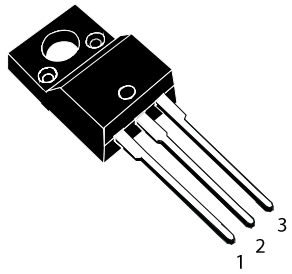
# STF13N60DM2

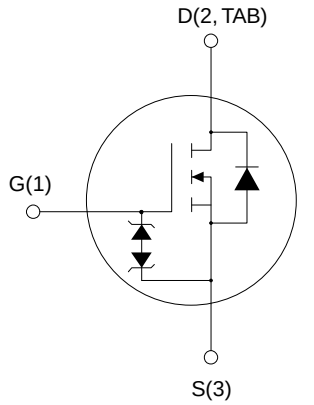
## N-channel 600 V, 0.310 Ω typ., 11 A MDmesh™ DM2 Power MOSFET in a TO-220FP package

Datasheet - production data




**TO-220FP**

**Figure 1: Internal schematic diagram**




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STF13N60DM2 | 600 V | 0.365 Ω | 11 A |

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

## Applications

- Switching applications

## Description

This high voltage N-channel Power MOSFET is part of the MDmesh™ DM2 fast recovery diode series. It offers very low recovery charge ($Q_{rr}$) and time ($t_{rr}$) combined with low $R_{DS(on)}$, rendering it suitable for the most demanding high efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

**Table 1: Device summary**

| Order code | Marking | Package | Packing |
|---|---|---|---|
| STF13N60DM2 | 13N60DM2 | TO-220FP | Tube |

# Contents

# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{GS}$ | Gate-source voltage | ±25 | V |
| $I_D$ | Drain current (continuous) at $T_{case}$ = 25 °C | 11(1) | A |
| | Drain current (continuous) at $T_{case}$ = 100 °C | 7(1) | |
| $I_{DM}$(2) | Drain current (pulsed) | 44(1) | A |
| $P_{TOT}$ | Total dissipation at $T_{case}$ = 25 °C | 25 | W |
| dv/dt (3) | Peak diode recovery voltage slope | 40 | V/ns |
| dv/dt(4) | MOSFET dv/dt ruggedness | 50 | |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; $T_C$ = 25 °C) | 2500 | V |
| $T_{stg}$ | Storage temperature range | -55 to 150 | °C |
| $T_j$ | Operating junction temperature range | | |

**Notes:**

(1)Limited by maximum junction temperature

(2)Pulse width limited by safe operating area.

(3)$I_{SD}$ ≤ 11 A, di/dt ≤ 900 A/µs; $V_{DS\ peak}$ < $V_{(BR)DSS}$, $V_{DD}$=400 V.

(4) $V_{DS}$ ≤ 480 V.

**Table 3: Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case | 5 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient | 62.5 | |

**Table 4: Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (Pulse width limited by $T_{jmax}$) | 2.5 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 340 | mJ |

# 2 Electrical characteristics

($T_{case}$ = 25 °C unless otherwise specified)

**Table 5: Static**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS}$ = 0 V, $I_D$ = 1 mA | 600 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V | | | 1.5 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V, $T_{case}$ = 125 °C (1) | | | 100 | |
| $I_{GSS}$ | Gate-body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±25 V | | | ±10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 5.5 A | | 0.310 | 0.365 | Ω |

**Notes:**

(1)Defined by design, not subject to production test.

**Table 6: Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$ = 100 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 730 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 38 | - | |
| $C_{rss}$ | Reverse transfer capacitance | | - | 0.9 | - | |
| $C_{oss\ eq.}$ (1) | Equivalent output capacitance | $V_{DS}$ = 0 to 480 V, $V_{GS}$ = 0 V | - | 70 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz, $I_D$= 0 A | - | 5.1 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 480 V, $I_D$ = 11 A, $V_{GS}$ = 10 V (see *Figure 15: "Test circuit for gate charge behavior"*) | - | 19 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 4.4 | - | |
| $Q_{gd}$ | Gate-drain charge | | - | 9.9 | - | |

**Notes:**

(1) $C_{oss\ eq.}$ 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 V, $I_D$ = 5.5 A $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 14: "Test circuit for resistive load switching times"* and *Figure 19: "Switching time waveform"*) | - | 12.3 | - | ns |
| $t_r$ | Rise time | | - | 4.8 | - | |
| $t_{d(off)}$ | Turn-off delay time | | - | 42.5 | - | |
| $t_f$ | Fall time | | - | 10.6 | - | |

**Table 8: Source-drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 11 | A |
| $I_{SDM}$(1) | Source-drain current (pulsed) | | - | | 44 | A |
| $V_{SD}$(2) | Forward on voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 11 A | - | | 1.6 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 11 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V (see *Figure 16: "Test circuit for inductive load switching and diode recovery times"*) | - | 90 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 252 | | nC |
| $I_{RRM}$ | Reverse recovery current | | - | 5.6 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 11 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V, $T_j$ = 150 °C (see *Figure 16: "Test circuit for inductive load switching and diode recovery times"*) | - | 170 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 667 | | nC |
| $I_{RRM}$ | Reverse recovery current | | - | 8.6 | | A |

**Notes:**

(1) Pulse width is limited by safe operating area.

(2) Pulse test: pulse duration = 300 µs, duty cycle 1.5%.

**Table 9: Gate-source Zener diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)GSO}$ | Gate-source breakdown voltage | $I_{GS}$ = ±250 µA, $I_D$ = 0 A | ±30 | - | - | V |

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics (curves)

**Figure 2: Safe operating area**

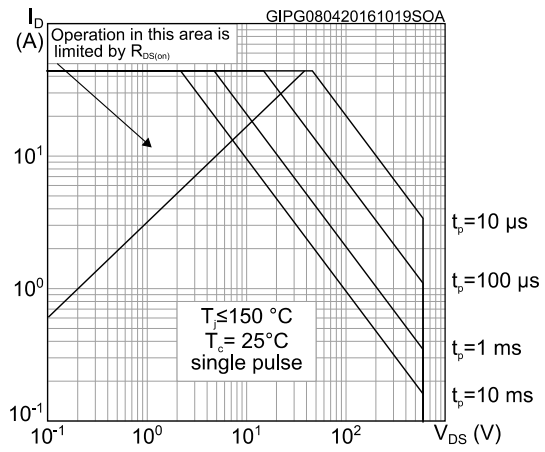



**Figure 3: Thermal impedance**

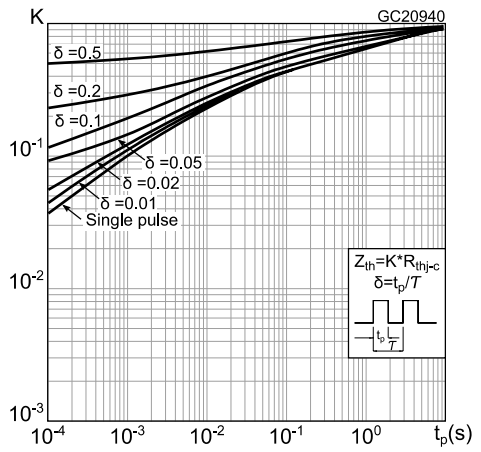



**Figure 4: Output characteristics**

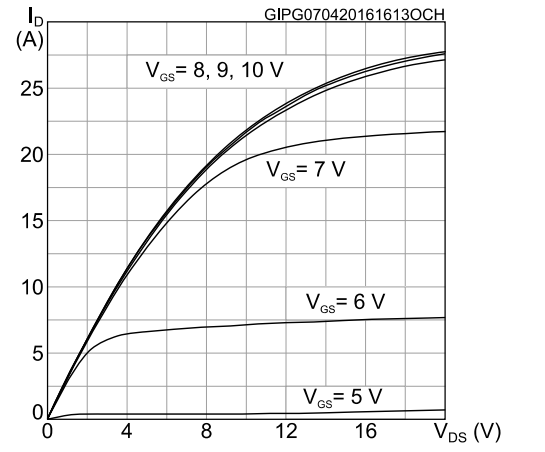



**Figure 5: Transfer characteristics**

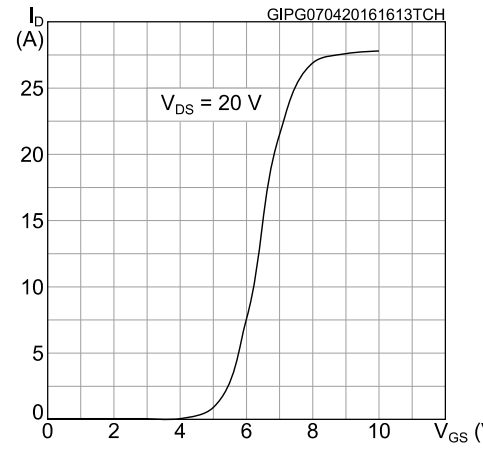



**Figure 6: Gate charge vs gate-source voltage**

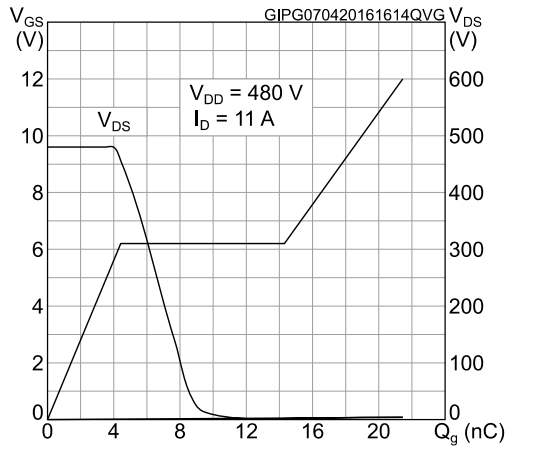



**Figure 7: Static drain-source on-resistance**

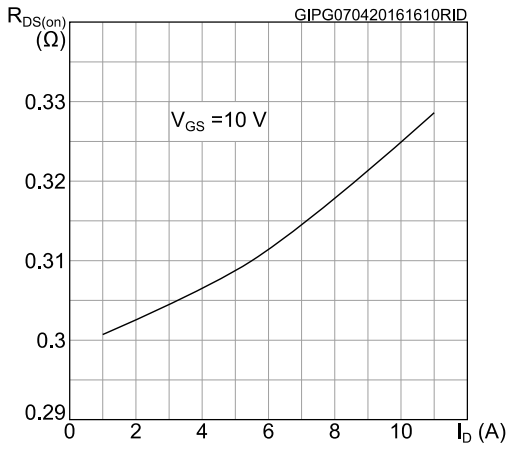


**Figure 8: Capacitance variations**

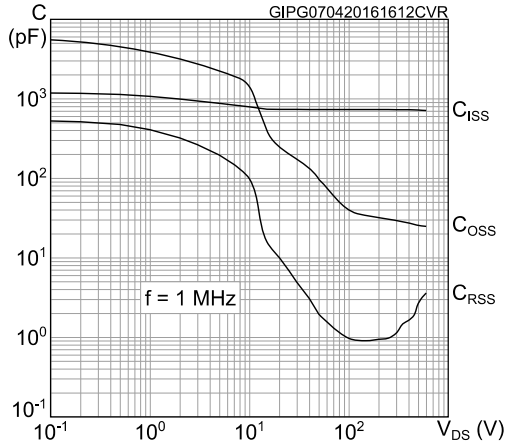



**Figure 9: Normalized gate threshold voltage vs temperature**

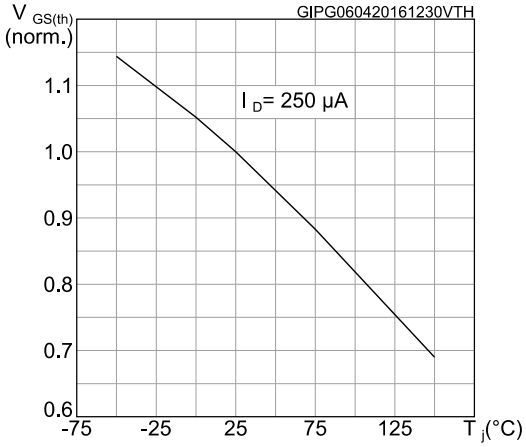



**Figure 10: Normalized on-resistance vs temperature**

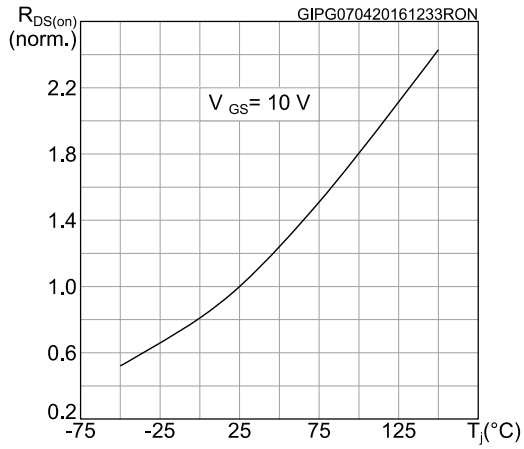



**Figure 11: Normalized V(BR)DSS vs temperature**

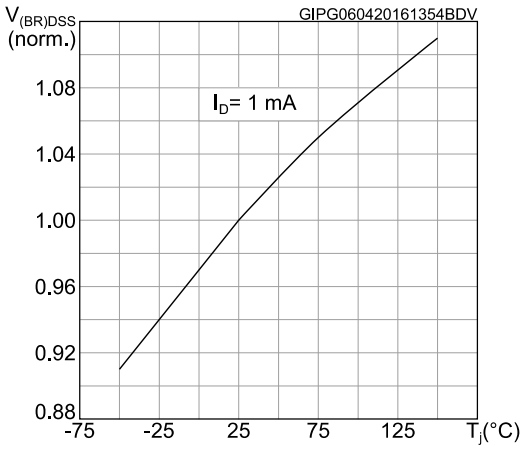



**Figure 12: Output capacitance stored energy**

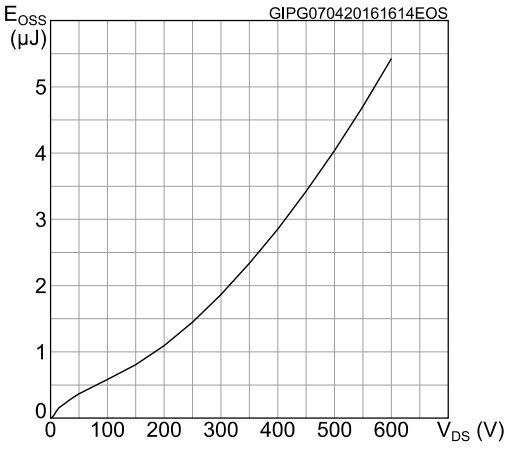
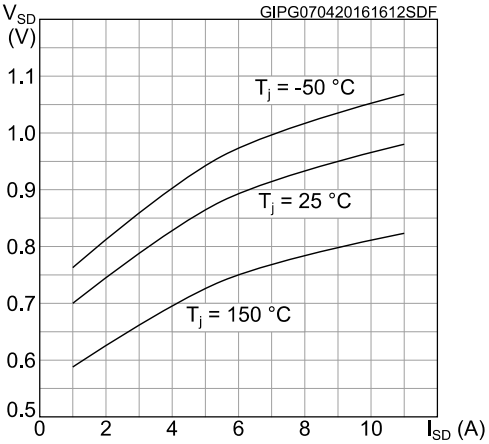



**Figure 13: Source- drain diode forward characteristics**



# 3 Test circuits

**Figure 14: Test circuit for resistive load switching times**

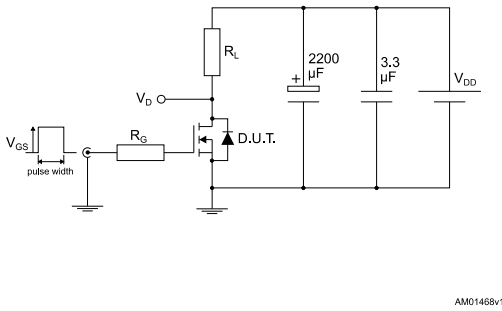



**Figure 15: Test circuit for gate charge behavior**

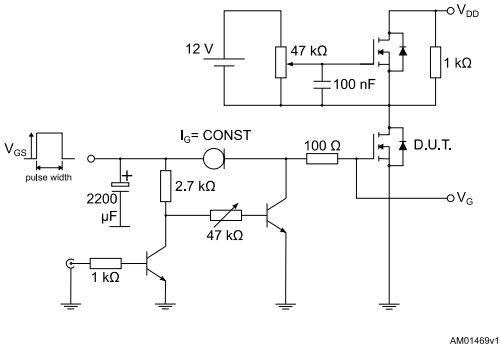



**Figure 16: Test circuit for inductive load switching and diode recovery times**

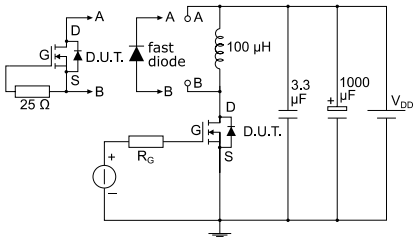



**Figure 17: Unclamped inductive load test circuit**

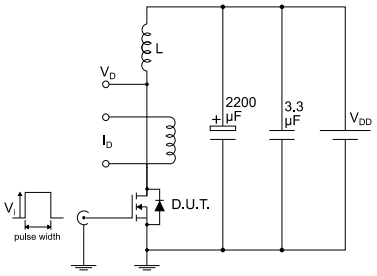



**Figure 18: Unclamped inductive waveform**

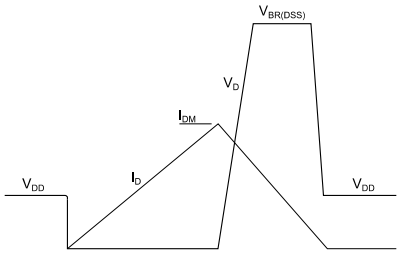
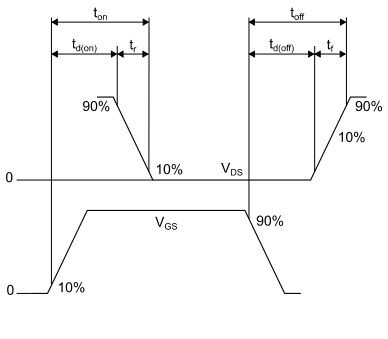



**Figure 19: Switching time waveform**



# 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 information

Figure 20: TO-220FP package outline

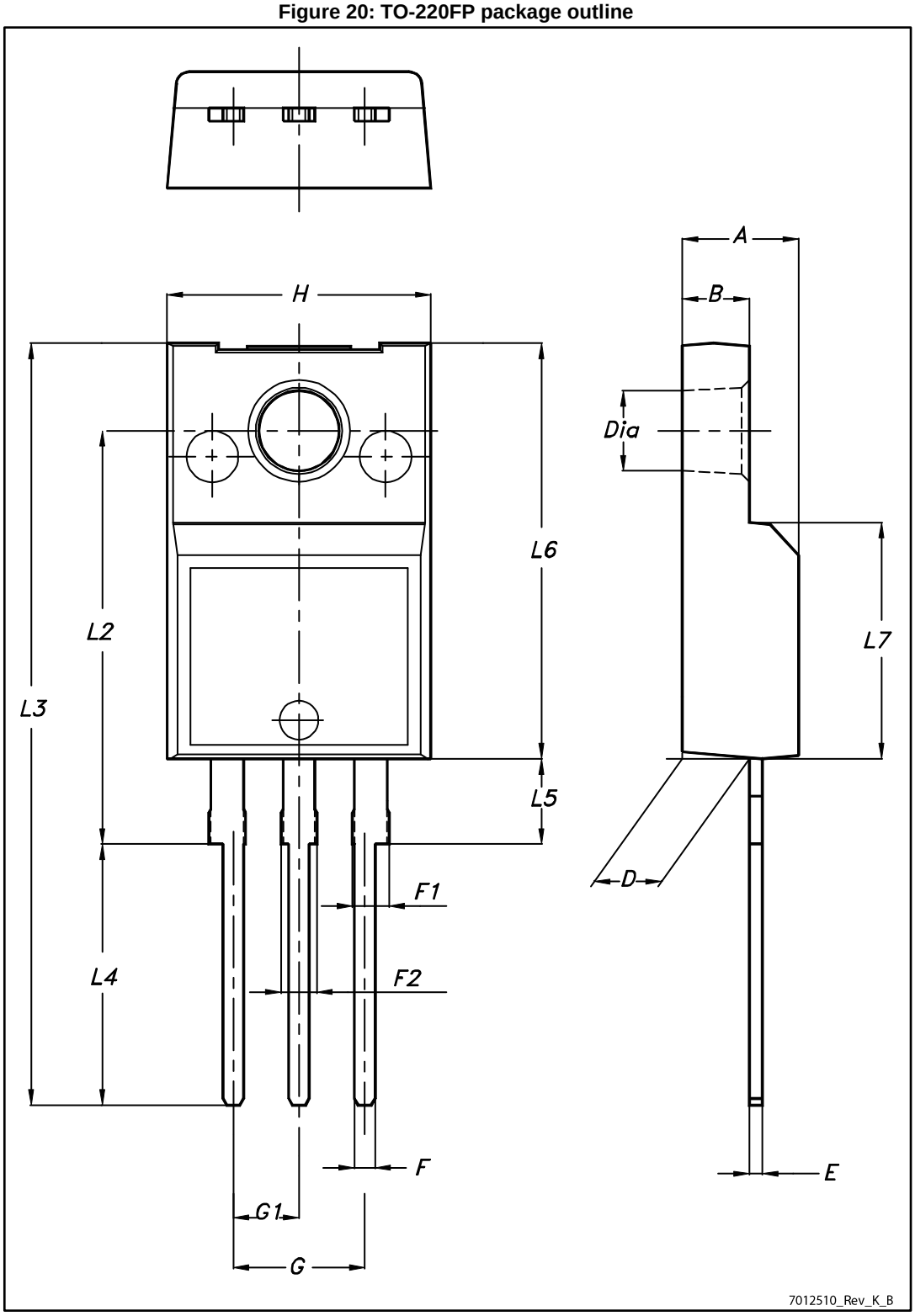


Table 10: TO-220FP package mechanical data

| 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 |

# 5 Revision history

Table 11: Document revision history

| Date | Revision | Changes |
|---|---|---|
| 08-Apr-2016 | 1 | First release. |
| 07-Dec-2016 | 2 | Document status promoted from preliminary to production data. |

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