

N-channel 900 V, 0.91 Ω typ., 6 A MDmesh™ K5 Power MOSFET in a TO-220FP package

Datasheet - production data

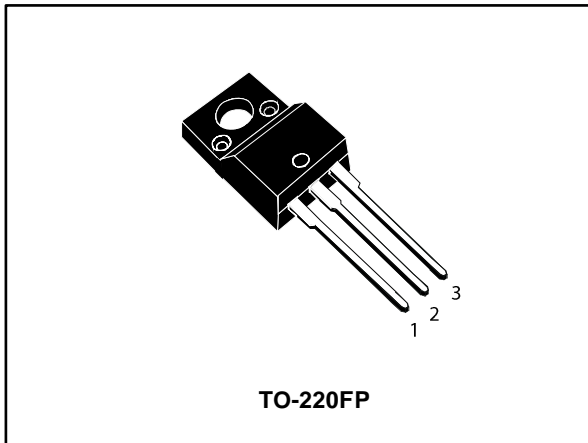
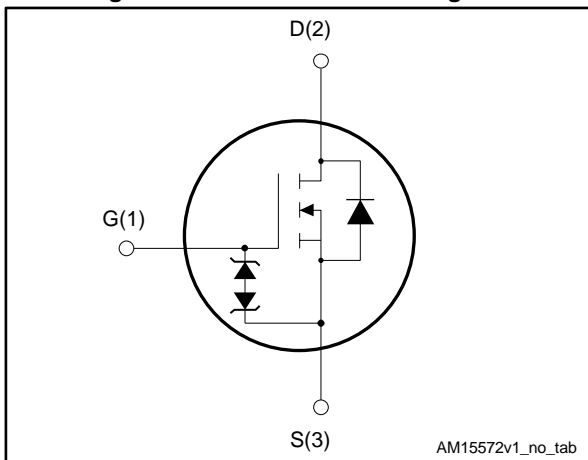


Figure 1: Internal schematic diagram



Features

| Order code | V _{DS} | R _{DS(on)} max. | I _D |
|------------|-----------------|--------------------------|----------------|
| STF6N90K5 | 900 V | 1.10 Ω | 6 A |

- Industry's lowest R_{DS(on)} x area
- Industry's best FoM (figure of merit)
- 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 |
|------------|---------|----------|---------|
| STF6N90K5 | 6N90K5 | TO-220FP | Tube |

Contents

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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 _C = 25 °C | 6 ⁽¹⁾ | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 4 ⁽¹⁾ | A |
| I _D ⁽²⁾ | Drain current (pulsed) | 24 | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 25 | W |
| dv/dt ⁽³⁾ | Peak diode recovery voltage slope | 4.5 | 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 _J | Operating junction temperature range | - 55 to 150 | °C |
| T _{stg} | Storage temperature range | | |

Notes:

(1)Limited by package

(2)Pulse width limited by safe operating area

(3)I_{SD} ≤ 6 A, di/dt ≤ 100 A/μs; V_{DS} peak < V_{(BR)DSS}, V_{DD} = 450 V.

(4)V_{DS} ≤ 720 V

Table 3: Thermal data

| Symbol | Parameter | Value | Unit |
|-----------------------|-------------------------------------|-------|------|
| R _{thj-case} | Thermal resistance junction-case | 5 | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient | 62.5 | °C/W |

Table 4: Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|-----------------|--|-------|------|
| I _{AR} | Avalanche current, repetitive or not repetitive (pulse width limited by T _{jmax}) | 2 | A |
| E _{AS} | Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V) | 210 | mJ |

2 Electrical characteristics

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

Table 5: On/off-state

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------------------|--|------|------|----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$ | 900 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}$, $V_{DS} = 900\text{ V}$ | | | 1 | μA |
| | | $V_{GS} = 0\text{ V}$, $V_{DS} = 900\text{ V}$ $T_C = 125\text{ °C}^{(1)}$ | | | 50 | μA |
| I_{GSS} | Gate body leakage current | $V_{DS} = 0\text{ V}$, $V_{GS} = \pm 20\text{ V}$ | | | ± 10 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DD} = V_{GS}$, $I_D = 100\text{ }\mu\text{A}$ | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$, $I_D = 3\text{ A}$ | | 0.91 | 1.10 | 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 | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$ | - | 342 | - | pF |
| C_{oss} | Output capacitance | | - | 31 | - | pF |
| C_{rss} | Reverse transfer capacitance | | - | 1.2 | - | pF |
| $C_{o(tr)}^{(1)}$ | Equivalent capacitance time related | $V_{DS} = 0\text{ to }720\text{ V}$, $V_{GS} = 0\text{ V}$ | - | 55 | - | pF |
| $C_{o(er)}^{(2)}$ | Equivalent capacitance energy related | | - | 20 | - | pF |
| R_g | Intrinsic gate resistance | $f = 1\text{ MHz}$, $I_D = 0\text{ A}$ | - | 6.4 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 720\text{ V}$, $I_D = 6\text{ A}$ $V_{GS} = 10\text{ V}$ (see Figure 15: "Test circuit for gate charge behavior") | - | 11 | - | nC |
| Q_{gs} | Gate-source charge | | - | 2.5 | - | nC |
| Q_{gd} | Gate-drain charge | | - | 7 | - | nC |

Notes:

⁽¹⁾ $C_{o(tr)}$ is a constant capacitance value that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⁽²⁾ $C_{o(er)}$ is a constant capacitance value that gives the same stored energy as C_{oss} while V_{DS} is rising 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 | $V_{DD} = 450\text{ V}$, $I_D = 3\text{ A}$, $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$ (see Figure 14: "Test circuit for resistive load switching times" and Figure 19: "Switching time waveform") | - | 12.4 | - | ns |
| t_r | Rise time | | - | 12.2 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 30.4 | - | ns |
| t_f | Fall time | | - | 15.5 | - | ns |

Table 8: Source-drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 6 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 24 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 6\text{ A}$, $V_{GS} = 0\text{ V}$ | - | | 1.5 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 6\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 16: "Test circuit for inductive load switching and diode recovery times") | - | 342 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 3.13 | | μC |
| I_{RRM} | Reverse recovery current | | - | 18.3 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 6\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 16: "Test circuit for inductive load switching and diode recovery times") | - | 536 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 4.42 | | μC |
| I_{RRM} | Reverse recovery current | | - | 16.5 | | A |

Notes:

(1)Pulse width limited by safe operating area

(2)Pulsed: 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 | $I_{GS} = \pm 1\text{ mA}$, $I_D = 0\text{ A}$ | 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)

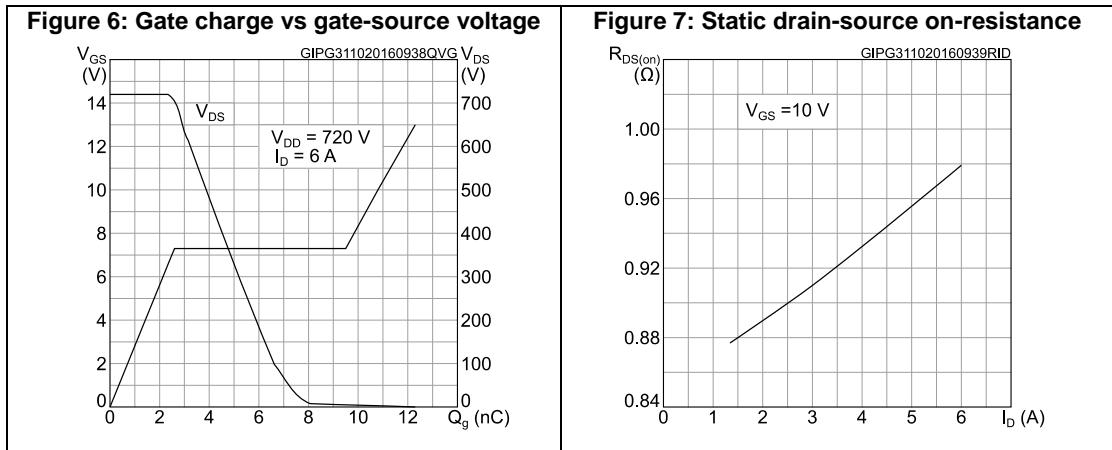
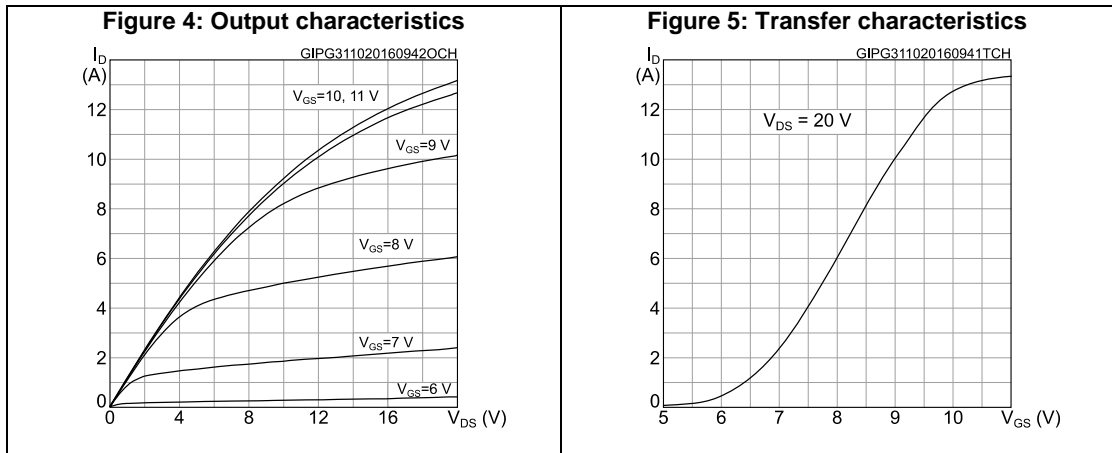
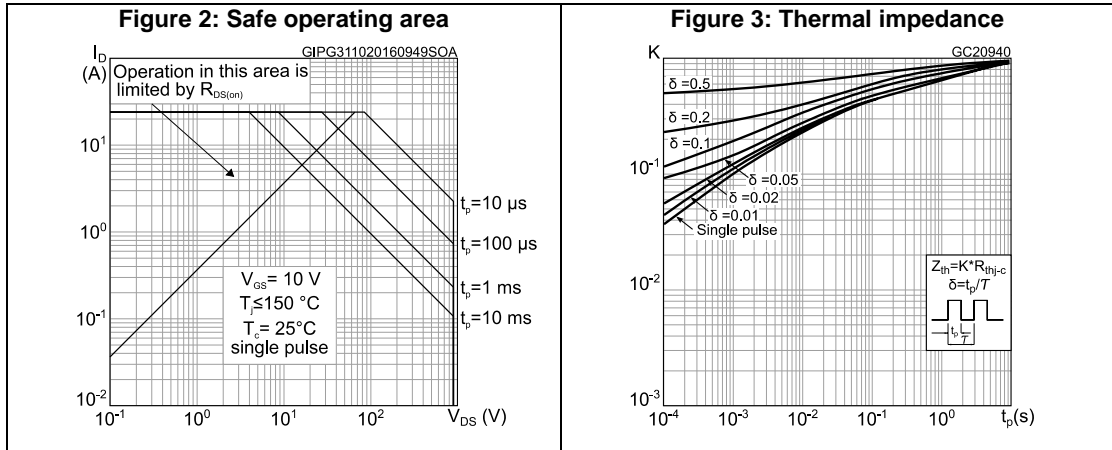


Figure 8: Capacitance variations

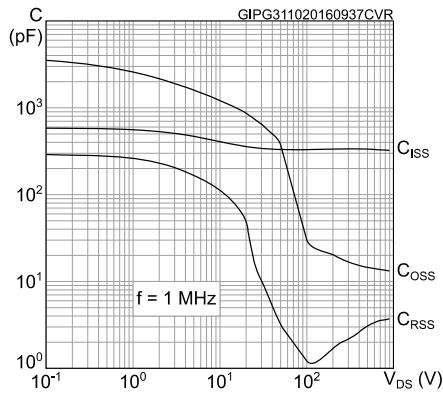


Figure 9: Normalized gate threshold voltage vs temperature

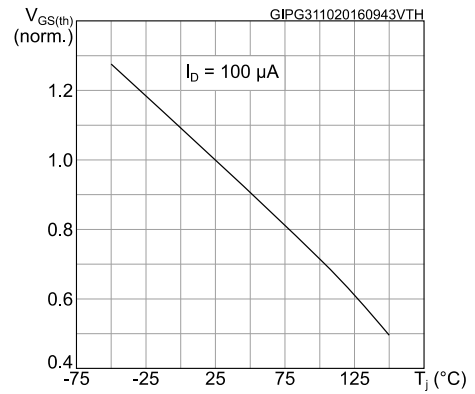


Figure 10: Normalized on-resistance vs temperature

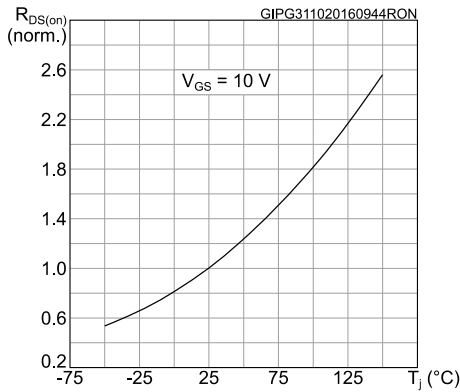


Figure 11: Normalized V_(BR)DSS vs temperature

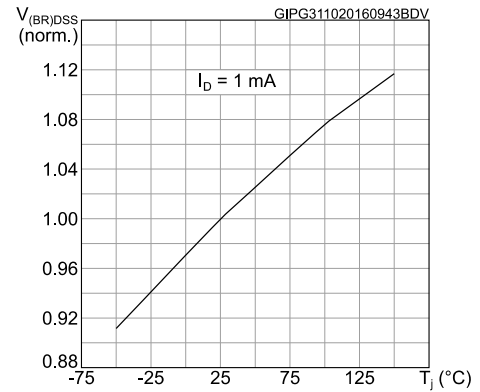


Figure 12: Maximum avalanche energy vs starting T_J

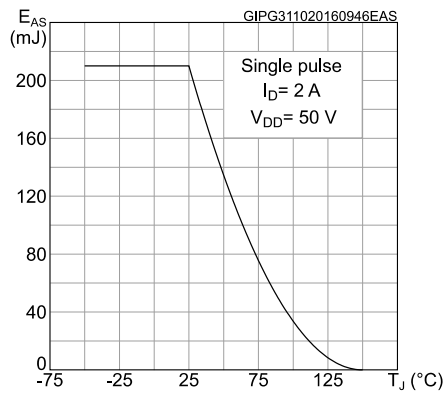
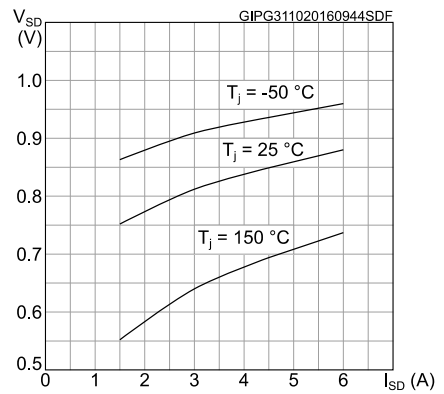
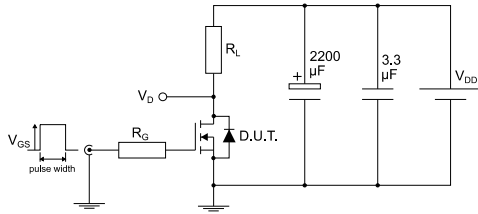


Figure 13: Source-drain diode forward characteristics



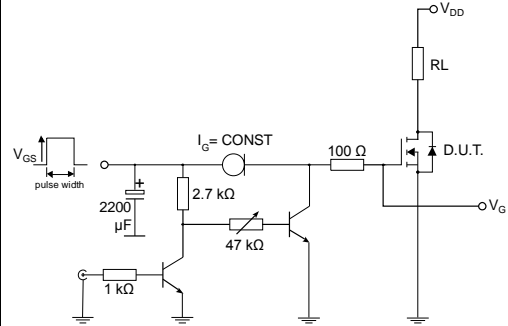
3 Test circuits

Figure 14: Test circuit for resistive load switching times



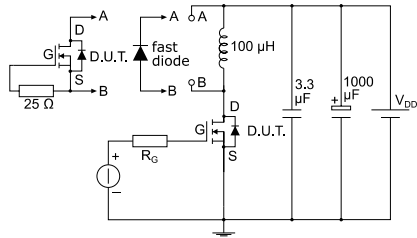
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Figure 15: Test circuit for gate charge behavior



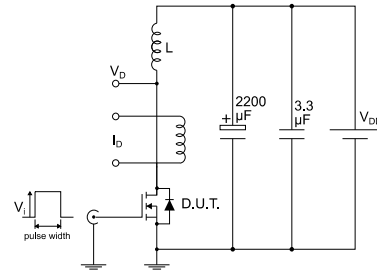
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Figure 16: Test circuit for inductive load switching and diode recovery times



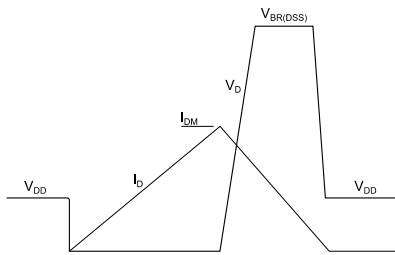
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Figure 17: Unclamped inductive load test circuit



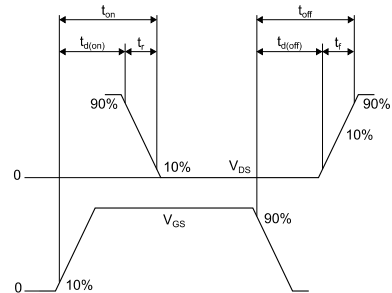
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Figure 18: Unclamped inductive waveform



AM01472v1

Figure 19: Switching time waveform



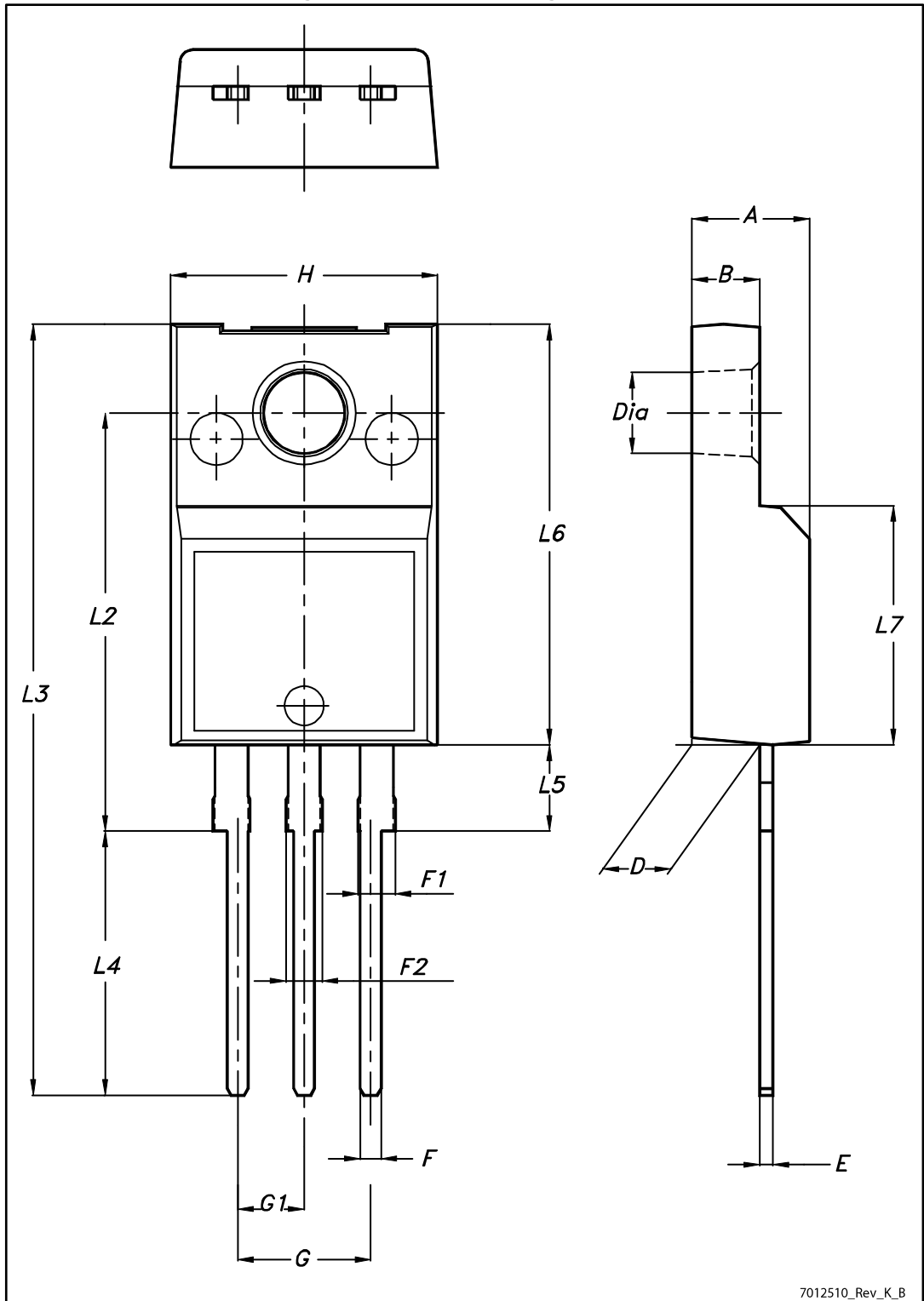
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4 Package information

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



7012510_Rev_K_B

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 |
|-------------|----------|----------------|
| 02-Nov-2016 | 1 | First release. |

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