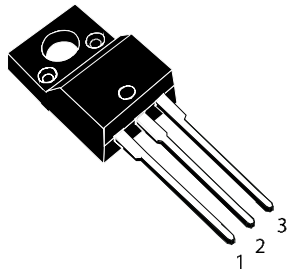
# STF23N80K5

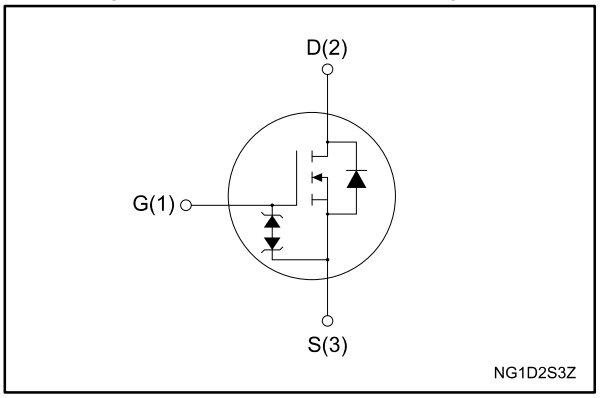
## N-channel 800 V, 0.23 Ω typ., 16 A MDmesh™ K5 Power MOSFET in a TO-220FP package

Datasheet - production data




**TO-220FP**

**Figure 1: Internal schematic diagram**




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ | $P_{TOT}$ |
|---|---|---|---|---|
| STF23N80K5 | 800 V | 0.28 Ω | 16 A | 35 W |

- Industry's lowest $R_{DS(on)}$ x area
- Industry's best figure of merit (FoM)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications

## Description

This very high voltage N-channel Power MOSFET is designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

**Table 1: Device summary**

| Order code | Marking | Package | Packing |
|---|---|---|---|
| STF23N80K5 | 23N80K5 | TO-220FP | Tube |

# Contents

# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{GS}$ | Gate-source voltage | ±30 | V |
| $I_D$ | Drain current (continuous) at $T_{case}$ = 25 °C | 16 | A |
| | Drain current (continuous) at $T_{case}$ = 100 °C | 10 | |
| $I_{DM}$(1) | Drain current (pulsed) | 64 | A |
| $P_{TOT}$ | Total dissipation at $T_{case}$ = 25 °C | 35 | W |
| dv/dt(2) | Peak diode recovery voltage slope | 4.5 | V/ns |
| dv/dt(3) | 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 | -55 to 150 | °C |
| $T_j$ | Operating junction temperature | | |

**Notes:**

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

(2) $I_{SD}$ ≤ 16 A, di/dt=100 A/µs; $V_{DS}$ peak < $V_{(BR)DSS}$, $V_{DD}$ = 80% $V_{(BR)DSS}$.

(3) $V_{DS}$ ≤ 640 V

**Table 3: Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case | 3.6 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient | 62.5 | |

**Table 4: Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$(1) | Avalanche current, repetitive or not repetitive | 5 | A |
| $E_{AS}$(2) | Single pulse avalanche energy | 400 | mJ |

**Notes:**

(1) Pulse width limited by $T_{jmax}$.

(2) starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V.

# 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 | 800 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 800 V | | | 1 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 800 V, $T_{case}$ = 125 °C | | | 50 | |
| $I_{GSS}$ | Gate-body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±20 V | | | ±10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 100 µA | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 8 A | | 0.23 | 0.28 | Ω |

**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 | - | 1000 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 65 | - | |
| $C_{rss}$ | Reverse transfer capacitance | | - | 1.5 | - | |
| $C_{O(tr)}$ (1) | Equivalent output capacitance | $V_{DS}$ = 0 to 640 V, $V_{GS}$ = 0 V | - | 165 | - | pF |
| $C_{O(er)}$ (2) | Equivalent output capacitance | $V_{DS}$ = 0 to 640 V, $V_{GS}$ = 0 V | - | 59 | - | |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz, $I_D$ = 0 A | - | 4.7 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 640 V, $I_D$ = 16 A, $V_{GS}$ = 10 V (see *Figure 14: "Test circuit for gate charge behavior"*) | - | 33 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 6 | - | |
| $Q_{gd}$ | Gate-drain charge | | - | 25 | - | |

**Notes:**

(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 |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 400 V, $I_D$ = 8 A $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see *Figure 13: "Test circuit for resistive load switching times"* and *Figure 18: "Switching time waveform"*) | - | 14 | - | ns |
| $t_r$ | Rise time | | - | 9 | - | |
| $t_{d(off)}$ | Turn-off delay time | | - | 48 | - | |
| $t_f$ | Fall time | | - | 9 | - | |

**Table 8: Source-drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 16 | A |
| $I_{SDM}$(1) | Source-drain current (pulsed) | | - | | 64 | A |
| $V_{SD}$(2) | Forward on voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 16 A | - | | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 16 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V (see *Figure 15: "Test circuit for inductive load switching and diode recovery times"*) | - | 410 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 7 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 34 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 16 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V, $T_j$ = 150 °C (see *Figure 15: "Test circuit for inductive load switching and diode recovery times"*) | - | 650 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 10 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 32 | | 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 | $I_{GS}$ = ±1 mA, $I_D$ = 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**

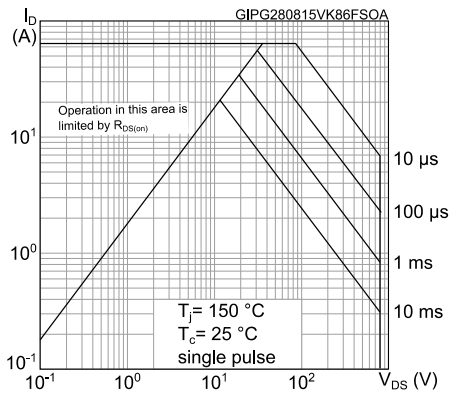



**Figure 3: Thermal impedance**

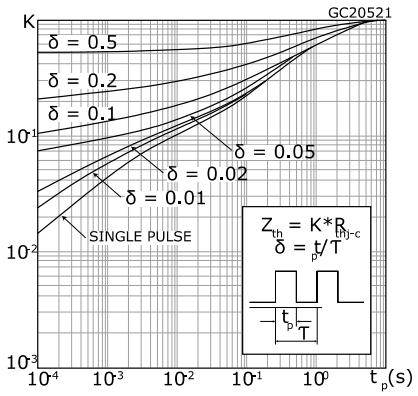



**Figure 4: Output characteristics**

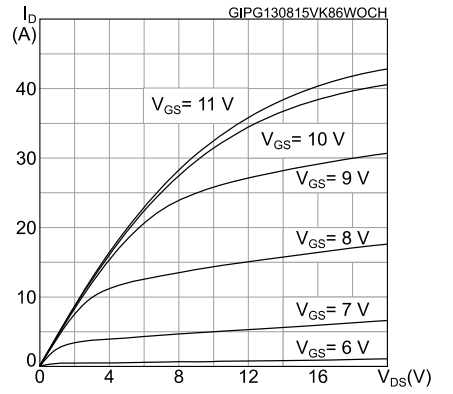



**Figure 5: Transfer characteristics**

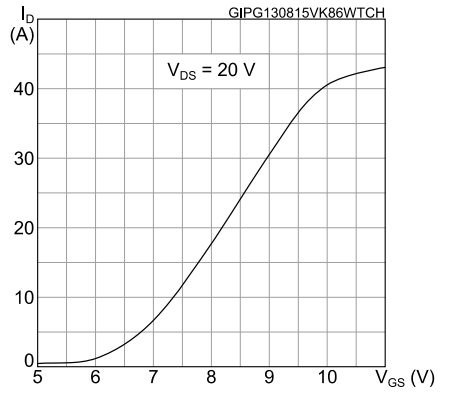



**Figure 6: Gate charge vs gate-source voltage**

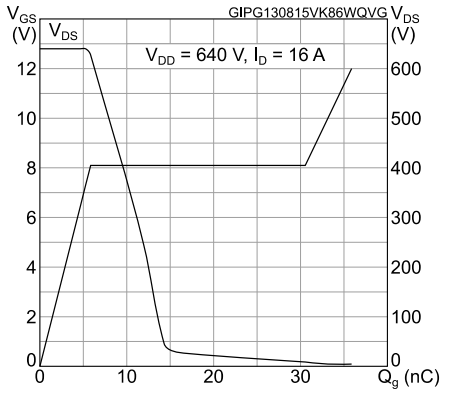



**Figure 7: Static drain-source on-resistance**

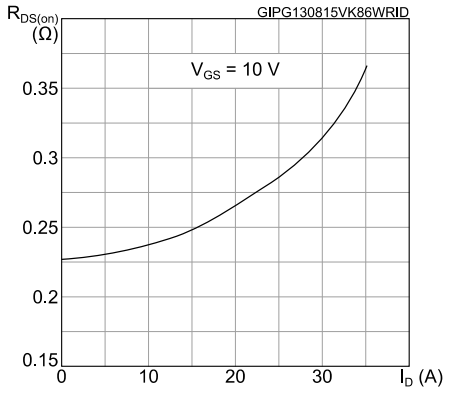


**Figure 8: Capacitance variations**

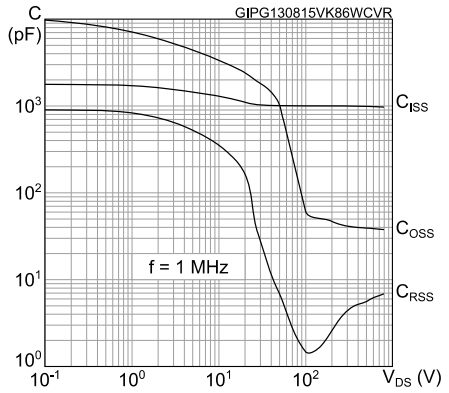



**Figure 9: Normalized gate threshold voltage vs temperature**

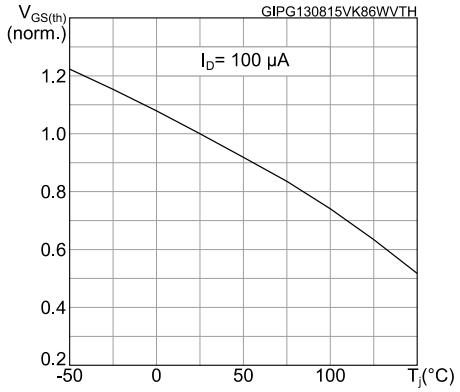



**Figure 10: Normalized on-resistance vs temperature**

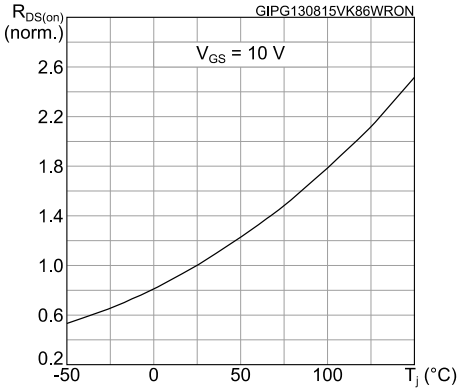



**Figure 11: Normalized V(BR)DSS vs temperature**

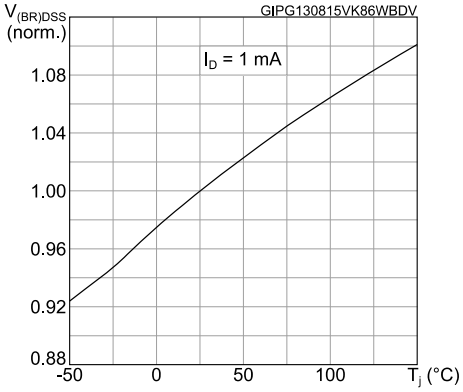
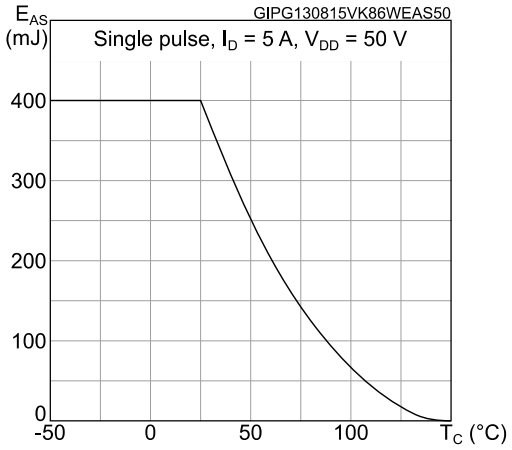



**Figure 12: Maximum avalanche energy vs temperature**



# 3 Test circuits

**Figure 13: Test circuit for resistive load switching times**

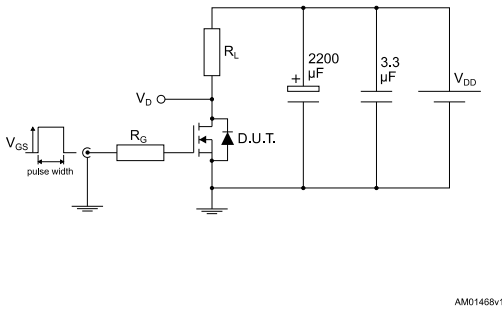



**Figure 14: Test circuit for gate charge behavior**

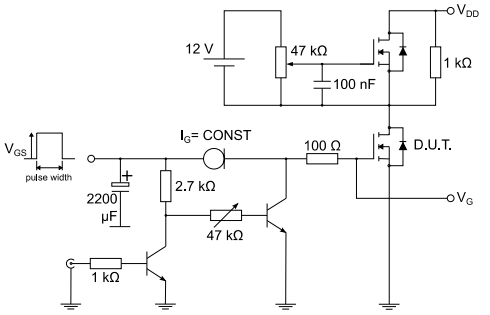



**Figure 15: Test circuit for inductive load switching and diode recovery times**

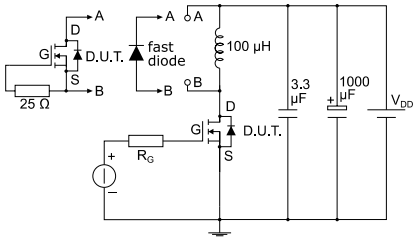



**Figure 16: Unclamped inductive load test circuit**

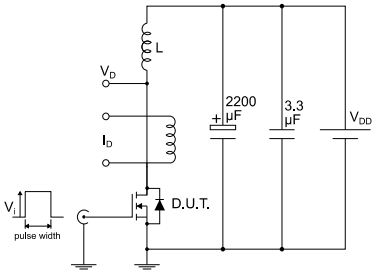



**Figure 17: Unclamped inductive waveform**

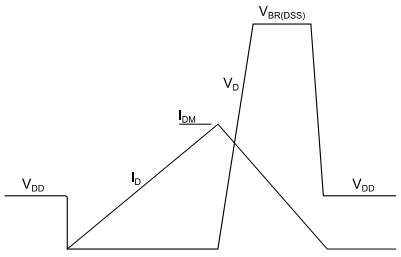
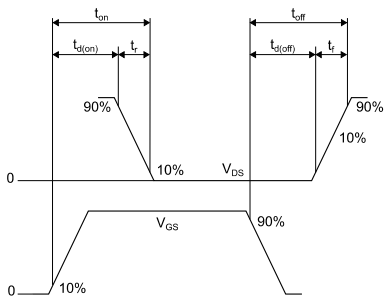



**Figure 18: Switching time waveform**



# 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 19: TO-220FP package outline

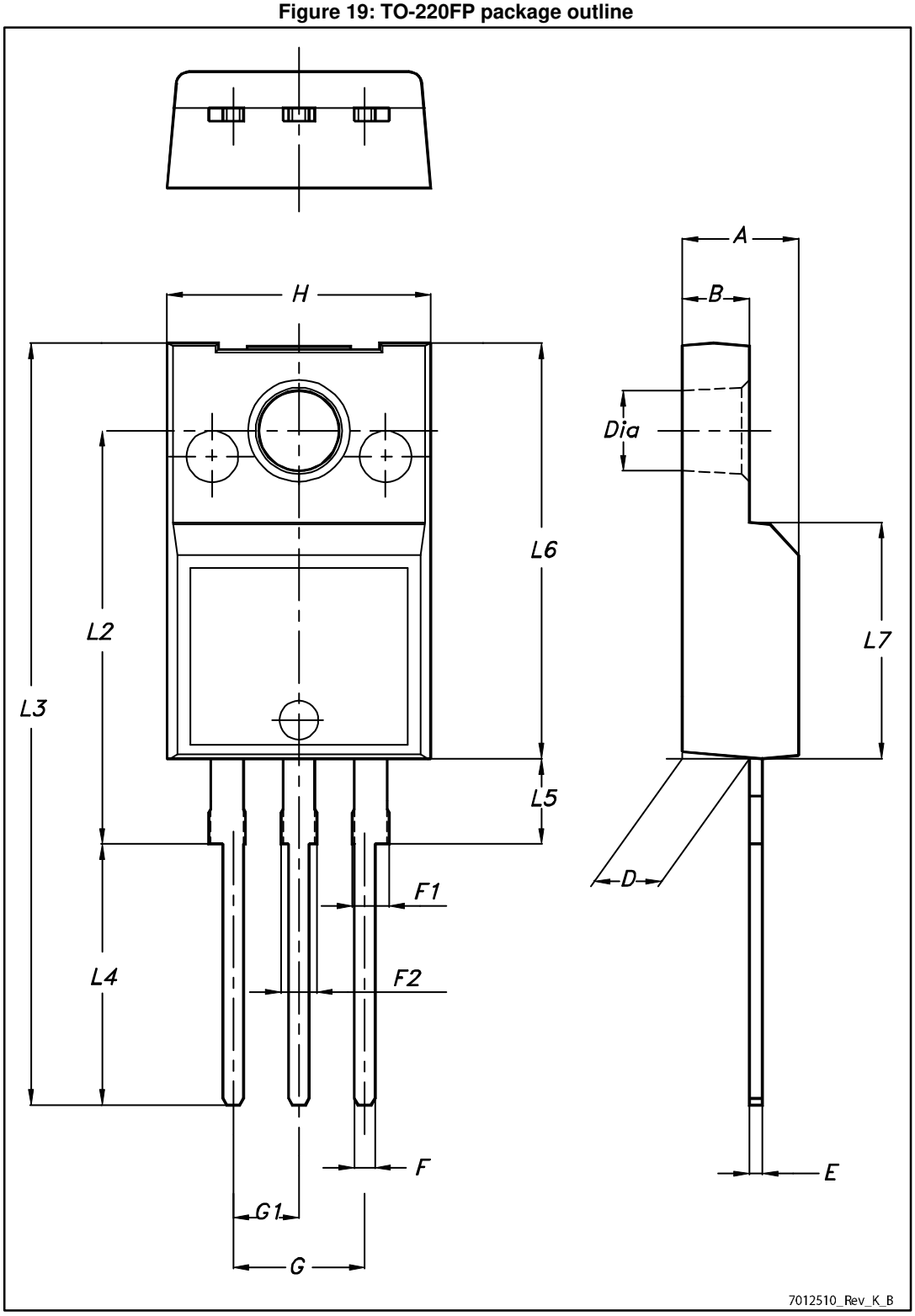


Table 10: TO-220FP package mechanical data

| 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 |
|---|---|---|
| 28-Aug-2015 | 1 | First release. |

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