

N-channel 600 V, 0.094 Ω typ., 28 A MDmesh™ DM2 Power MOSFET in a TO-220FP package

Datasheet - production data

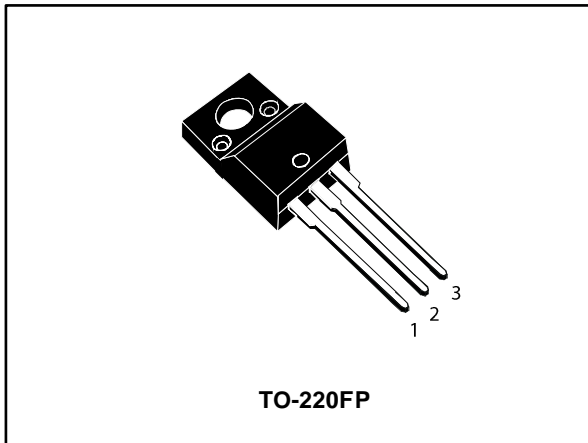
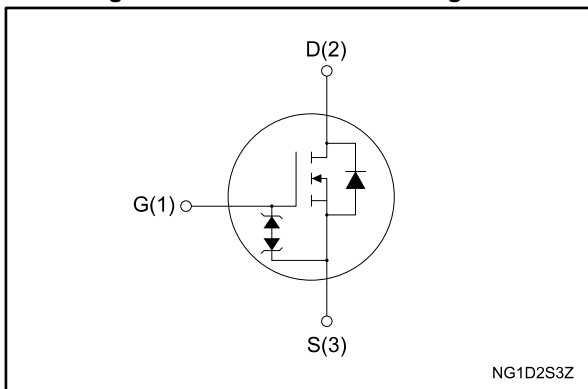


Figure 1: Internal schematic diagram



Features

| Order code | V _{DS} | R _{DS(on)} max. | I _D | P _{TOT} |
|-------------|-----------------|--------------------------|----------------|------------------|
| STF35N60DM2 | 600 V | 0.110 Ω | 28 A | 40 W |

- 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 |
|-------------|----------|----------|---------|
| STF35N60DM2 | 35N60DM2 | 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 | ± 25 | V |
| $I_D^{(1)}$ | Drain current (continuous) at $T_{case} = 25\text{ }^\circ\text{C}$ | 28 | A |
| | Drain current (continuous) at $T_{case} = 100\text{ }^\circ\text{C}$ | 17 | |
| $I_{DM}^{(2)}$ | Drain current (pulsed) | 112 | A |
| P_{TOT} | Total dissipation at $T_{case} = 25\text{ }^\circ\text{C}$ | 40 | W |
| $dv/dt^{(3)}$ | Peak diode recovery voltage slope | 50 | V/ns |
| $dv/dt^{(4)}$ | MOSFET dv/dt ruggedness | 50 | |
| V_{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink ($t = 1\text{ s}$; $T_c = 25\text{ }^\circ\text{C}$) | 2.5 | kV |
| T_{stg} | Storage temperature | -55 to 150 | $^\circ\text{C}$ |
| T_j | Operating junction temperature | | |

Notes:

- (1) Limited by maximum junction temperature.
 (2) Pulse width is limited by safe operating area.
 (3) $I_{SD} \leq 28\text{ A}$, $di/dt=900\text{ A}/\mu\text{s}$; $V_{DS\text{ peak}} < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$
 (4) $V_{DS} \leq 480\text{ V}$.

Table 3: Thermal data

| Symbol | Parameter | Value | Unit |
|----------------|----------------------------------|-------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case | 3.1 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-amb | 62.5 | |

Table 4: Avalanche characteristics

| Symbol | Parameter | Value | Unit |
|----------------|---|-------|------|
| I_{AR} | Avalanche current, repetitive or not repetitive | 6 | A |
| $E_{AS}^{(1)}$ | Single pulse avalanche energy | 650 | mJ |

Notes:

- (1) starting $T_j = 25\text{ }^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$.

2 Electrical characteristics

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

Table 5: Static

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|-----------------------------------|--|------|-------|---------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$ | 600 | | | V |
| I_{DSS} | Zero gate voltage drain current | $V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$ | | | 10 | μA |
| | | $V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$, $T_{\text{case}} = 125\text{ °C}$ | | | 100 | |
| I_{GSS} | Gate-body leakage current | $V_{DS} = 0\text{ V}$, $V_{GS} = \pm 25\text{ V}$ | | | ± 5 | μA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$ | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS} = 10\text{ V}$, $I_D = 14\text{ A}$ | | 0.094 | 0.11 | Ω |

Table 6: Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------------------|--|------|------|------|---------------|
| C_{iss} | Input capacitance | $V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$ | - | 2400 | - | μF |
| C_{oss} | Output capacitance | | - | 110 | - | |
| C_{rss} | Reverse transfer capacitance | | - | 2.8 | - | |
| $C_{oss\text{ eq.}}^{(1)}$ | Equivalent output capacitance | $V_{DS} = 0\text{ to }480\text{ V}$, $V_{GS} = 0\text{ V}$ | - | 190 | - | μF |
| R_G | Intrinsic gate resistance | $f = 1\text{ MHz}$, $I_D = 0\text{ A}$ | - | 4.3 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 480\text{ V}$, $I_D = 28\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 15: "Test circuit for gate charge behavior") | - | 54 | - | nC |
| Q_{gs} | Gate-source charge | | - | 14.6 | - | |
| Q_{gd} | Gate-drain charge | | - | 24.2 | - | |

Notes:

⁽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 | $V_{DD} = 300\text{ V}$, $I_D = 14\text{ A}$ $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 14: "Test circuit for resistive load switching times" and Figure 19: "Switching time waveform") | - | 21.2 | - | ns |
| t_r | Rise time | | - | 17 | - | |
| $t_{d(off)}$ | Turn-off delay time | | - | 68 | - | |
| t_f | Fall time | | - | 10.7 | - | |

Table 8: Source-drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|--|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 28 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | - | | 112 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $V_{GS} = 0\text{ V}$, $I_{SD} = 28\text{ A}$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 28\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 16: "Test circuit for inductive load switching and diode recovery times") | - | 120 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 572 | | nC |
| I_{RRM} | Reverse recovery current | | - | 10.2 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 28\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 16: "Test circuit for inductive load switching and diode recovery times") | - | 215 | | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.89 | | μC |
| I_{RRM} | Reverse recovery current | | - | 17.7 | | 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 | $I_{GS} = \pm 250\ \mu\text{A}$, $I_D = 0\text{ A}$ | ± 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)

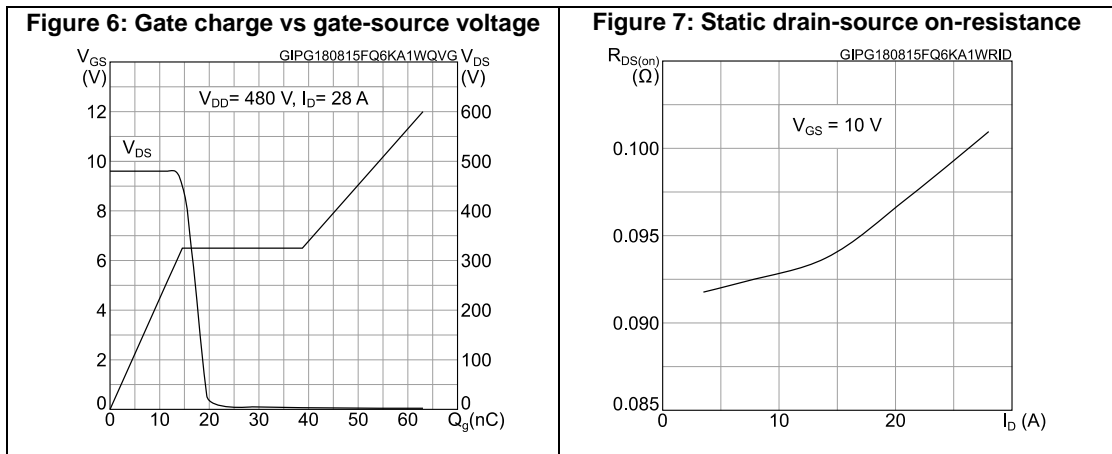
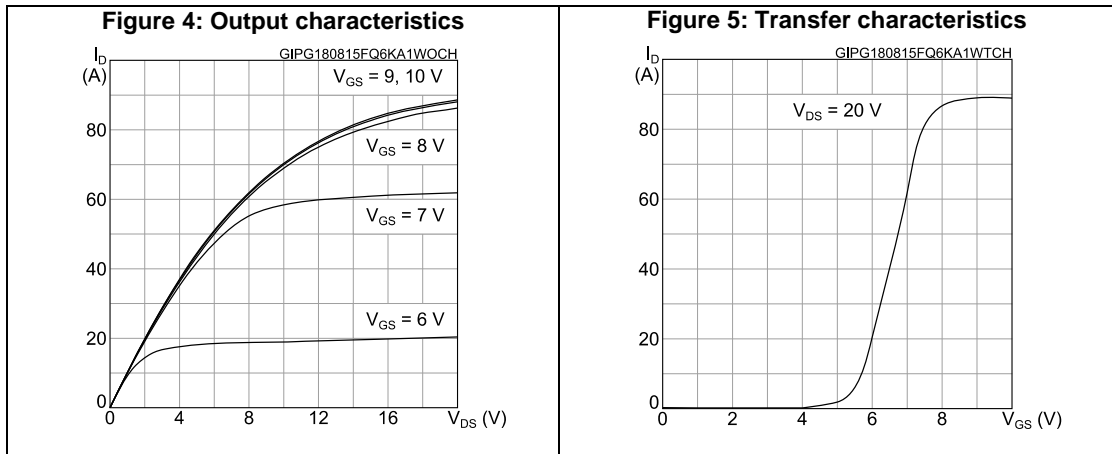
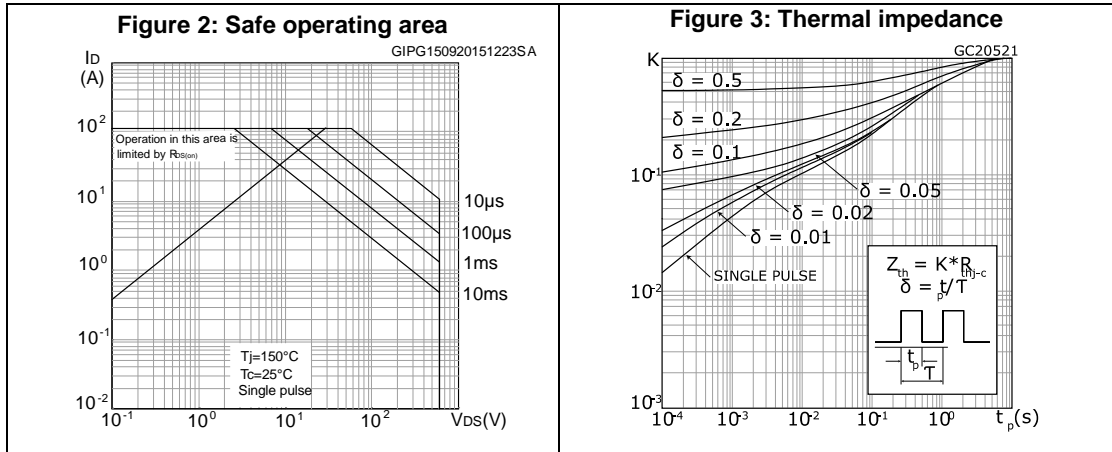


Figure 8: Capacitance variations

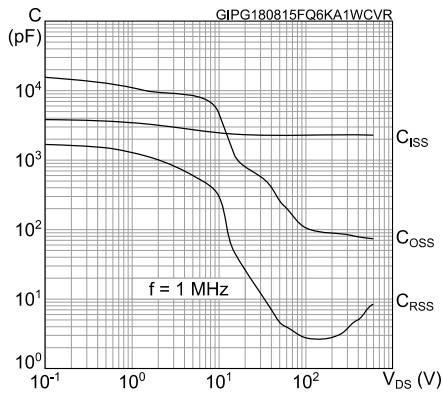


Figure 9: Normalized gate threshold voltage vs temperature

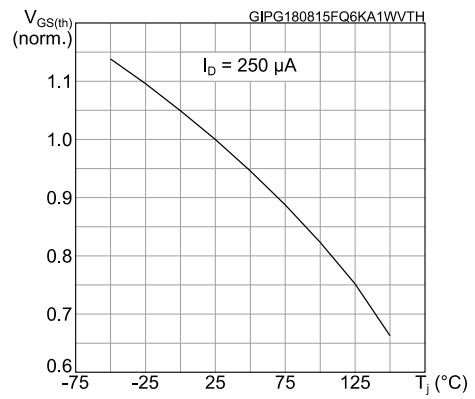


Figure 10: Normalized on-resistance vs temperature

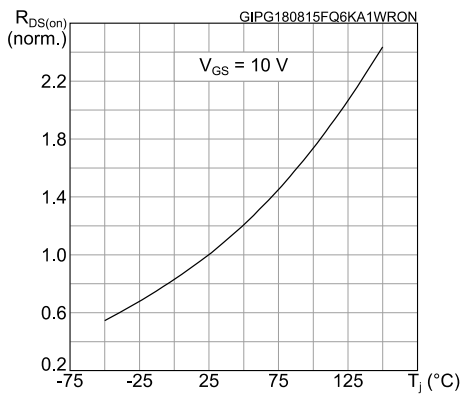


Figure 11: Normalized V(BR)DSS vs temperature

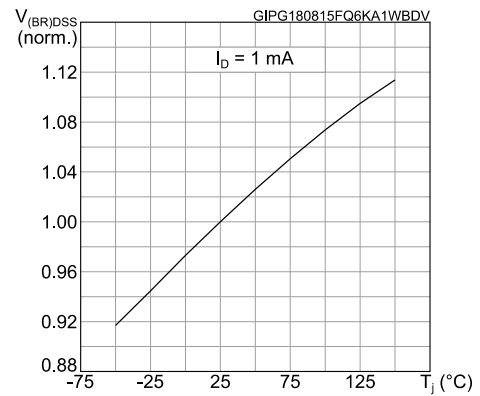


Figure 12: Output capacitance stored energy

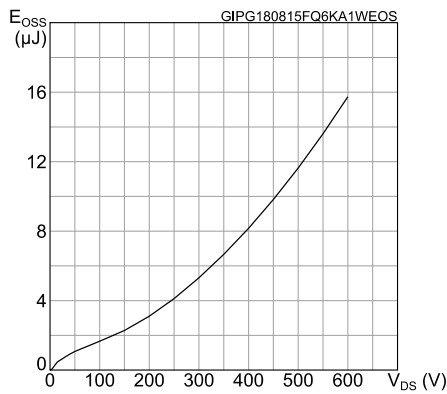
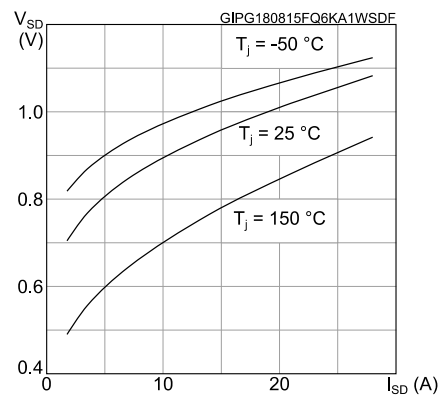


Figure 13: Source-drain diode forward characteristics



3 Test circuits

Figure 14: Test circuit for resistive load switching times



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Figure 15: Test circuit for gate charge behavior



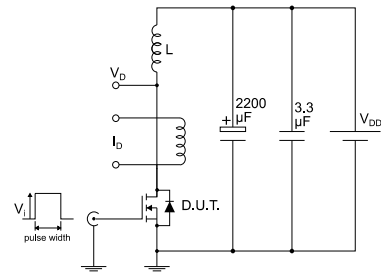
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Figure 16: Test circuit for inductive load switching and diode recovery times



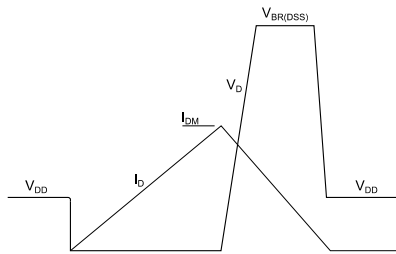
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Figure 17: Unclamped inductive load test circuit



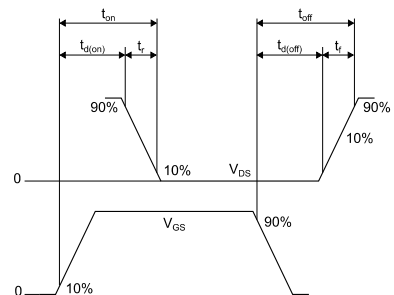
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Figure 18: Unclamped inductive waveform



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Figure 19: Switching time waveform



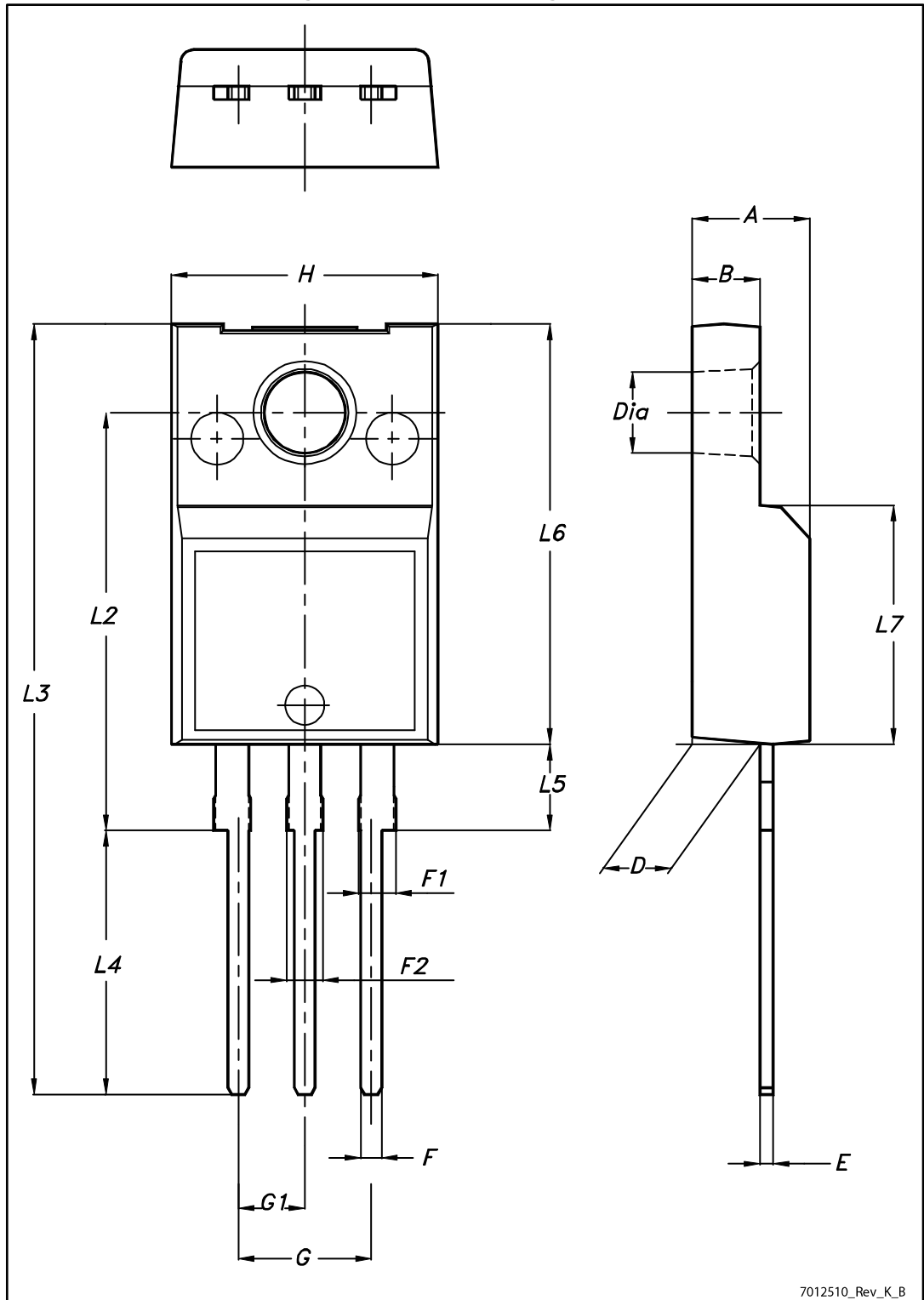
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4 Package information

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 |
|-------------|----------|-----------------|
| 15-Sep-2015 | 1 | Initial version |

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