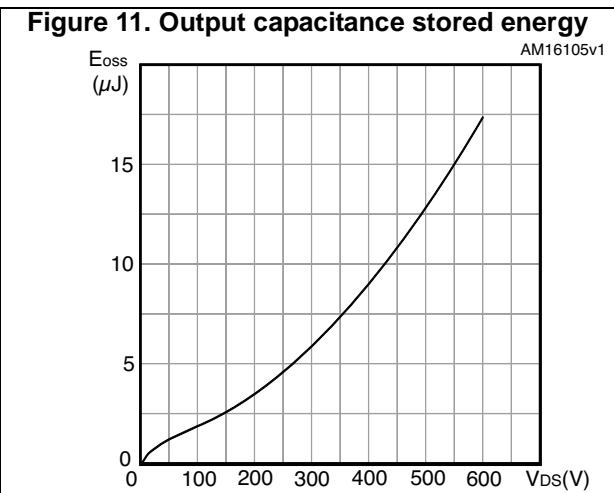
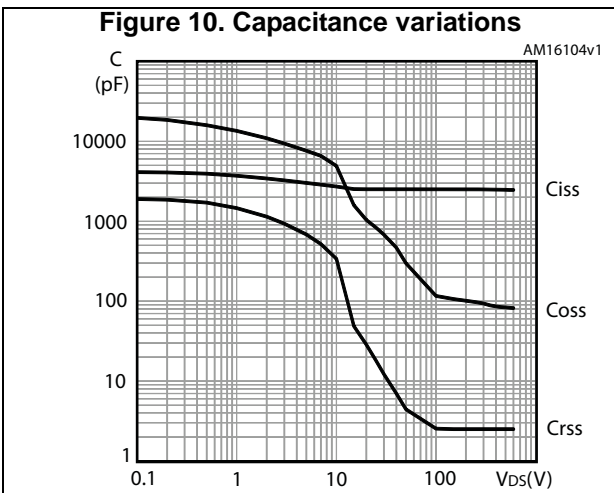
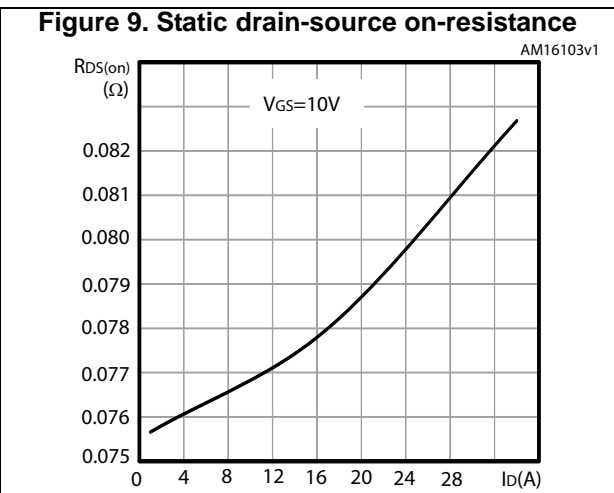
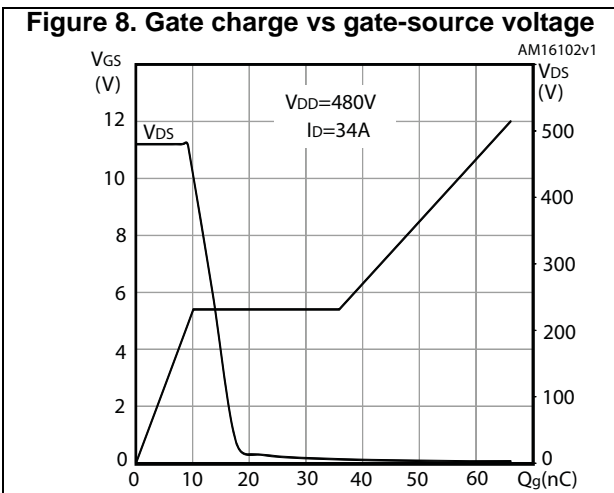


Figure 14. Normalized $V_{(BR)DSS}$ vs temperature

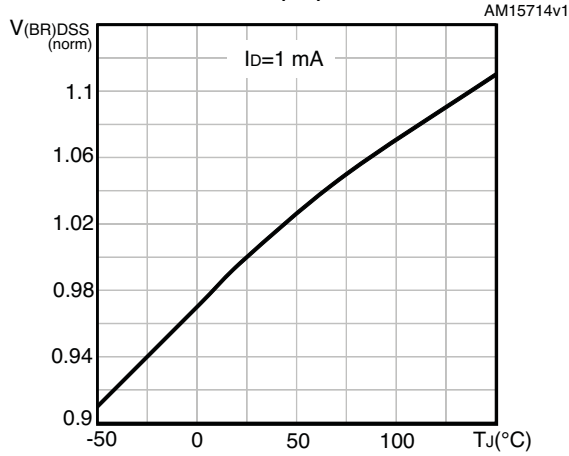
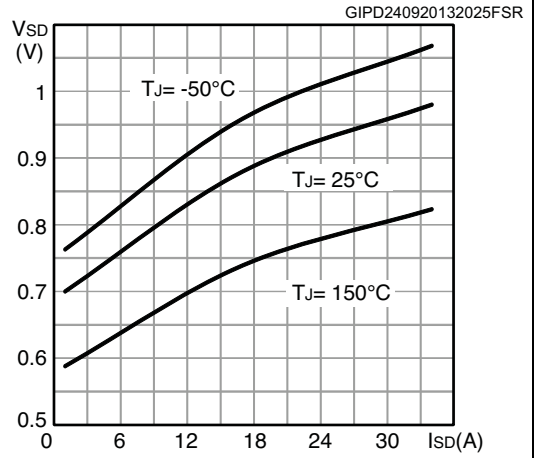
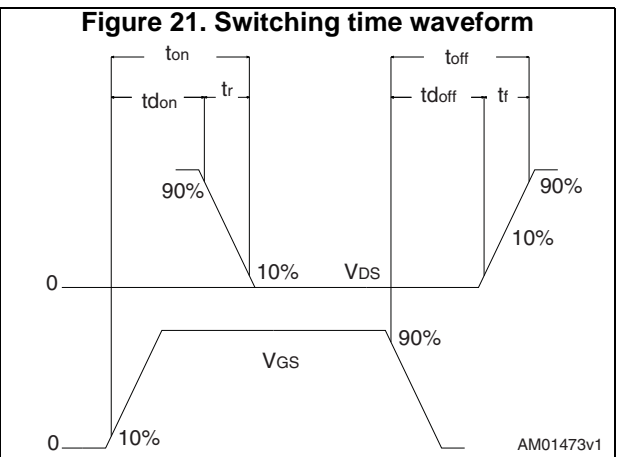
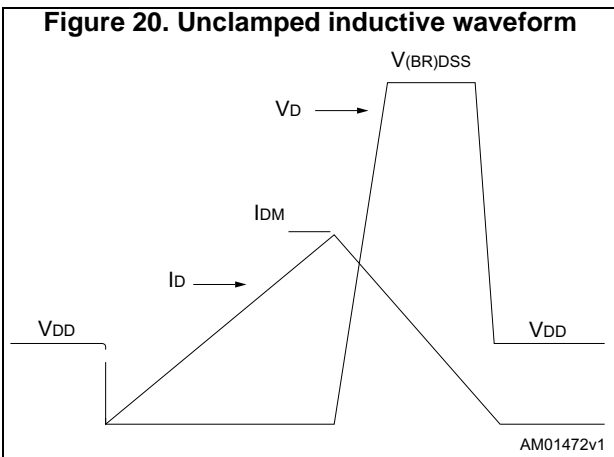
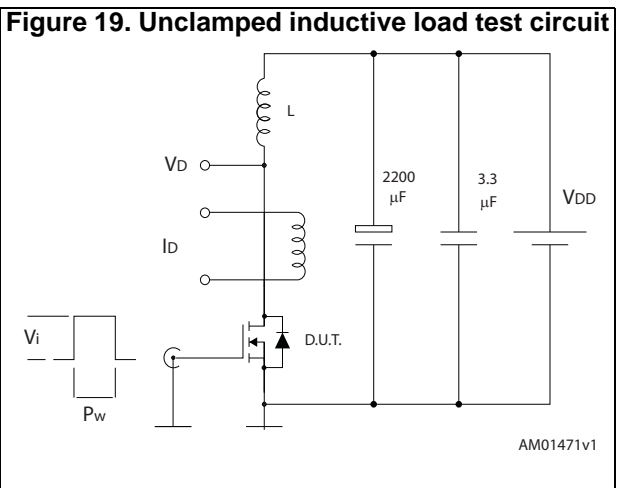
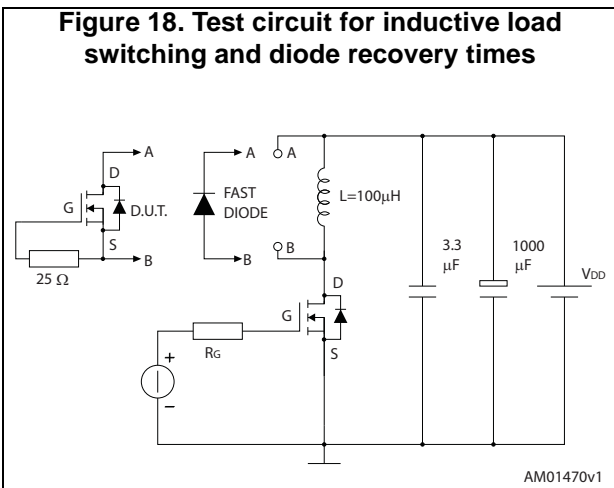
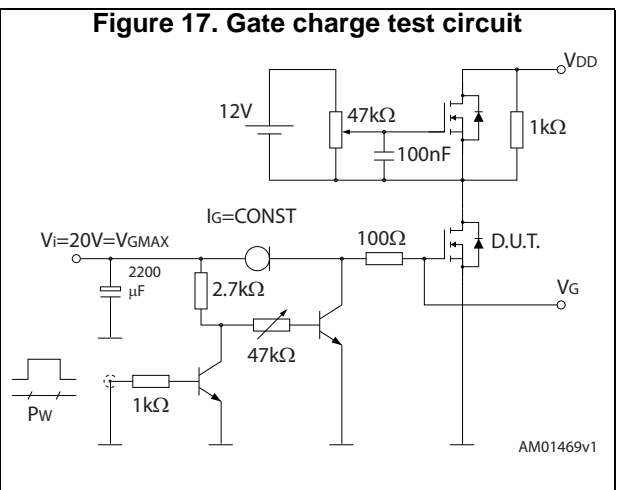
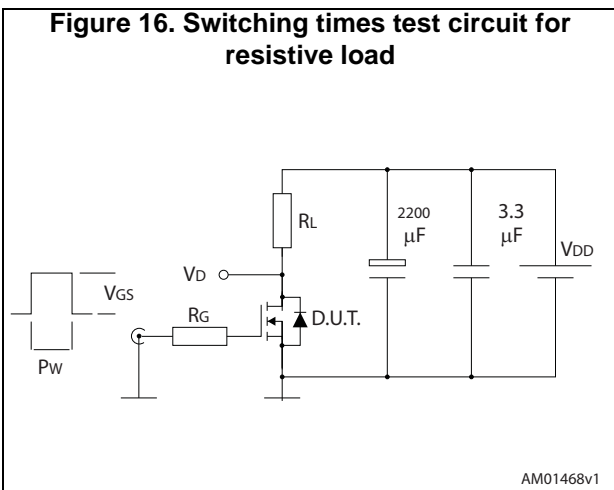


Figure 15. Source-drain diode forward vs temperature



3 Test circuits

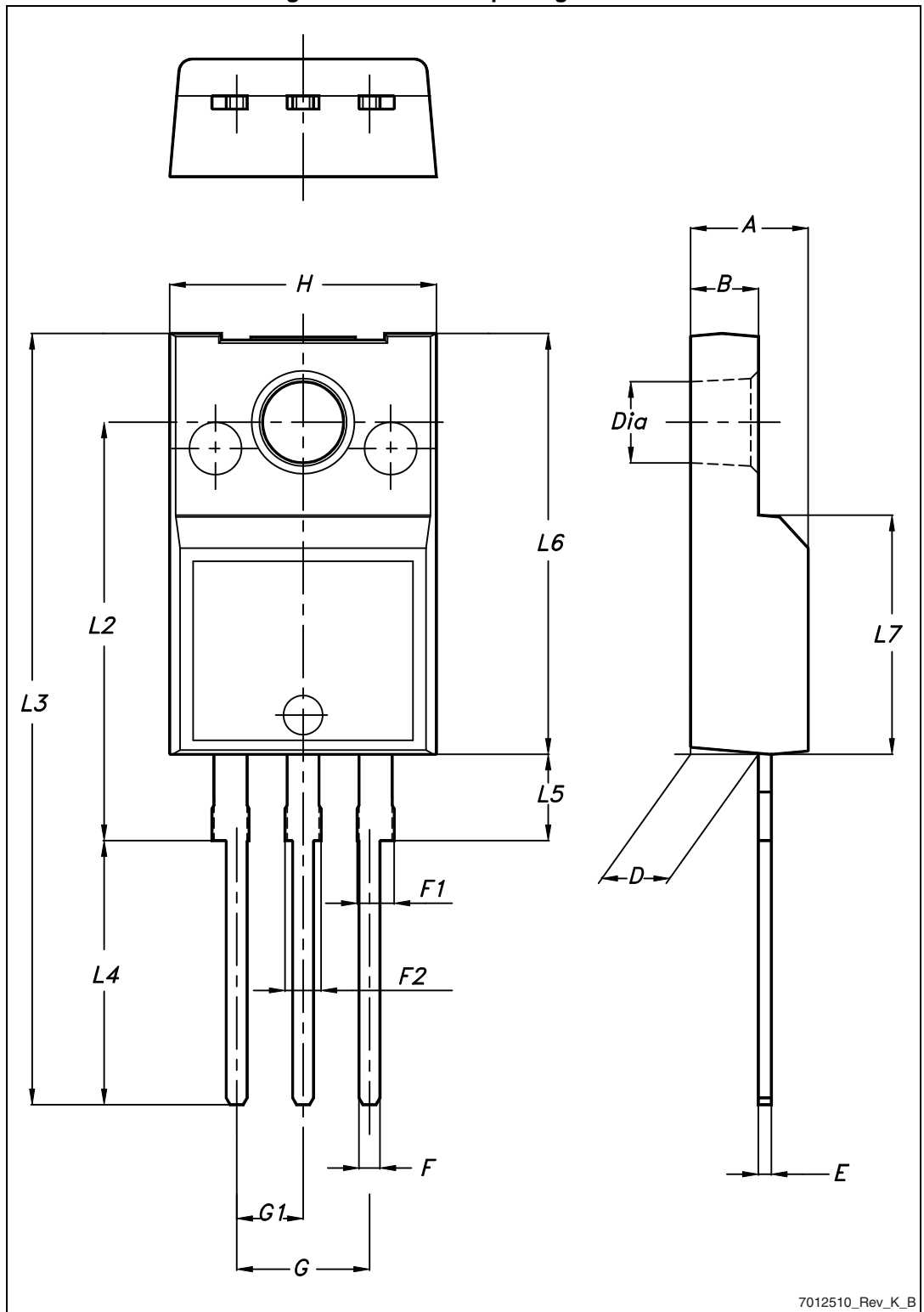


4 Package information

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.

4.1 TO-220FP, package outline

Figure 22. TO-220FP package outline



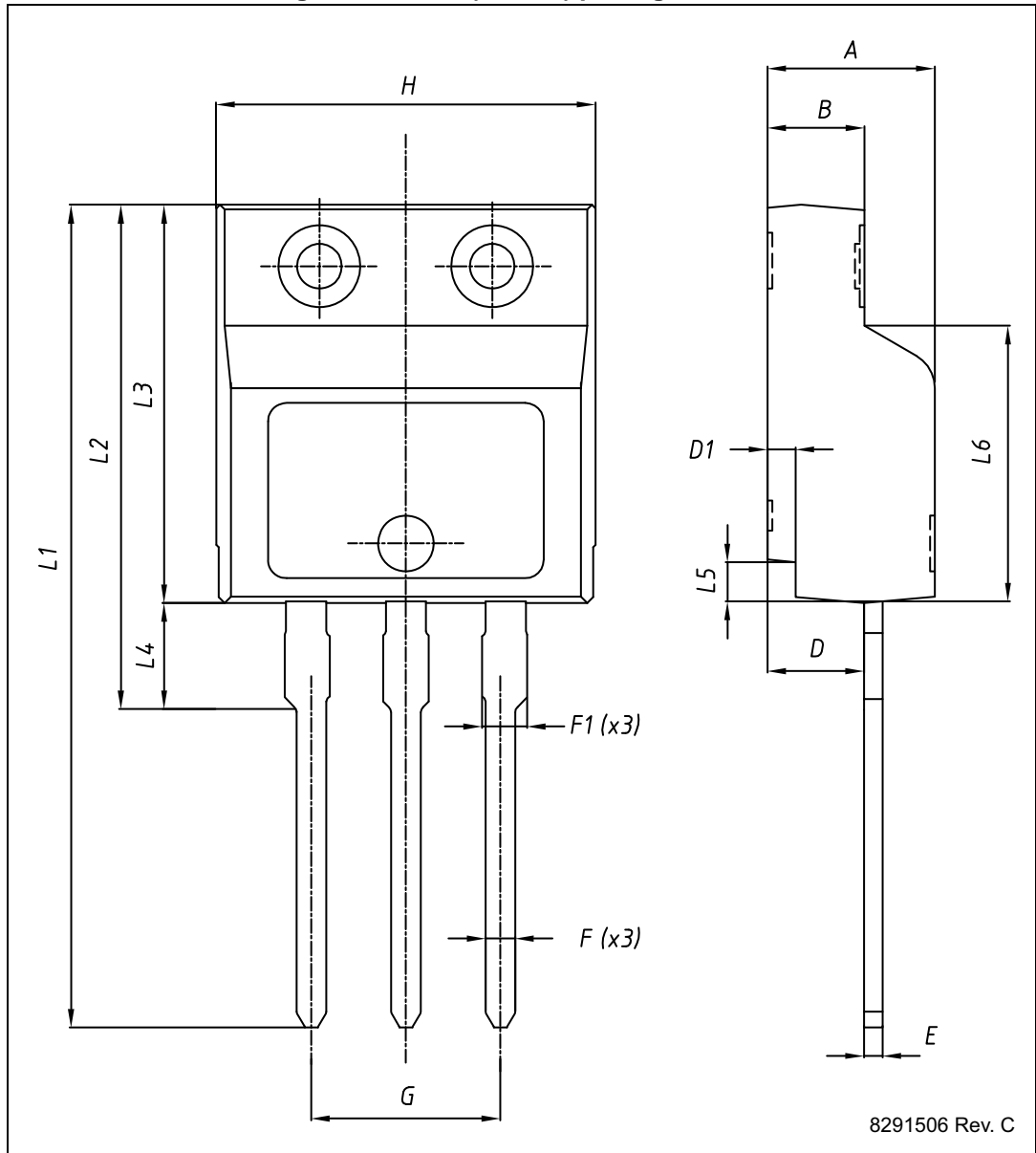
7012510_Rev_K_B

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 I²PAKFP (TO-281) package information

Figure 23. I²PAK(TO-281) package outline



8291506 Rev. C

Table 10. I²PAKFP (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 |

4.3 TO-3PF, package information

Figure 24. TO-3PF package outline

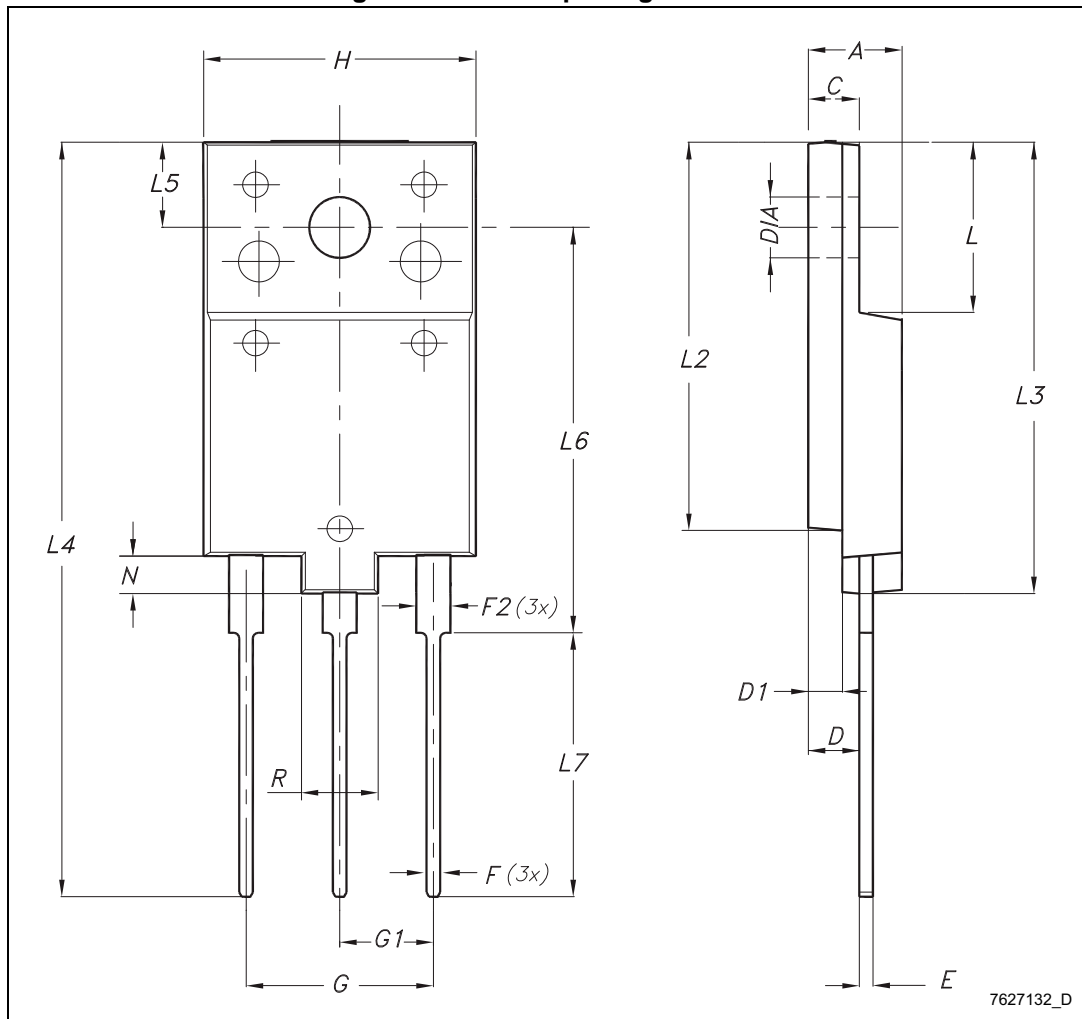


Table 11. TO-3PF package mechanical data

| 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 12. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 15-May-2014 | 1 | First release. Part numbers STF40N60M2 and STFI40N60M2 previously included in datasheet DocID024932. |
| 28-Sep-2016 | 2 | Updated title in cover page. Updated Table 2: Absolute maximum ratings , Table 5: On /off states , Table 6: Dynamic and Table 8: Source drain diode . Minor text changes. |

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