# STU6N90K5

## N-channel 900 V, 0.91 Ω typ., 6 A MDmesh™ K5 Power MOSFET in an IPAK package

Datasheet - production data

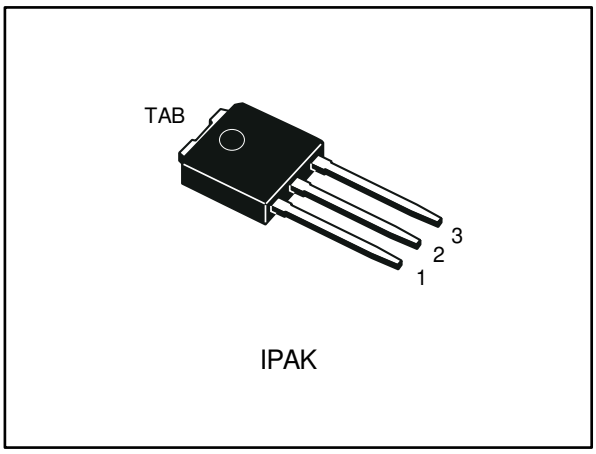
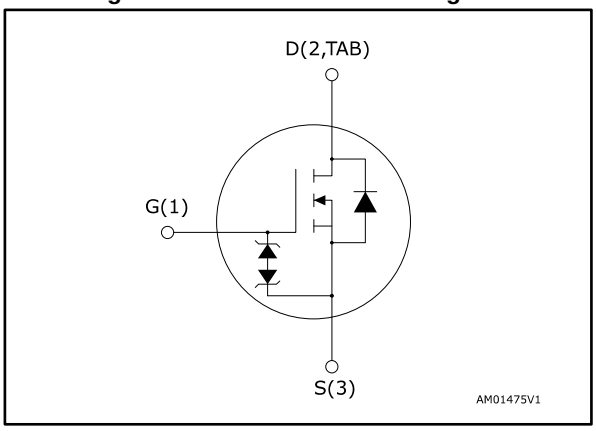



**Figure 1: Internal schematic diagram**




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STU6N90K5 | 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 |
|---|---|---|---|
| STU6N90K5 | 6N90K5 | IPAK | Tube |

# Contents

# 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 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 4 | A |
| $I_D$ (1) | Drain current (pulsed) | 24 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 110 | W |
| dv/dt (2) | Peak diode recovery voltage slope | 4.5 | V/ns |
| dv/dt (3) | MOSFET dv/dt ruggedness | 50 | |
| $T_j$ | Operating junction temperature range | - 55 to 150 | °C |
| $T_{stg}$ | Storage temperature range | | |

**Notes:**

(1)Pulse width limited by safe operating area

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

(3)$V_{DS}$ ≤ 720 V

**Table 3: Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal resistance junction-case | 1.14 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal resistance junction-ambient | 100 | °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 °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 V, $I_D$ = 1 mA | 900 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 900 V | | | 1 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 900 V $T_C$ = 125 °C(1) | | | 50 | µA |
| $I_{GSS}$ | Gate body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±20 V | | | ±10 | µA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DD}$ = $V_{GS}$, $I_D$ = 100 µA | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 3 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 V, f = 1 MHz, $V_{GS}$ = 0 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 to 720 V, $V_{GS}$ = 0 V | - | 55 | - | pF |
| $C_{o(er)}$(2) | Equivalent capacitance energy related | | - | 20 | - | pF |
| $R_g$ | Intrinsic gate resistance | f = 1 MHz, $I_D$ = 0 A | - | 6.4 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 720 V, $I_D$ = 6 A $V_{GS}$= 10 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 V, $I_D$ = 3 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"*) | - | 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 A, $V_{GS}$ = 0 V | - | | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 6 A, di/dt = 100 A/µs, $V_{DD}$ = 60 V (see *Figure 16: "Test circuit for inductive load switching and diode recovery times"*) | - | 342 | | ns |
| $Q_{rr}$ | Reverrse recovery charge | | - | 3.13 | | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 18.3 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 6 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"*) | - | 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 | $I_{GS}$ = ± 1 mA,$I_D$ = 0 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 2: Safe operating area**

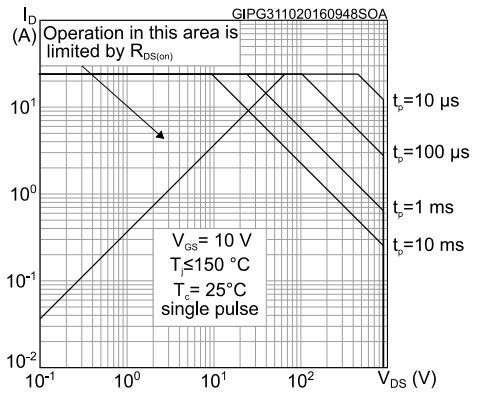



**Figure 3: Thermal impedance**

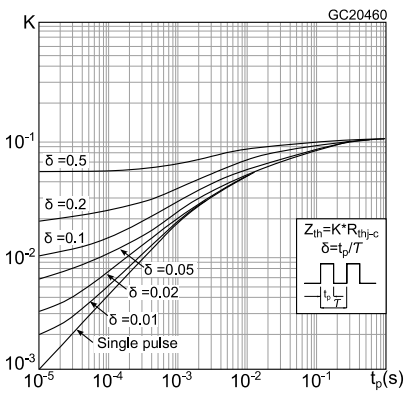



**Figure 4: Output characteristics**

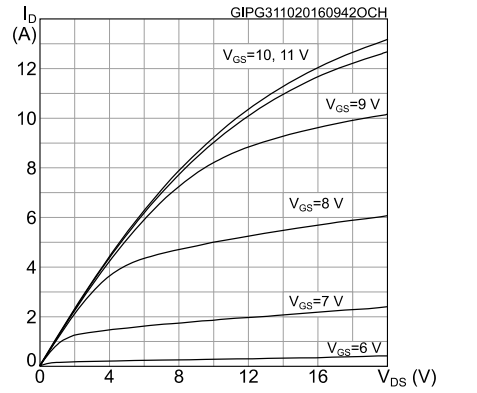



**Figure 5: Transfer characteristics**

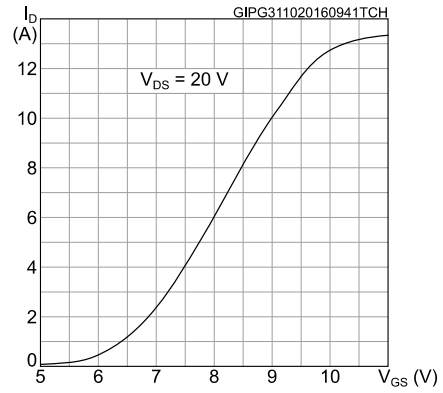



**Figure 6: Gate charge vs gate-source voltage**

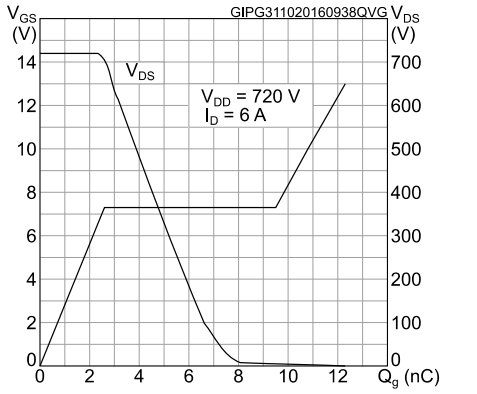



**Figure 7: Static drain-source on-resistance**

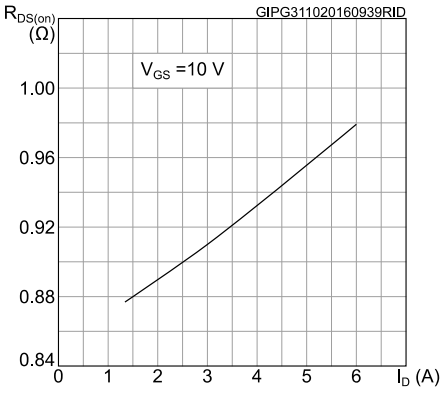


**Figure 8: Capacitance variations**

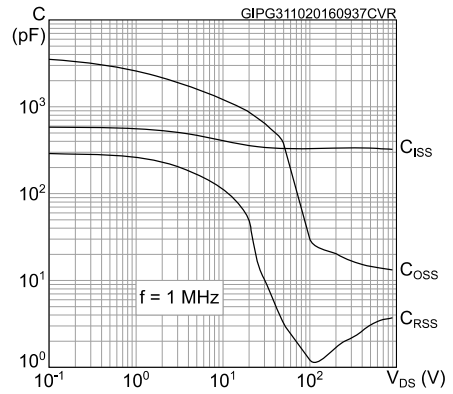



**Figure 9: Normalized gate threshold voltage vs temperature**

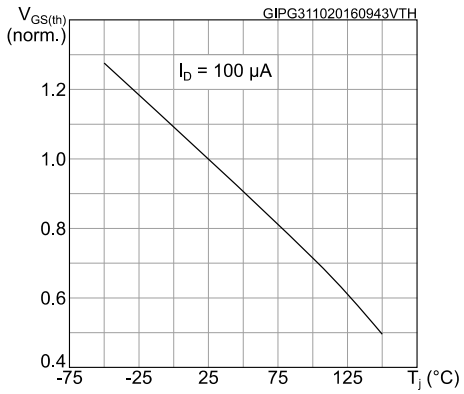



**Figure 10: Normalized on-resistance vs temperature**

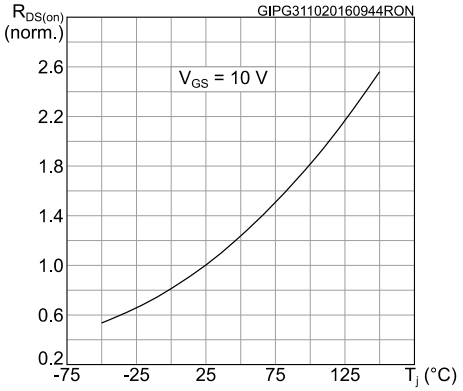



**Figure 11: Normalized $V_{(BR)DSS}$ vs temperature**

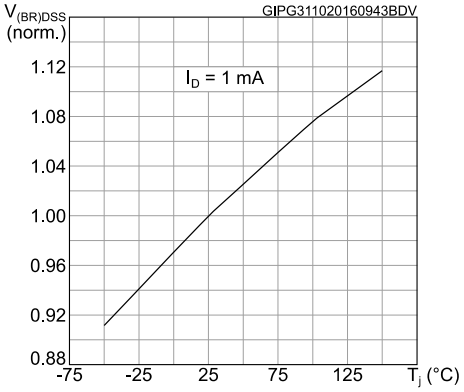



**Figure 12: Maximum avalanche energy vs starting $T_J$**

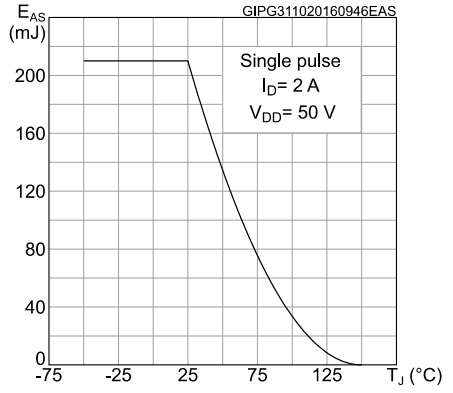
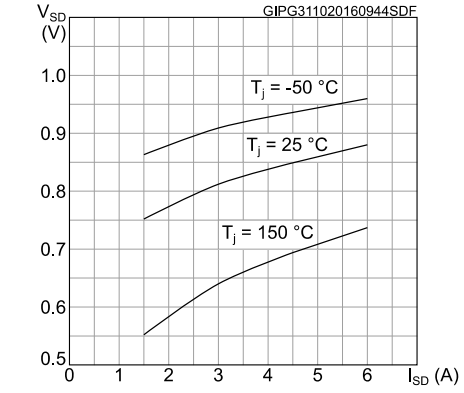



**Figure 13: Source-drain diode forward characteristics**



# 3 Test circuits

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

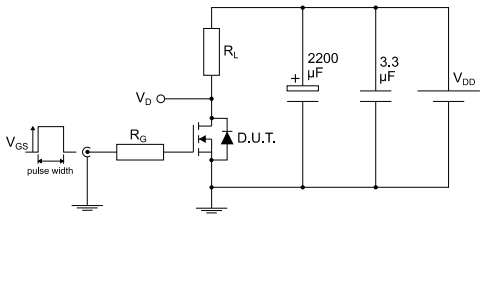



**Figure 15: Test circuit for gate charge behavior**

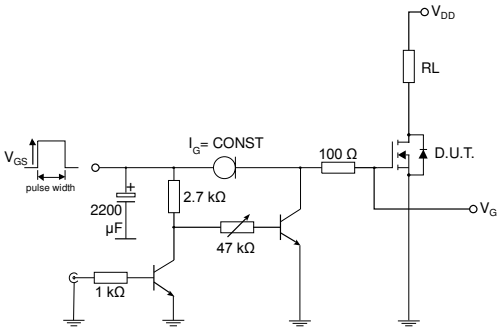



**Figure 16: Test circuit for inductive load switching and diode recovery times**

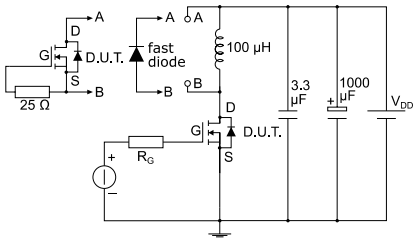



**Figure 17: Unclamped inductive load test circuit**

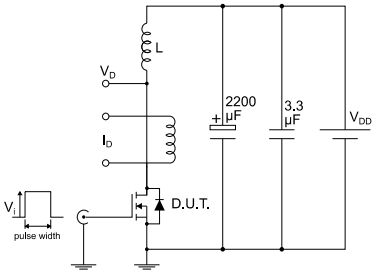



**Figure 18: Unclamped inductive waveform**

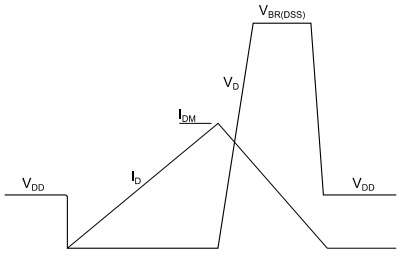
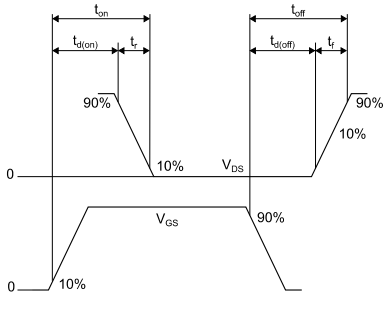



**Figure 19: Switching time waveform**



# 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 IPAK (TO-251) type C package information

**Figure 20: IPAK (TO-251) type C package outline**

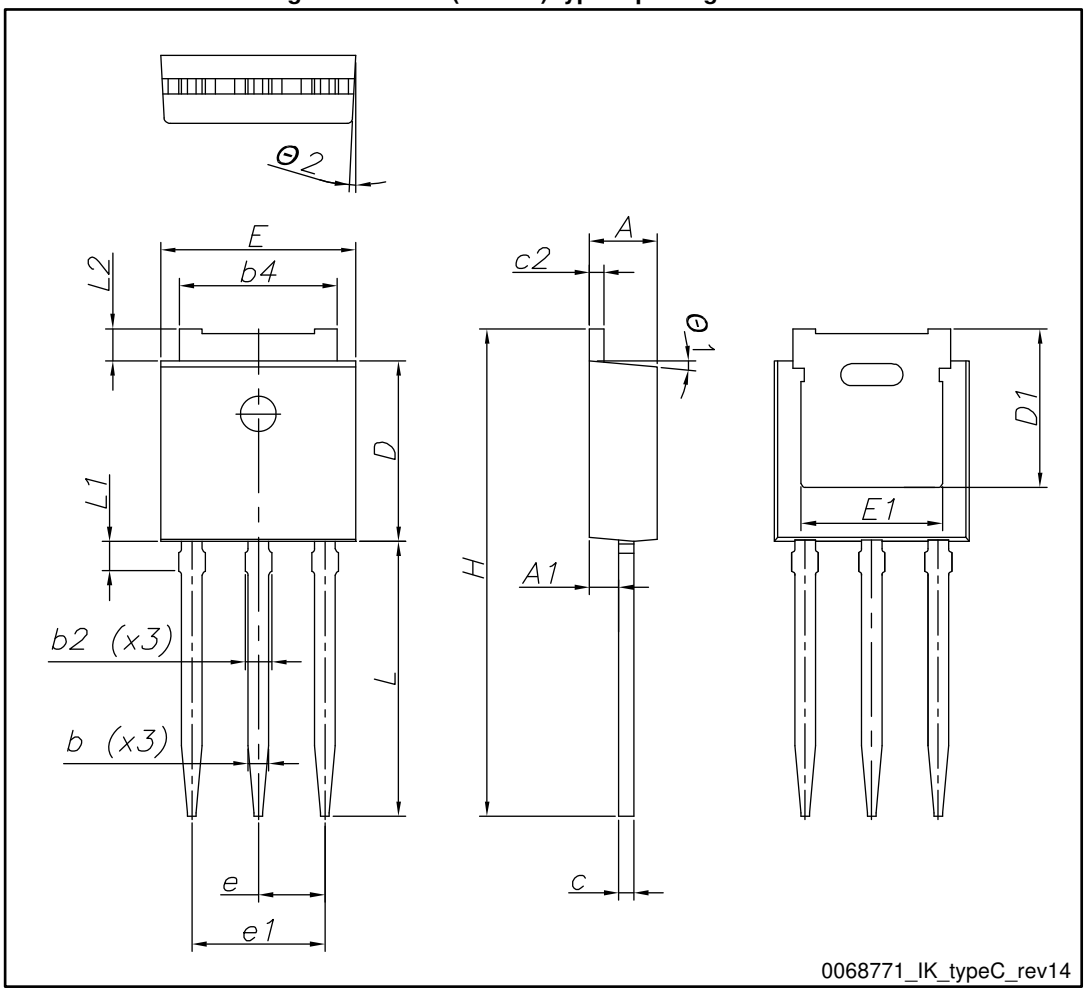


Table 10: IPAK (TO-251) type C package mechanical data

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 2.20 | 2.30 | 2.35 |
| A1 | 0.90 | 1.00 | 1.10 |
| b | 0.66 | | 0.79 |
| b2 | | | 0.90 |
| b4 | 5.23 | 5.33 | 5.43 |
| c | 0.46 | | 0.59 |
| c2 | 0.46 | | 0.59 |
| D | 6.00 | 6.10 | 6.20 |
| D1 | 5.20 | 5.37 | 5.55 |
| E | 6.50 | 6.60 | 6.70 |
| E1 | 4.60 | 4.78 | 4.95 |
| e | 2.20 | 2.25 | 2.30 |
| e1 | 4.40 | 4.50 | 4.60 |
| H | 16.18 | 16.48 | 16.78 |
| L | 9.00 | 9.30 | 9.60 |
| L1 | 0.90 | 1.00 | 1.20 |
| L2 | 0.90 | 1.08 | 1.25 |
| θ1 | 3° | 5° | 7° |
| θ2 | 1° | 3° | 5° |

# 5 Revision history

Table 11: Document revision history

| Date | Revision | Changes |
|---|---|---|
| 02-Nov-2016 | 1 | First release. |

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