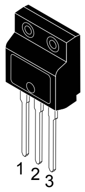
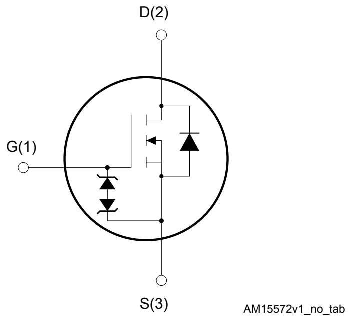
**STFI11N60M2-EP**

Datasheet

# N-channel 600 V, 0.550 Ω typ., 7.5 A MDmesh™ M2 EP Power MOSFET in an I²PAKFP package




I²PAKFP
(TO-281)




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STFI11N60M2-EP | 600 V | 0.595 Ω | 7.5 A |

- Extremely low gate charge
- Excellent output capacitance ($C_{OSS}$) profile
- Very low turn-off switching losses
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications

## Description

This device is an N-channel Power MOSFET developed using MDmesh™ M2 enhanced performance (EP) technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance, optimized switching characteristics with very low turn-off switching losses, rendering it suitable for the most demanding very high frequency converters.

| Product status |
|---|
| STFI11N60M2-EP |

| Product summary | |
|---|---|
| **Order code** | STFI11N60M2-EP |
| **Marking** | 11N60M2EP |
| **Package** | I²PAKFP (TO-281) |
| **Packing** | Tube |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{GS}$ | Gate-source voltage | ±25 | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 7.5 | A |
| | Drain current (continuous) at $T_C$ = 100 °C | 4.7 | A |
| $I_{DM}$ (1) | Drain current (pulsed) | 30 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 25 | W |
| dv/dt (2) | Peak diode recovery voltage slope | 15 | V/ns |
| dv/dt (3) | 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) | 2.5 | kV |
| $T_{stg}$ | Storage temperature range | -55 to 150 | °C |
| $T_j$ | Operating junction temperature range | | |

1. *Pulse width limited by safe operating area.*
2. *$I_{SD}$ ≤ 7.5 A, di/dt ≤ 400 A/μs, $V_{DS\ peak}$ < $V_{(BR)DSS}$, $V_{DD}$ = 400 V*
3. *$V_{DS}$ ≤ 480 V*

**Table 2. 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 3. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$) | 2.4 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 115 | mJ |

# 2 Electrical characteristics

$T_C$ = 25 °C unless otherwise specified

**Table 4. On/off states**

| 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 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V, $T_C$ = 125 °C (1) | | | 100 | µA |
| $I_{GSS}$ | 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 | 3.25 | 4 | 4.75 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 3.75 A | | 0.550 | 0.595 | Ω |

1. *Defined by design, not subject to production test.*

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$= 100 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 390 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 22 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 0.7 | - | pF |
| $C_{oss\ eq.}$ (1) | Equivalent output capacitance | $V_{DS}$ = 0 to 480 V, $V_{GS}$ = 0 V | - | 49 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz, $I_D$ = 0 A | - | 9 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 480 V, $I_D$ = 7.5 A, $V_{GS}$ = 0 to 10 V (see Figure 15. Test circuit for gate charge behavior) | - | 12.4 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 2.1 | - | nC |
| $Q_{gd}$ | Gate-drain charge | | - | 6 | - | nC |

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 6. Switching energy**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $E_{(off)}$ | Turn-off energy (from 90% $V_{GS}$ to 0% $I_D$) | $V_{DD}$ = 400 V, $I_D$ = 1 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V | - | 2.5 | - | µJ |
| | | $V_{DD}$ = 400 V, $I_D$ = 3 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V | - | 9 | - | µJ |

**Table 7. Switching times**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 300 V, $I_D$ = 3.75 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) | - | 9 | - | ns |
| $t_r$ | Rise time | | - | 5.5 | - | ns |
| $t_{d(off)}$ | Turn-off-delay time | | - | 26 | - | ns |
| $t_f$ | Fall time | | - | 8 | - | ns |

**Table 8. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 7.5 | A |
| $I_{SDM}$ (1) | Source-drain current (pulsed) | | - | | 30 | A |
| $V_{SD}$ (2) | Forward on voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 7.5 A | - | | 1.6 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 7.5 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V (see Figure 16. Test circuit for inductive load switching and diode recovery times) | - | 192 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 1.32 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 13.8 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 7.5 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) | - | 262 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 1.74 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 13.3 | | A |

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

## 2.1 Electrical characteristics curves

**Figure 1. Safe operating area**

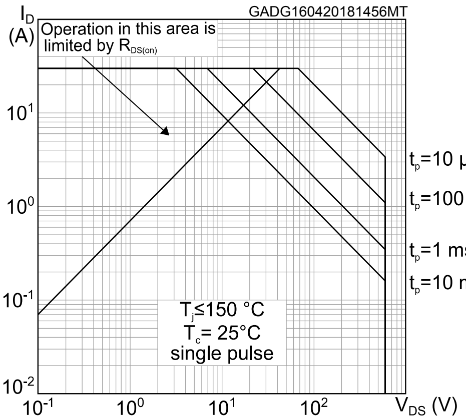



**Figure 2. Thermal impedance**

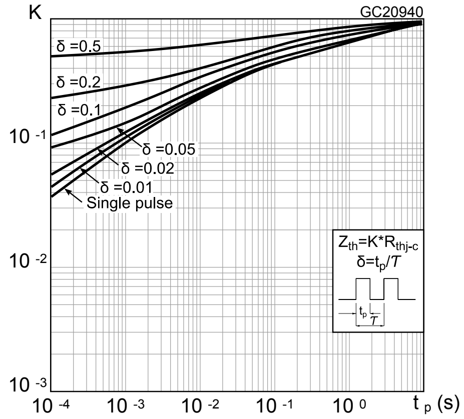



**Figure 3. Output characteristics**

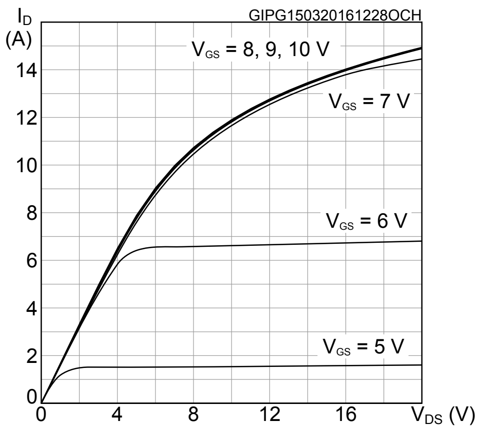



**Figure 4. Transfer characteristics**

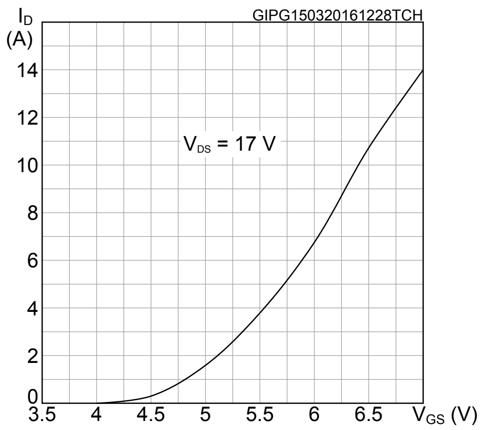



**Figure 5. Gate charge vs gate-source voltage**

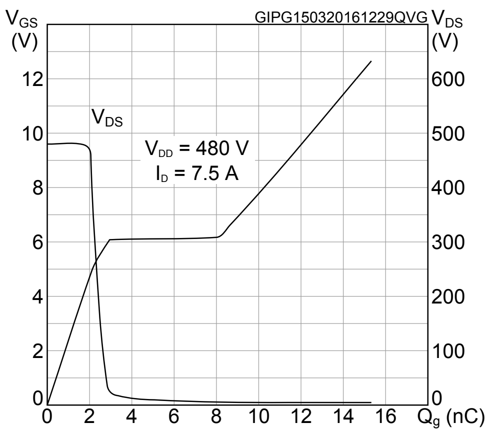



**Figure 6. Static drain-source on-resistance**

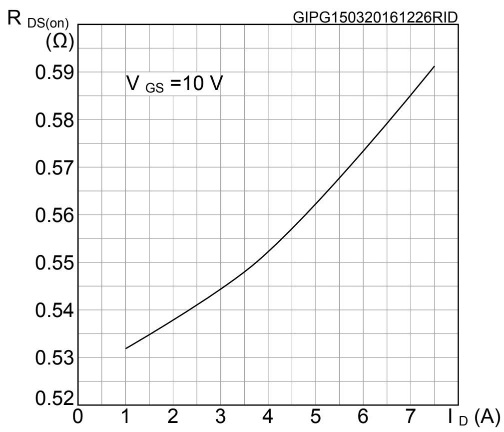


**Figure 7. Capacitance variations**

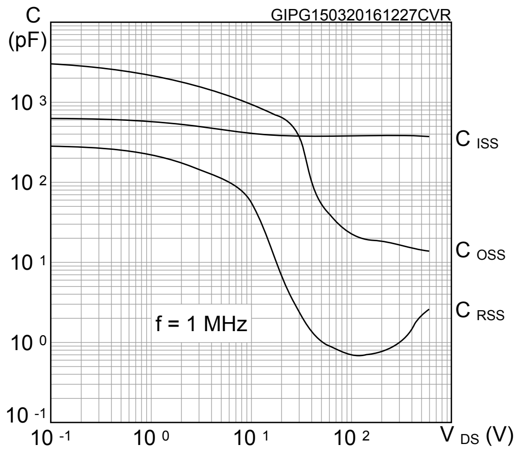



**Figure 8. Turn-off switching energy vs drain current**

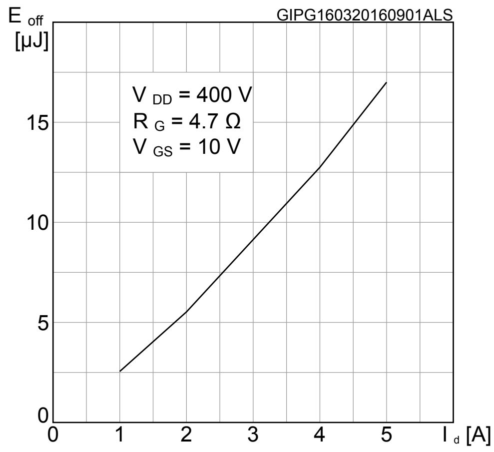



**Figure 9. Normalized gate threshold voltage vs temperature**

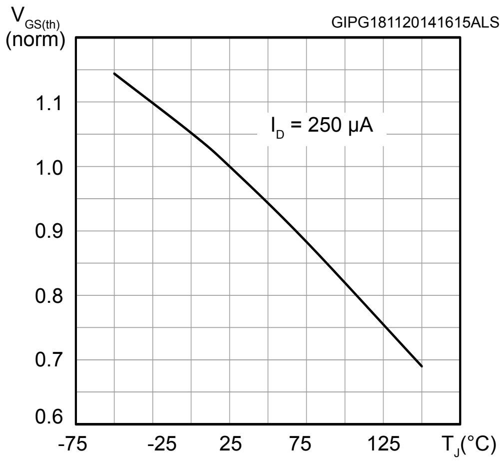



**Figure 10. Normalized on-resistance vs temperature**

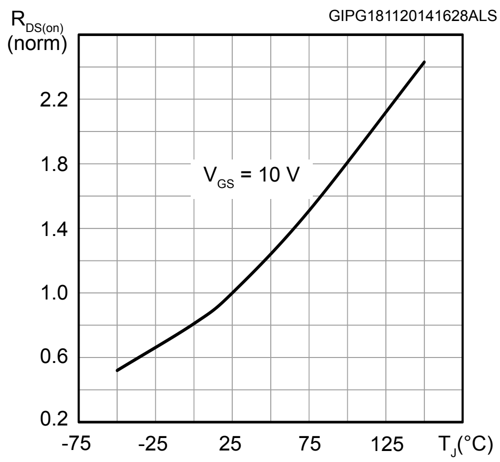



**Figure 11. Normalized $V_{(BR)DSS}$ vs temperature**

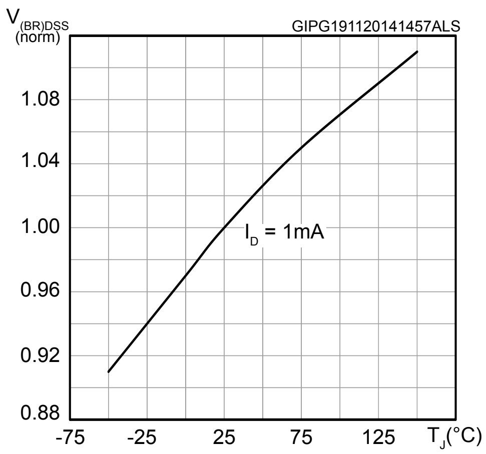
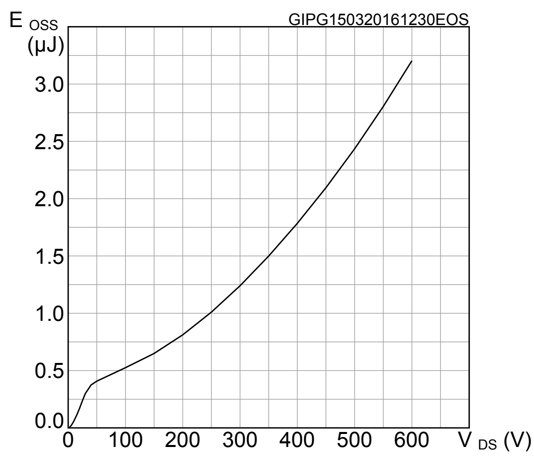



**Figure 12. Output capacitance stored energy**



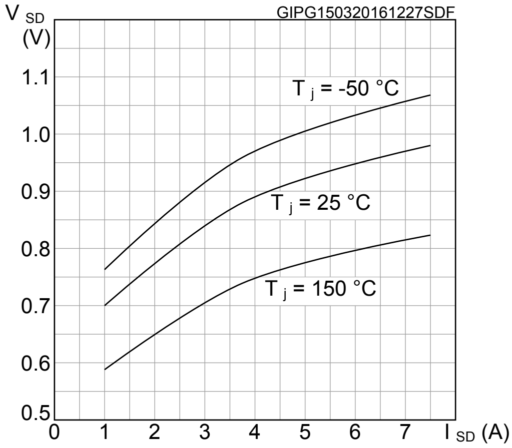



**Figure 13.** Source-drain diode forward characteristics

# 3 Test circuits

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

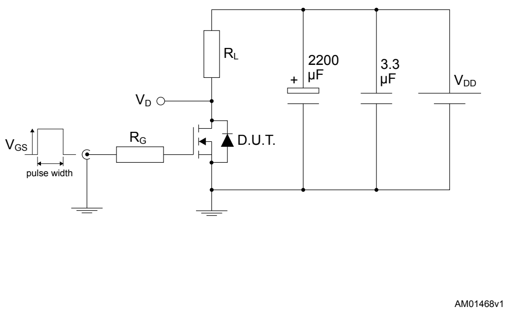



**Figure 15. Test circuit for gate charge behavior**

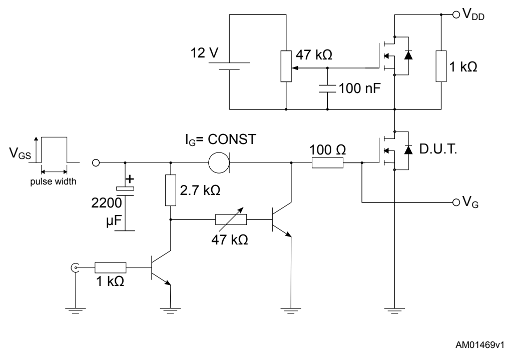



**Figure 16. Test circuit for inductive load switching and diode recovery times**

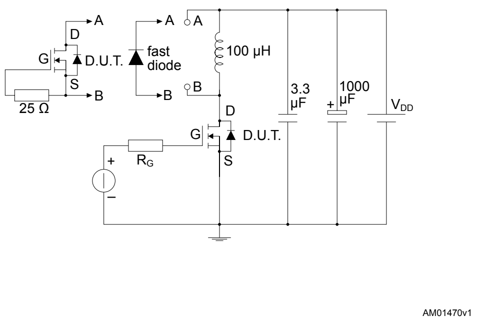



**Figure 17. Unclamped inductive load test circuit**

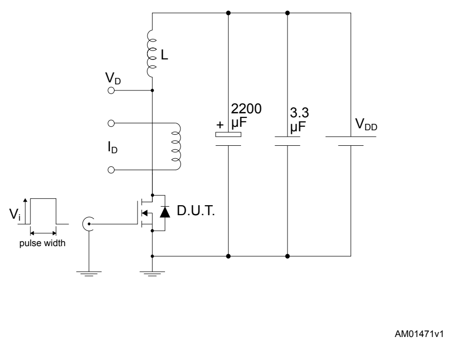



**Figure 18. Unclamped inductive waveform**

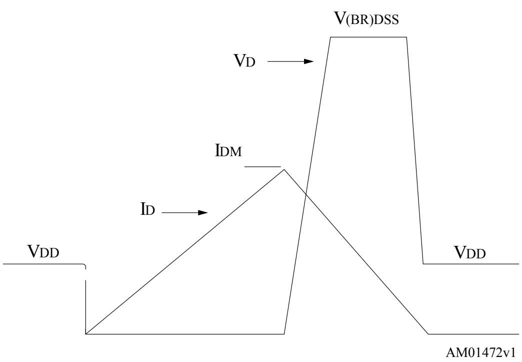
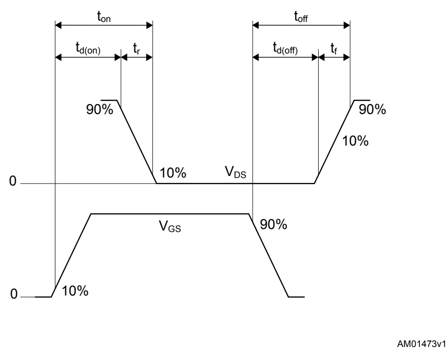



**Figure 19. Switching time waveform**



# 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 I²PAKFP (TO-281) package information

Figure 20. I²PAKFP (TO-281) package outline

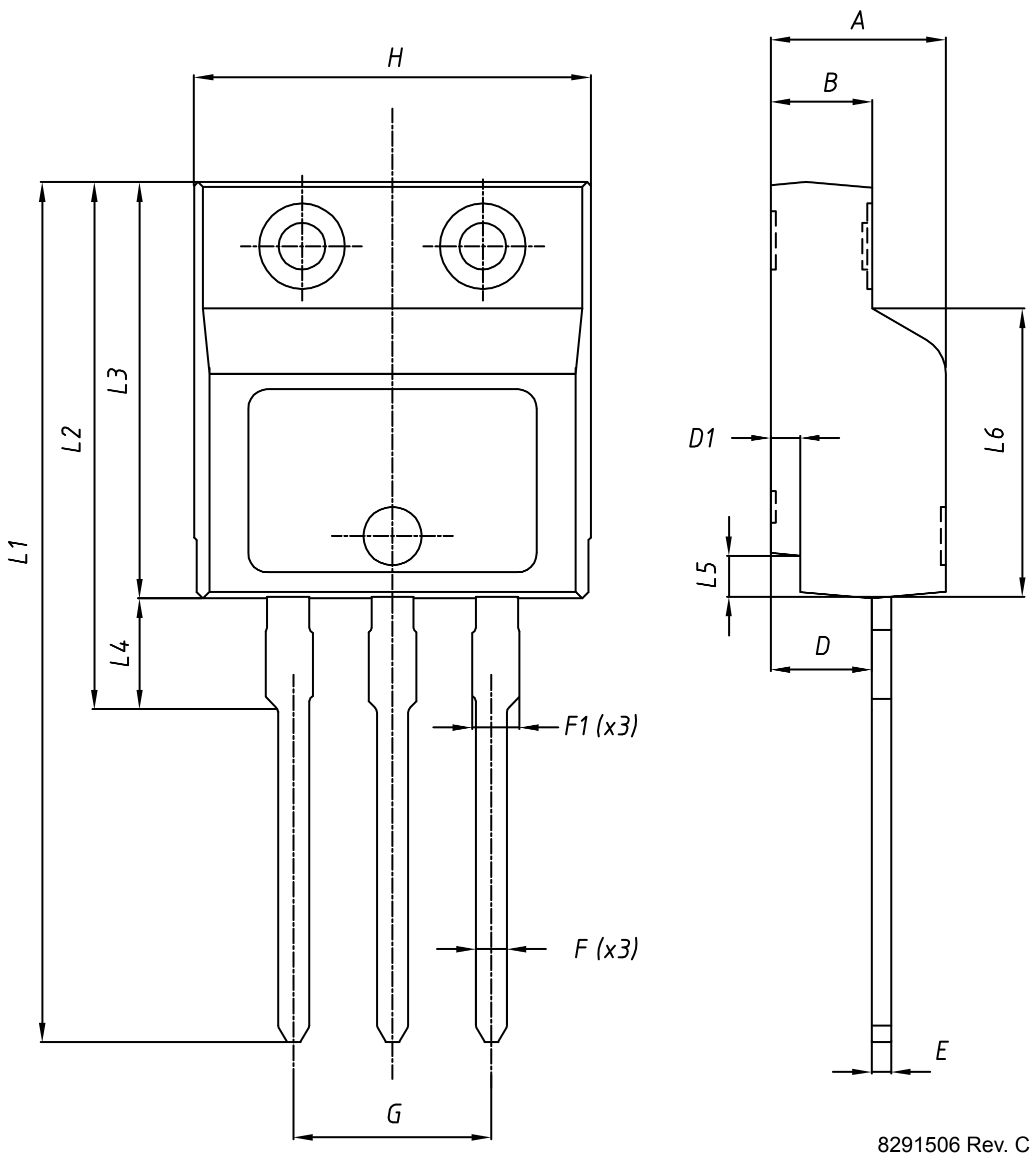


Table 9. I²PAKFP (TO-281) mechanical data

| 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 |

## Revision history

**Table 10. Document revision history**

| Date | Revision | Changes |
| --- | --- | --- |
| 12-Apr-2016 | 1 | First release. |
| 07-Oct-2016 | 2 | Document status changed from preliminary to production data. |
| 14-May-2018 | 3 | Removed document maturity status from cover page.<br>Updated Section 1 Electrical ratings, Section 2 Electrical characteristics and Section 2.1 Electrical characteristics curves.<br>Minor text changes |

## Contents