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# STP120N4F6

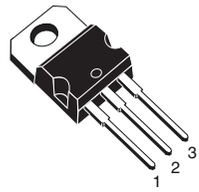
## N-channel 40 V, 3.8 mΩ , 80 A, TO-220 STripFET™ VI DeepGATE™ Power MOSFET

## Features

| Order code | $V_{DSS}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STP120N4F6 | 40 V | 4.3 mΩ | 80 A (1) |

1. Current limited by package

- Standard threshold drive
- 100% avalanche tested




TO-220

## Application

- Switching applications
- Automotive

## Description

This device is a 40 V N-channel STripFET™ VI Power MOSFET based on the ST's proprietary STripFET™ technology, with a new gate structure. The resulting Power MOSFET exhibits the lowest $R_{DS(on)}$ in all packages.

**Figure 1. Internal schematic diagram**

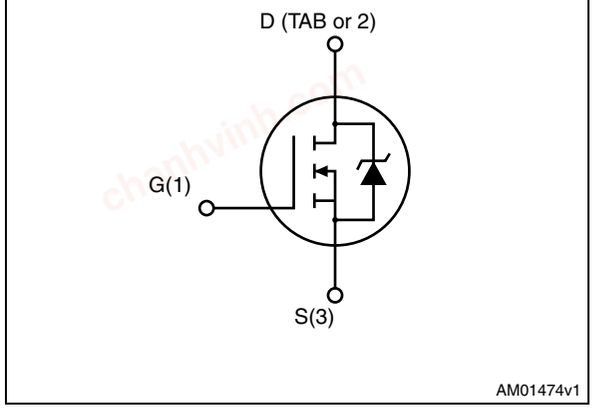



**Table 1. Device summary**

| Order code | Marking | Package | Packaging |
|---|---|---|---|
| STP120N4F6 | 120N4F6 | TO-220 | Tube |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Drain-source voltage ($V_{GS}$ = 0) | 40 | V |
| $V_{GS}$ | Gate-source voltage | ± 20 | V |
| $I_D$ (1) | Drain current (continuous) at $T_C$ = 25 °C | 80 | A |
| $I_D$ (1) | Drain current (continuous) at $T_C$ = 100 °C | 80 | A |
| $I_{DM}$ (2) | Drain current (pulsed) | 320 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 110 | W |
| $T_{stg}$ | Storage temperature | -55 to 175 | °C |
| $T_j$ | Operating junction temperature | | |

1. Current limited by package
2. Pulse width limited by safe operating area

**Table 3. Thermal resistance**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case max | 1.36 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-amb max | 62.5 | °C/W |

**Table 4. Thermal resistance**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ (1) | Avalanche current, repetitive or not-repetitive | 40 | A |
| $E_{AS}$ (2) | Single pulse avalanche energy | 394 | mJ |

1. Pulse width limited by Tj max
2. Starting Tj = 25 °C, $I_D$ = 40 A, $V_{DD}$ = 25 V

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# 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 | $I_D$ = 250 µA, $V_{GS}$= 0 | 40 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current ($V_{GS}$ = 0) | $V_{DS}$ = 20 V<br>$V_{DS}$ = 20 V,Tc = 125 °C | | | 1<br>10 | µA<br>µA |
| $I_{GSS}$ | Gate body leakage current ($V_{DS}$ = 0) | $V_{GS}$ = ± 20 V | | | ±100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 2 | | 4 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS}$ = 10 V, $I_D$ = 40 A | | 3.8 | 4.3 | mΩ |

**Table 6. Dynamic**

| Symbol | Parameter | Test conditions | Min | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS}$ = 25 V, f=1 MHz,<br>$V_{GS}$ = 0 V | - | 3850<br>650<br>350 | - | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$ | Total gate charge<br>Gate-source charge<br>Gate-drain charge | $V_{DD}$ = 20 V, $I_D$ = 80 A<br>$V_{GS}$ = 10 V<br>*(see Figure 14)* | -<br>- | 65<br>20<br>16 | - | nC<br>nC<br>nC |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz open drain | - | 1.5 | - | Ω |

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**Table 7. Switching on/off (inductive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$<br>$t_r$ | Turn-on delay time<br>Rise time | $V_{DD}$ = 20 V, $I_D$ = 40 A,<br>$R_G$ = 4.7 Ω, $V_{GS}$ = 10 V<br>*(see Figure 15)* | - | 20<br>70 | - | ns<br>ns |
| $t_{d(off)}$<br>$t_f$ | Turn-off delay time<br>Fall time | | - | 40<br>20 | - | ns<br>ns |

**Table 8. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$<br>$I_{SDM}$(1) | Source-drain current<br>Source-drain current (pulsed) | | - | | 80<br>320 | A<br>A |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$ = 40 A, $V_{GS}$ = 0 | - | | 1.1 | V |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD}$ = 80 A,<br>di/dt = 100 A/µs,<br>$V_{DD}$ = 30 V<br>*(see Figure 17)* | - | 40<br>56<br>2.8 | | ns<br>nC<br>A |

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

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## 2.1 Electrical characteristics (curves)

**Figure 2. Safe operating area**

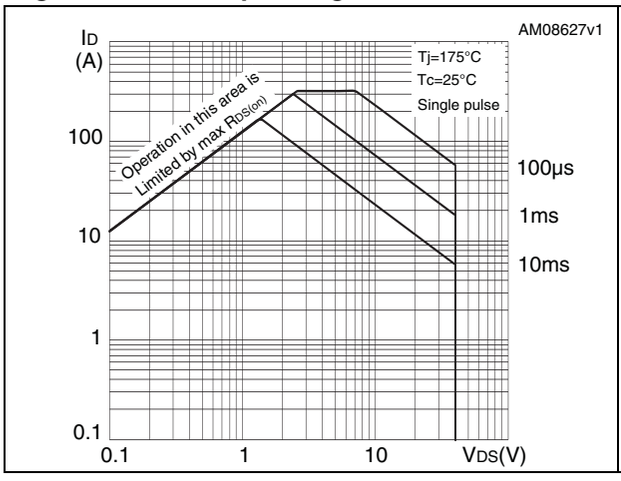



**Figure 3. Thermal impedance**

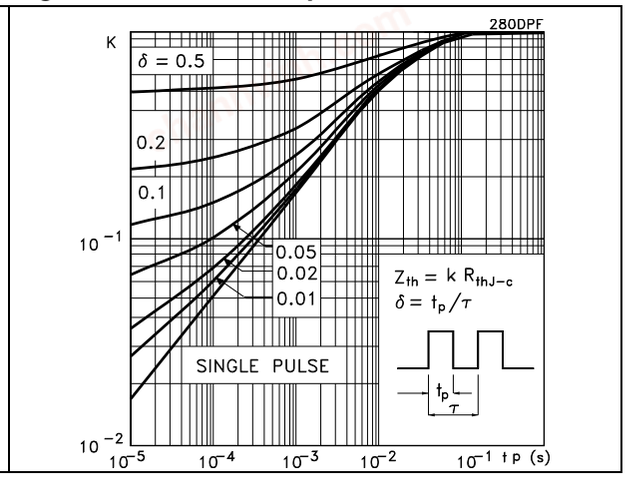



**Figure 4. Output characteristics**

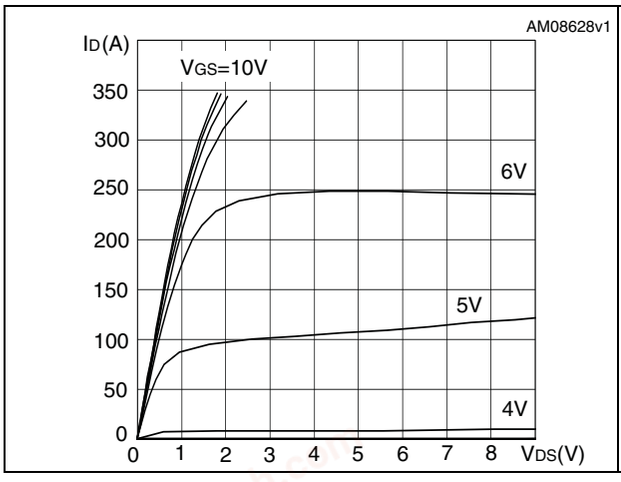



**Figure 5. Transfer characteristics**

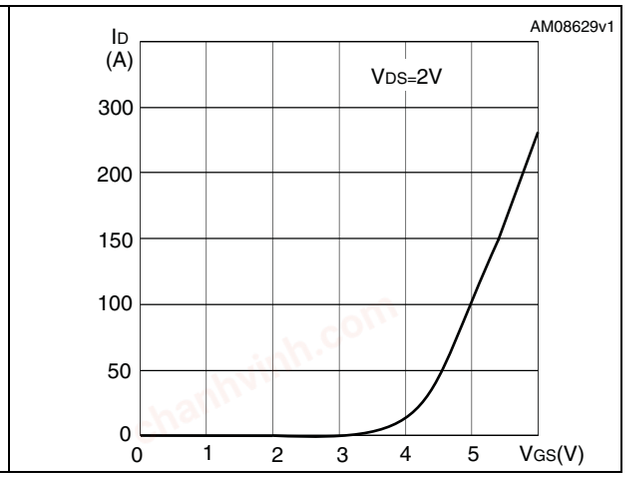



**Figure 6. Normalized $B_{VDSS}$ vs temperature**

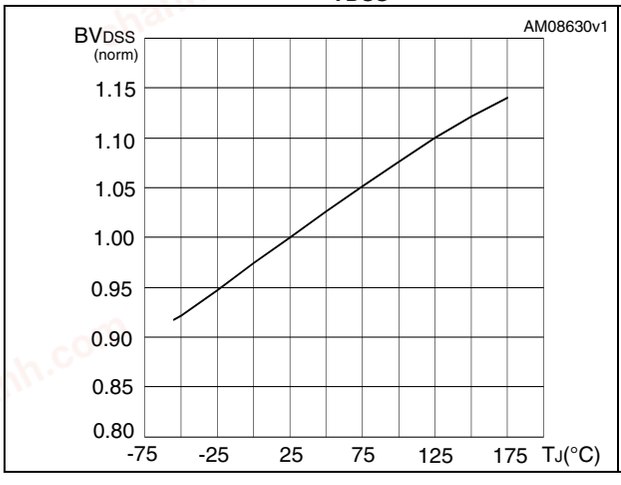
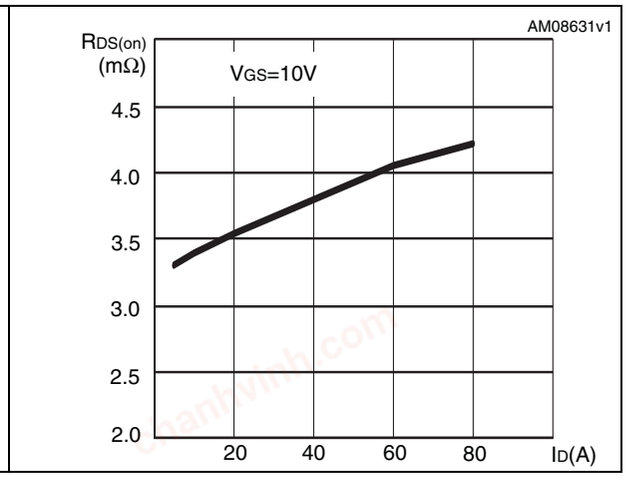



**Figure 7. Static drain-source on resistance**



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**Figure 8. Gate charge vs gate-source voltage**

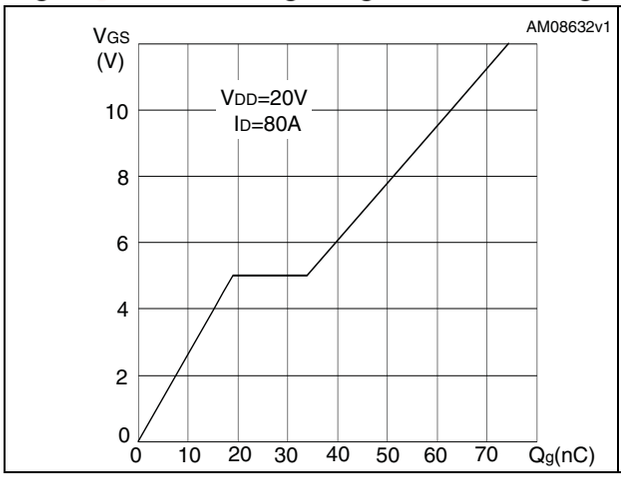



**Figure 9. Capacitance variations**

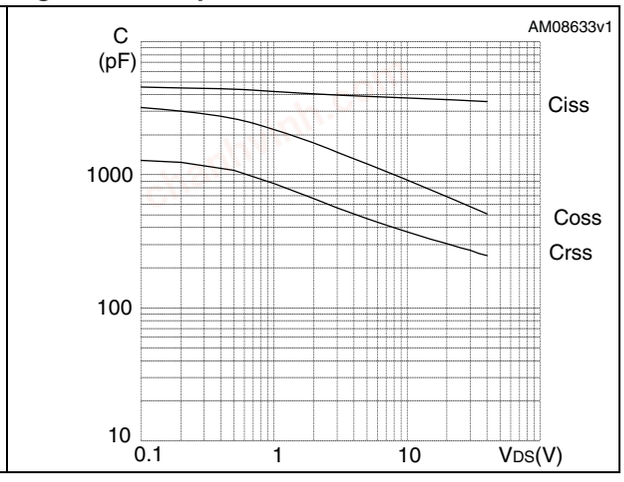



**Figure 10. Normalized gate threshold voltage vs temperature**

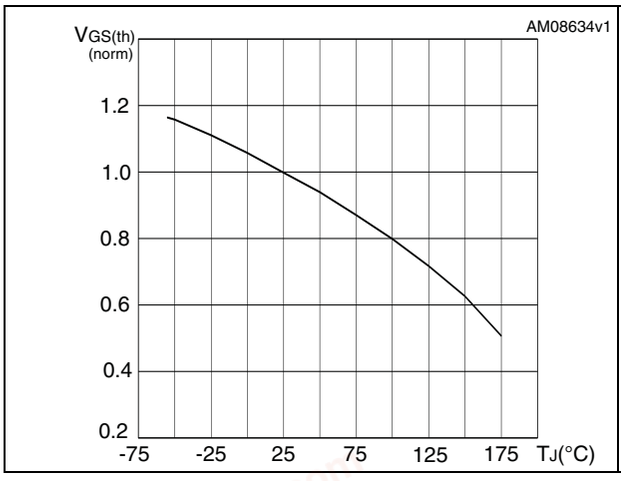



**Figure 11. Normalized on resistance vs temperature**

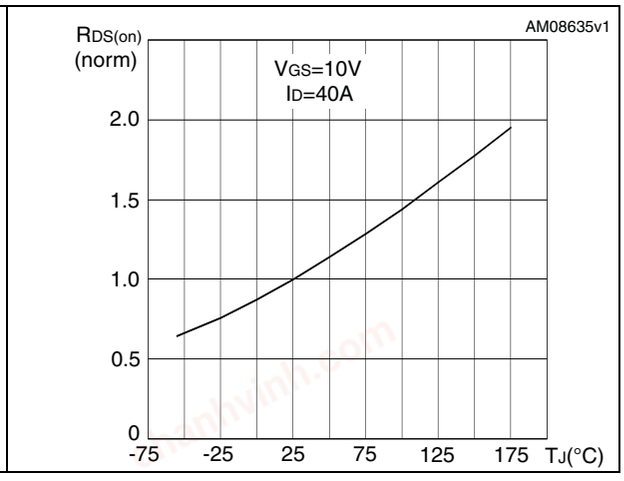
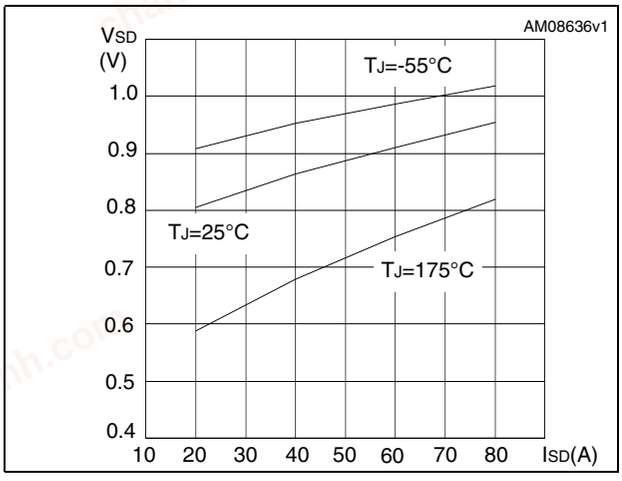



**Figure 12. Source-drain diode forward characteristics**



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# 3 Test circuits

**Figure 13. Switching times test circuit for resistive load**

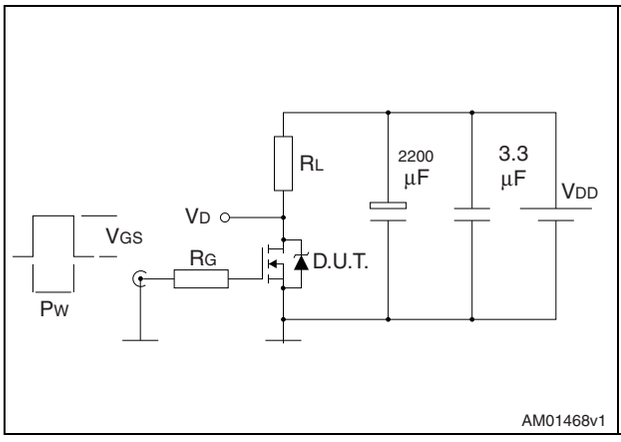



**Figure 14. Gate charge test circuit**

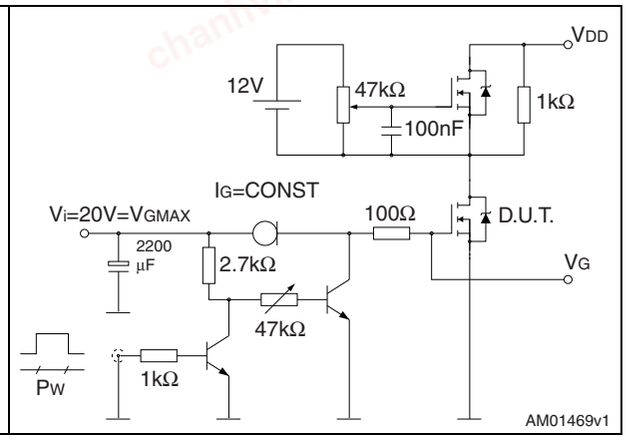



**Figure 15. Test circuit for inductive load switching and diode recovery times**

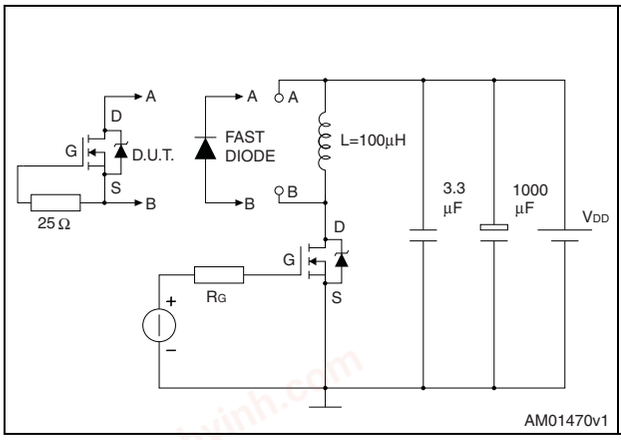



**Figure 16. Unclamped Inductive load test circuit**

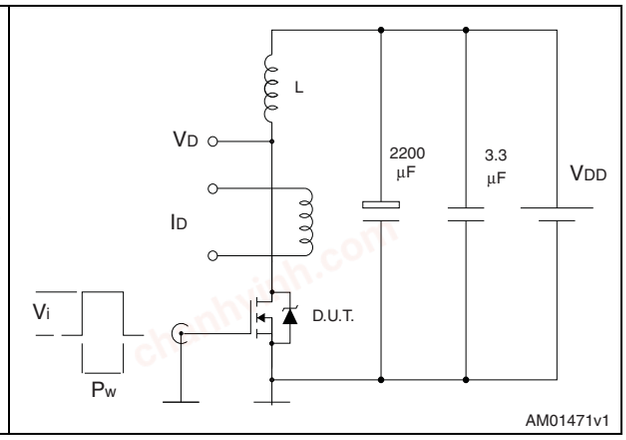



**Figure 17. Unclamped inductive waveform**

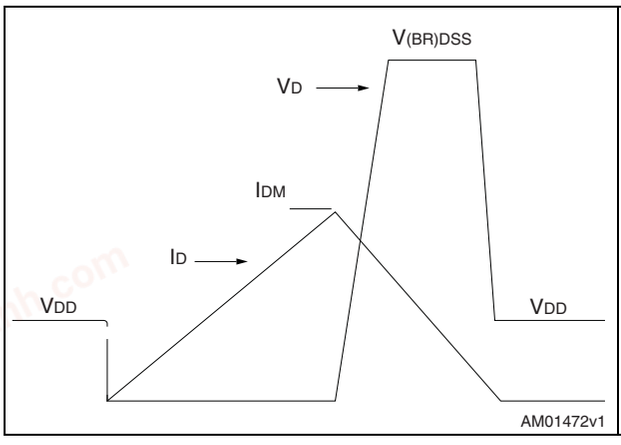
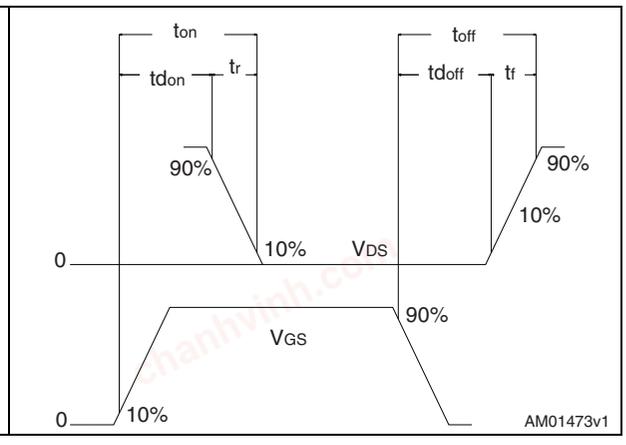



**Figure 18. Switching time waveform**



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# 4 Package mechanical data

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 products status are available at: www.st.com. ECOPACK is an ST trademark.

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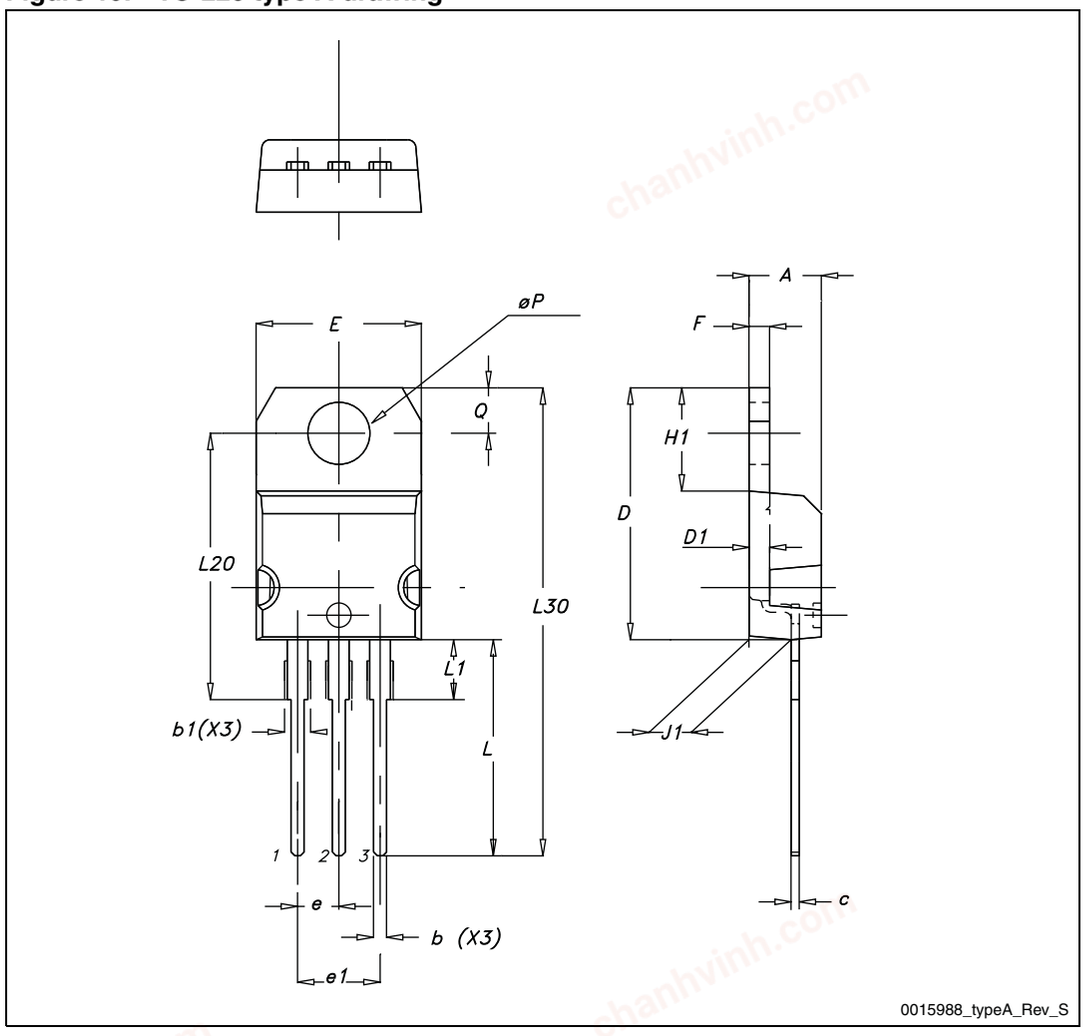
Table 9. TO-220 type A mechanical data

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.70 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10 | | 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 | | 14 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| ∅P | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

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**Figure 19. TO-220 type A drawing**



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# 5 Revision history

Table 10. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 17-May-2011 | 1 | First release |

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