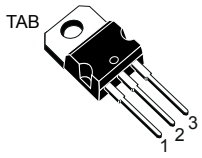
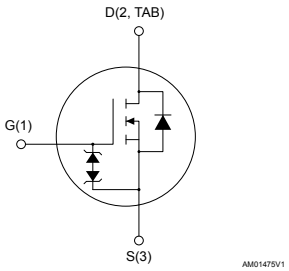
# STP25N60M2-EP

Datasheet

## N-channel 600 V, 0.175 Ω typ., 18 A MDmesh™ M2 EP Power MOSFET in a TO-220 package




**TO-220**




## Features

| Order code | $V_{DS}$ at $T_J$ max. | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STP25N60M2-EP | 650 V | 0.188 Ω | 18 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
- Tailored for Very high frequency converters (f > 150 kHz)

## 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 link | |
|---|---|
| STP25N60M2-EP | |
| **Product summary** | |
| **Order code** | STP25N60M2-EP |
| **Marking** | 25N60M2EP |
| **Package** | TO-220 |
| **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 | 18 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 11.3 | A |
| $I_{DM}$(1) | Drain current (pulsed) | 72 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 150 | W |
| dv/dt(2) | Peak diode recovery voltage slope | 15 | V/ns |
| dv/dt(3) | MOSFET dv/dt ruggedness | 50 | V/ns |
| $T_{stg}$ | Storage temperature range | -55 to 150 | °C |
| $T_j$ | Operating junction temperature range | | |

1. *Pulse width limited by safe operating area.*
2. *$I_{SD}$ ≤ 18 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 |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case | 0.83 | °C/W |
| $R_{thj\text{-}amb}$ | 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 $T_{jmax}$) | 3.5 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 200 | 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, $I_D$ = 9 A | | 0.175 | 0.188 | 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 | - | 1090 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 56 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 1.6 | - | pF |
| $C_{oss\ eq.}$ (1) | Equivalent output capacitance | $V_{DS}$ = 0 to 480 V, $V_{GS}$ = 0 V | - | 255 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz, $I_D$ = 0 A | - | 7 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 480 V, $I_D$ = 18 A, $V_{GS}$ = 0 to 10 V (see Figure 15. Test circuit for gate charge behavior) | - | 29 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 6 | - | nC |
| $Q_{gd}$ | Gate-drain charge | | - | 12 | - | 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, $I_D$ = 2 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V | - | 7 | - | µJ |
| | | $V_{DD}$ = 400 V, $I_D$ = 4 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V | - | 8 | - | µJ |

**Table 7. Switching times**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 300 V, $I_D$ = 9 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) | - | 15 | - | ns |
| $t_r$ | Rise time | | - | 10 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | | - | 61 | - | ns |
| $t_f$ | Fall time | | - | 16 | - | ns |

**Table 8. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | | 18 | A |
| $I_{SDM}$ (1) | Source-drain current (pulsed) | | - | | 72 | A |
| $V_{SD}$ (2) | Forward on voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 18 A | - | | 1.6 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 18 A, di/dt = 100 A/µs, $V_{DD}$ = 100 V (see Figure 16. Test circuit for inductive load switching and diode recovery times) | - | 360 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 5 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 28 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 18 A, di/dt = 100 A/µs, $V_{DD}$ = 100 V, $T_j$ = 150 °C (see Figure 16. Test circuit for inductive load switching and diode recovery times) | - | 445 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 6.5 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 29 | | 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**

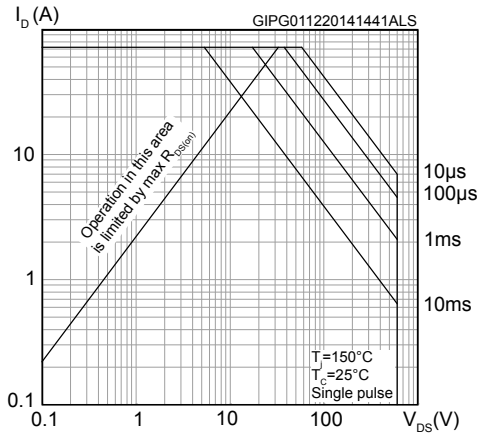



**Figure 2. Thermal impedance**

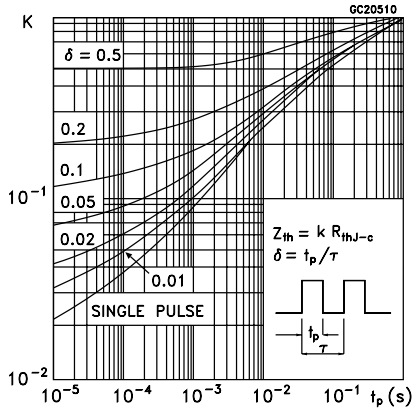



**Figure 3. Output characteristics**

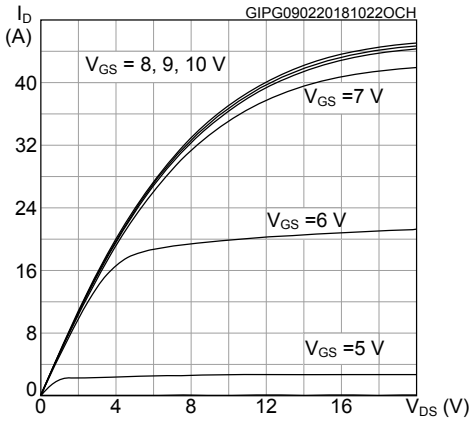



**Figure 4. Transfer characteristics**

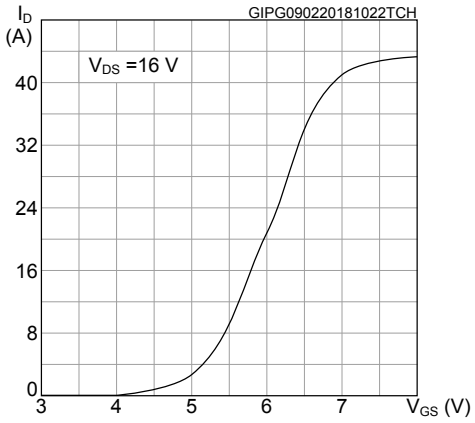



**Figure 5. Gate charge vs gate-source voltage**

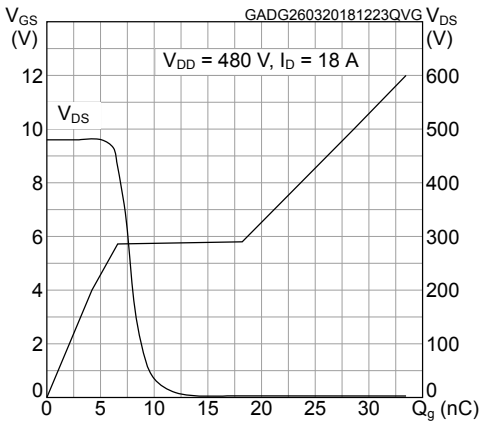



**Figure 6. Static drain-source on-resistance**

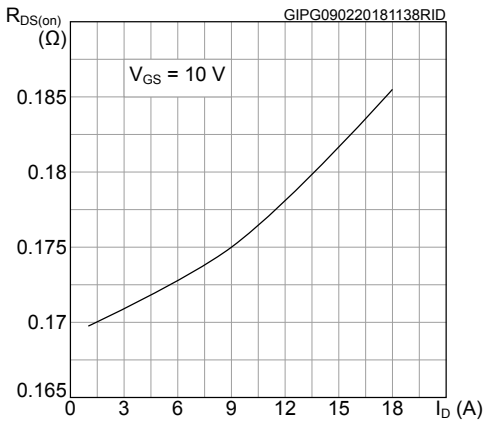


**Figure 7. Capacitance variations**

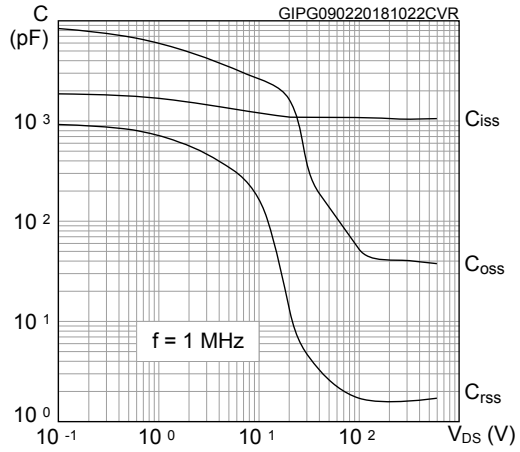



**Figure 8. Output capacitance stored energy**

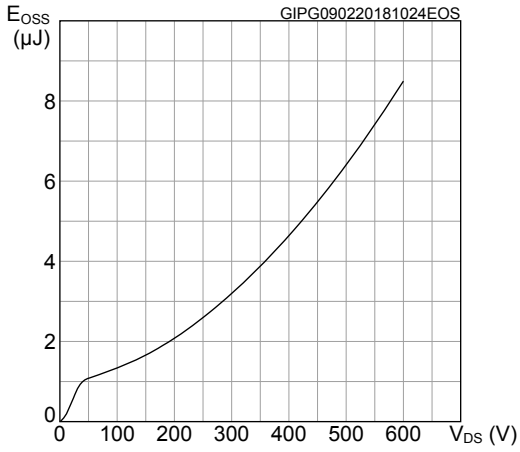



**Figure 9. Turn-off switching energy vs drain current**

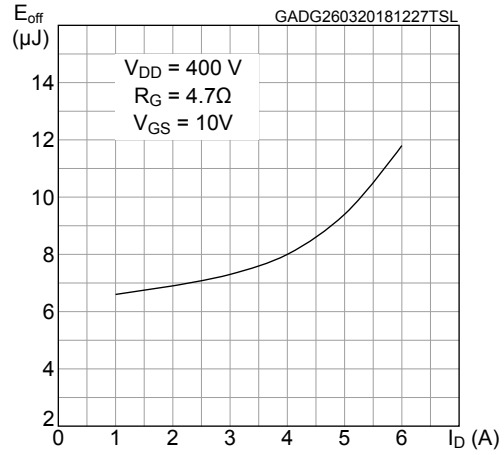



**Figure 10. Normalized gate threshold voltage vs temperature**

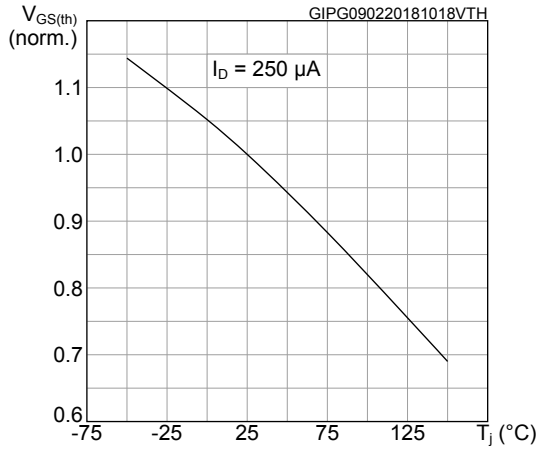



**Figure 11. Normalized on-resistance vs temperature**

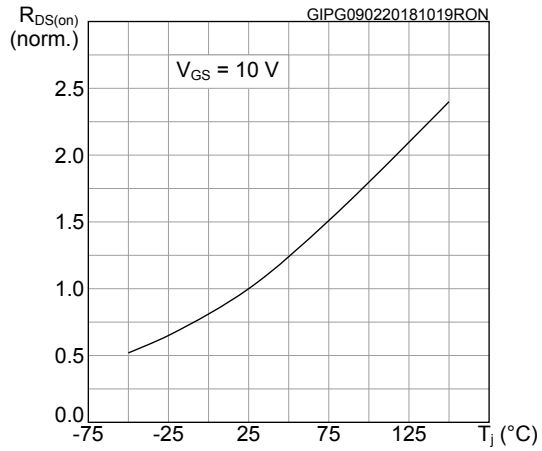



**Figure 12. Normalized $V_{(BR)DSS}$ vs temperature**

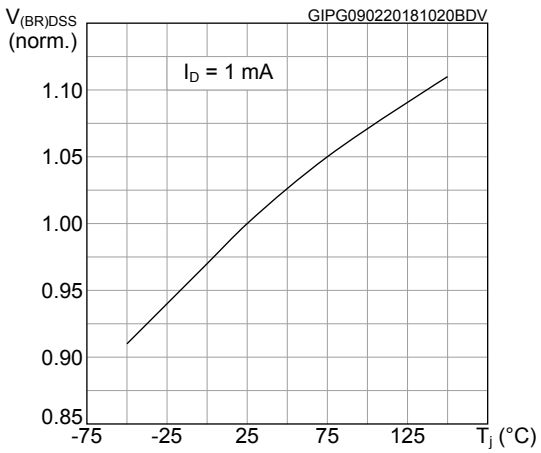
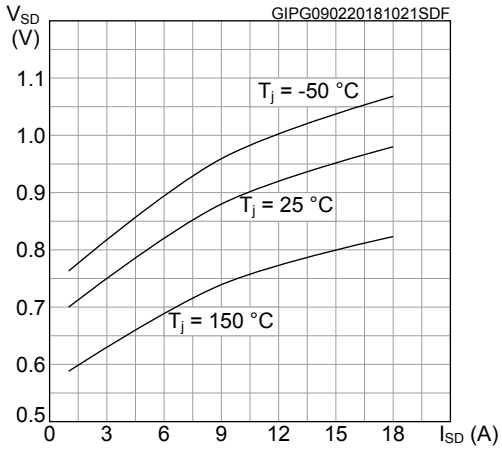


**Figure 13. Source-drain diode forward characteristics**



# 3 Test circuits

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

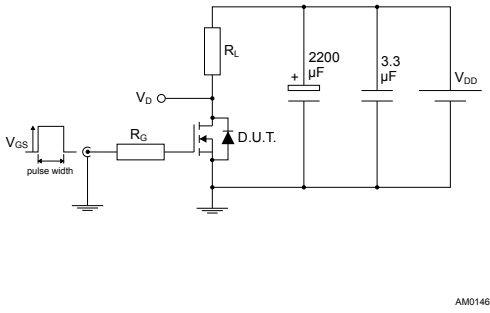



**Figure 15. Test circuit for gate charge behavior**

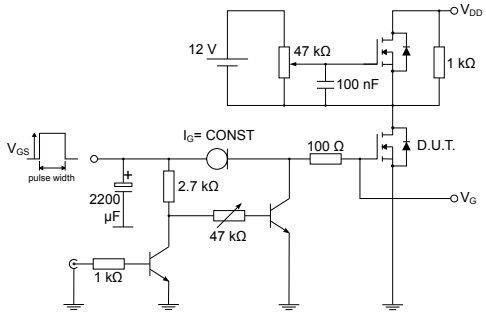



**Figure 16. Test circuit for inductive load switching and diode recovery times**

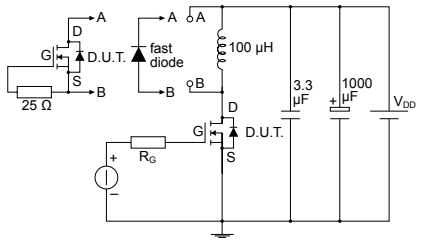



**Figure 17. Unclamped inductive load test circuit**

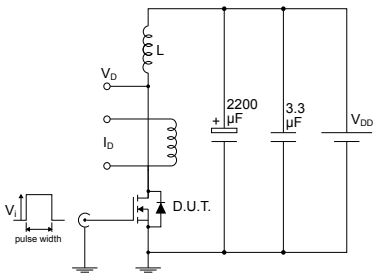



**Figure 18. Unclamped inductive waveform**

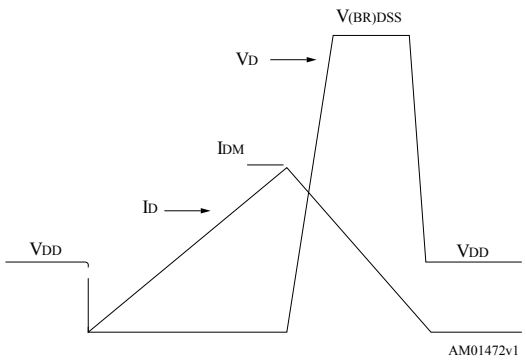
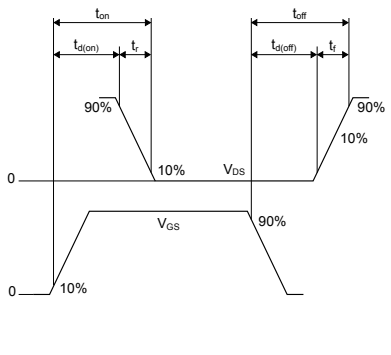



**Figure 19. Switching time waveform**

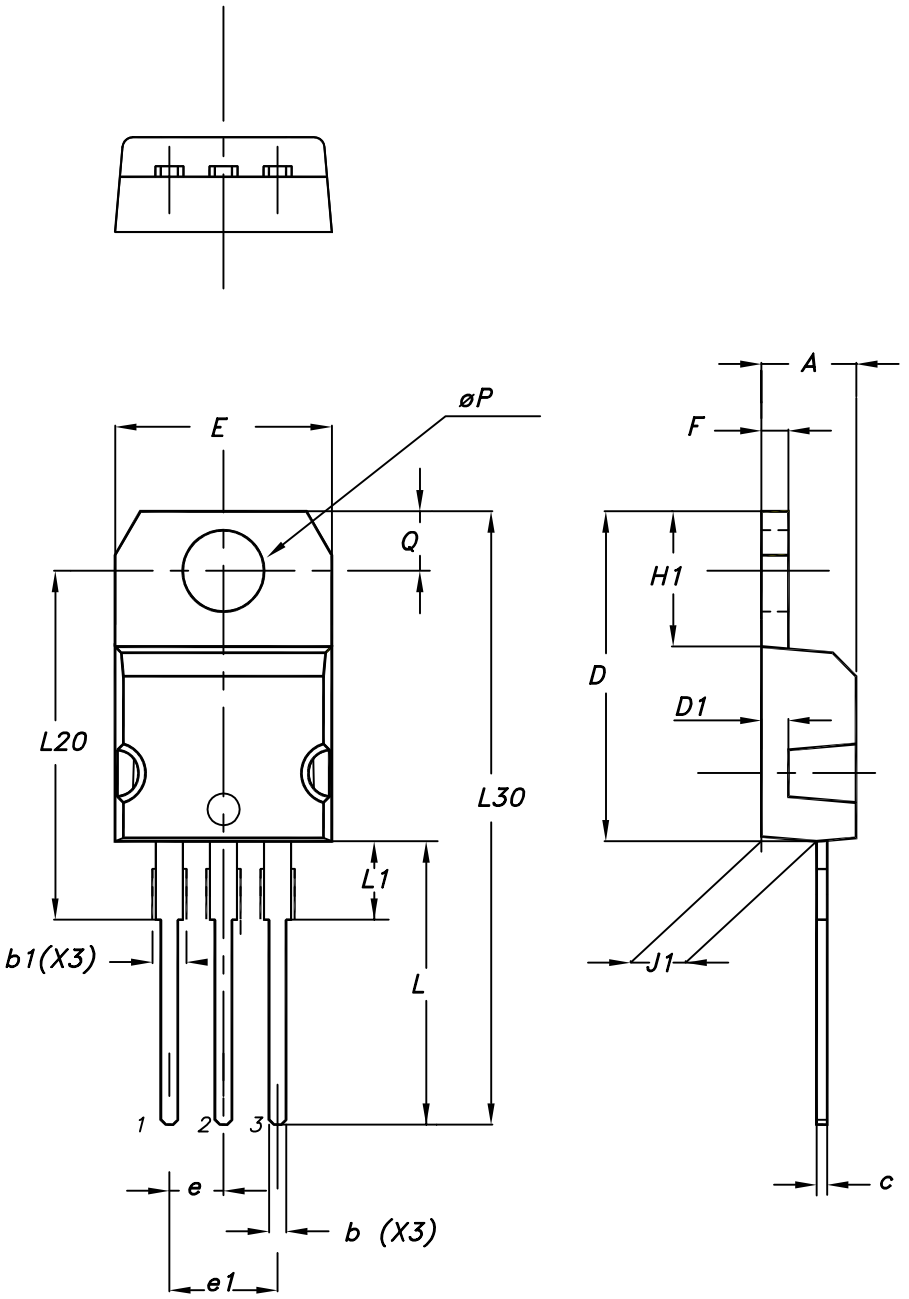


# 4 Package information

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-220 type A package information

Figure 20. **TO-220 type A package outline**




0015988_typeA_Rev_21

Table 9. **TO-220 type A package mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.55 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10.00 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 6.20 | | 6.60 |
| J1 | 2.40 | | 2.72 |
| L | 13.00 | | 14.00 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| øP | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

## Revision history

Table 10. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 01-Dec-2014 | 1 | First release. |
| 12-Jan-2015 | 2 | Updated product status from “preliminary data” to “production data”. |
| 13-Feb-2018 | 3 | Removed maturity status indication from cover page.<br>Modified schematic on cover page.<br>Modified *Table 1. Absolute maximum ratings, Table 4. On/off states, Table 5. Dynamic, Table 6. Switching energy, Table 7. Switching times* and *Table 8. Source drain diode.*<br>Updated *Section 2.1 Electrical characteristics (curves)*.<br>Minor text changes. |
| 28-May-2018 | 4 | Updated Table 1. Absolute maximum ratings.<br>Updated Section 2 Electrical characteristics and Section 2.1 Electrical characteristics (curves).<br>Minor text changes |

# Contents