



BUK961R6-40E

N-channel TrenchMOS logic level FET

28 July 2016

Product data sheet

1. General description

Logic level N-channel MOSFET in a SOT404 package using TrenchMOS technology. This product has been designed and qualified to AEC Q101 standard for use in high performance automotive applications.

2. Features and benefits

- AEC Q101 compliant
- Repetitive avalanche rated
- Suitable for thermally demanding environments due to 175 °C rating
- True logic level gate with $V_{GS(th)}$ rating of greater than 0.5V at 175 °C

3. Applications

- 12 V Automotive systems
- Motors, lamps and solenoid control
- Start-Stop micro-hybrid applications
- Transmission control
- Ultra high performance power switching

4. Quick reference data

Table 1. Quick reference data

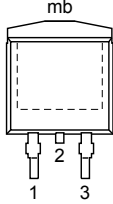
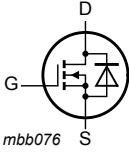
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|---|-----|-----|------|-----|------------|
| V_{DS} | drain-source voltage | $T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$ | | - | - | 40 | V |
| I_D | drain current | $V_{GS} = 5\text{ V}; T_{mb} = 25\text{ °C};$ Fig. 2 | [1] | - | - | 120 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C};$ Fig. 1 | | - | - | 349 | W |
| Static characteristics | | | | | | | |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 5\text{ V}; I_D = 25\text{ A}; T_j = 25\text{ °C};$ Fig. 11 | | - | 1.35 | 1.6 | m Ω |
| Dynamic characteristics | | | | | | | |
| Q_{GD} | gate-drain charge | $V_{GS} = 5\text{ V}; I_D = 25\text{ A}; V_{DS} = 32\text{ V};$ Fig. 13; Fig. 14 | | - | 40.9 | - | nC |

[1] Continuous current is limited by package.

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5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|-----------------------------------|---|---|
| 1 | G | gate |  <p>D2PAK (SOT404)</p> |  |
| 2 | D | drain | | |
| 3 | S | source | | |
| mb | D | mounting base; connected to drain | | |

6. Ordering information

Table 3. Ordering information

| Type number | Package | | |
|--------------|---------|--|---------|
| | Name | Description | Version |
| BUK961R6-40E | D2PAK | plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped) | SOT404 |

7. Marking

Table 4. Marking codes

| Type number | Marking code |
|--------------|--------------|
| BUK961R6-40E | BUK961R6-40E |

8. Limiting values

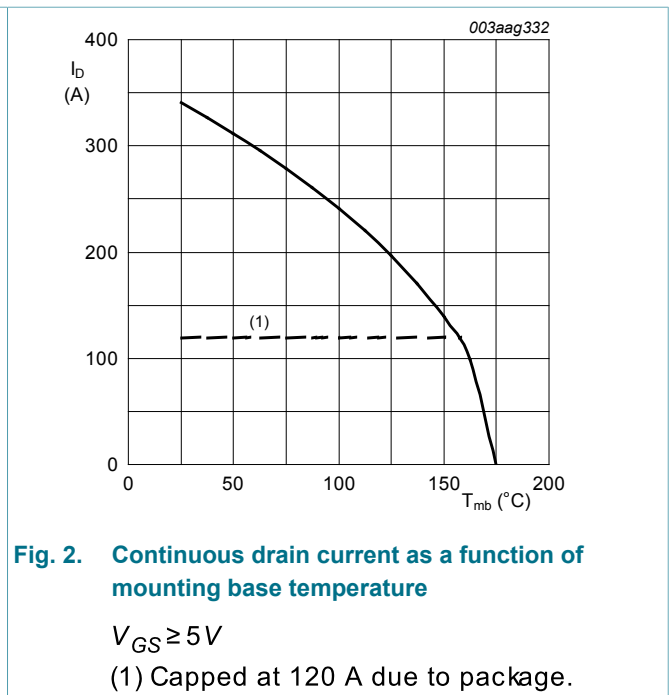
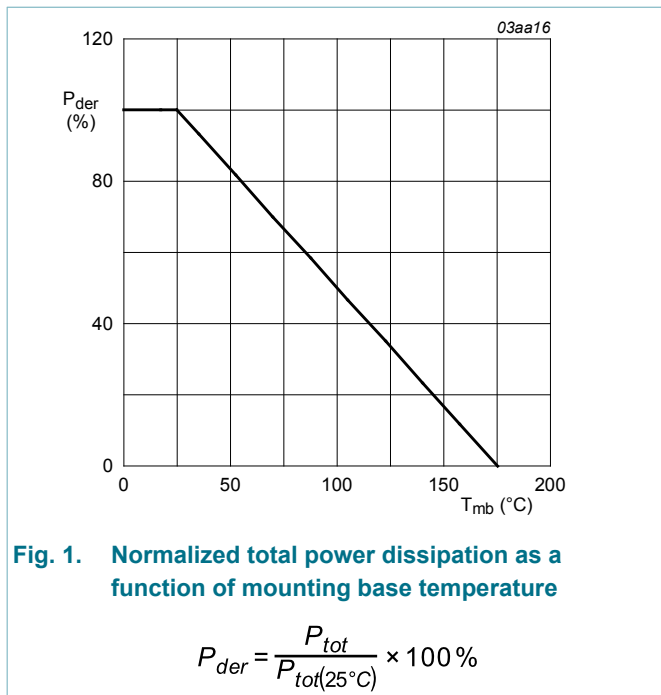
Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol | Parameter | Conditions | Min | Max | Unit | |
|-----------|-------------------------|---|--------|------|------|---|
| V_{DS} | drain-source voltage | $T_j \geq 25\text{ °C}$; $T_j \leq 175\text{ °C}$ | - | 40 | V | |
| V_{DGR} | drain-gate voltage | $R_{GS} = 20\text{ k}\Omega$ | - | 40 | V | |
| V_{GS} | gate-source voltage | $T_j \leq 175\text{ °C}$; DC | -10 | 10 | V | |
| | | $T_j \leq 175\text{ °C}$; Pulsed | [1][2] | -15 | 15 | V |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C}$; Fig. 1 | - | 349 | W | |
| I_D | drain current | $T_{mb} = 25\text{ °C}$; $V_{GS} = 5\text{ V}$; Fig. 2 | [3] | - | 120 | A |
| | | $T_{mb} = 100\text{ °C}$; $V_{GS} = 5\text{ V}$; Fig. 2 | [3] | - | 120 | A |
| I_{DM} | peak drain current | $T_{mb} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$; Fig. 3 | - | 1348 | A | |
| T_{stg} | storage temperature | | -55 | 175 | °C | |

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|-----------------------------|--|---|--------|-----|------|------|
| T _j | junction temperature | | | -55 | 175 | °C |
| Source-drain diode | | | | | | |
| I _S | source current | T _{mb} = 25 °C | [3] | - | 120 | A |
| I _{SM} | peak source current | pulsed; t _p ≤ 10 μs; T _{mb} = 25 °C | | - | 1348 | A |
| Avalanche ruggedness | | | | | | |
| E _{DS(AL)S} | non-repetitive drain-source avalanche energy | I _D = 120 A; V _{sup} ≤ 40 V; R _{GS} = 50 Ω; V _{GS} = 5 V; T _{j(init)} = 25 °C; unclamped; Fig. 4 | [4][5] | - | 1008 | mJ |

- [1] Accumulated pulse duration up to 50 hours delivers zero defect ppm
- [2] Significantly longer life times are achieved by lowering T_j and or V_{GS}
- [3] Continuous current is limited by package.
- [4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [5] Refer to application note AN10273 for further information.



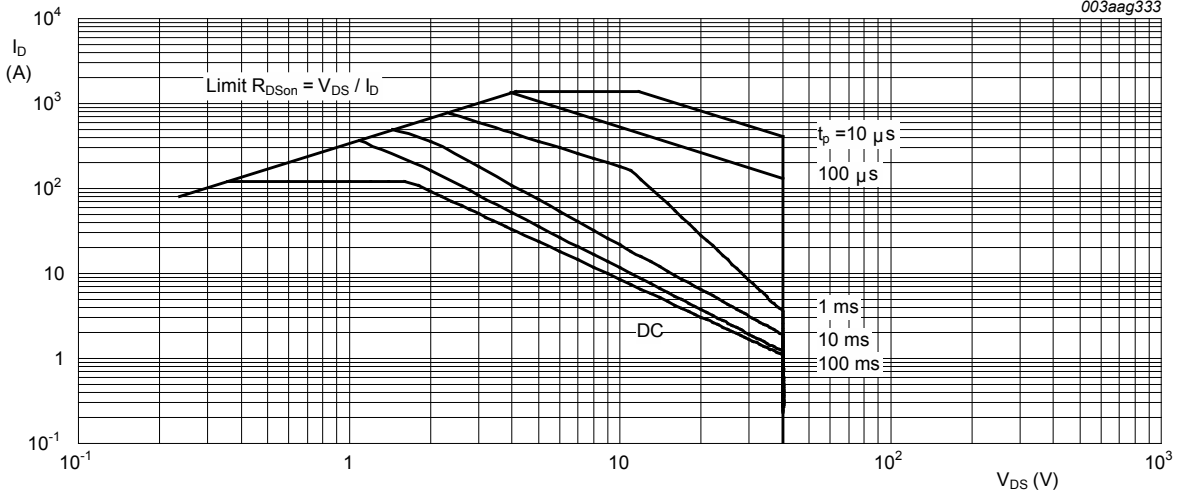


Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

$T_{mb} = 25^\circ C$; I_{DM} is a single pulse

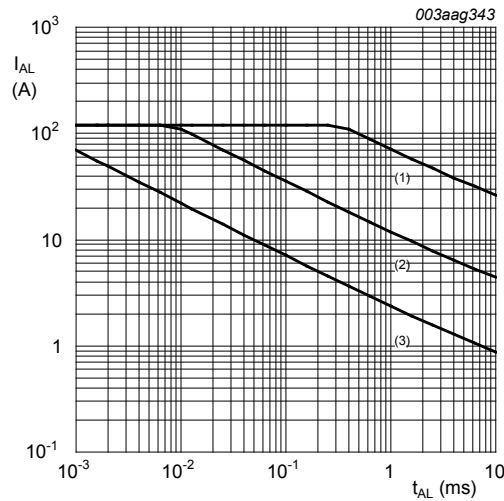


Fig. 4. Single-pulse and repetitive avalanche rating; avalanche current as a function of avalanche time

(1) $T_{j(init)} = 25^\circ C$; (2) $T_{j(init)} = 150^\circ C$; (3) Repetitive Avalanche

9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------|---|--|-----|-----|------|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | Fig. 5 | - | - | 0.43 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | minimum footprint ; mounted on a printed-circuit board | - | 50 | - | K/W |

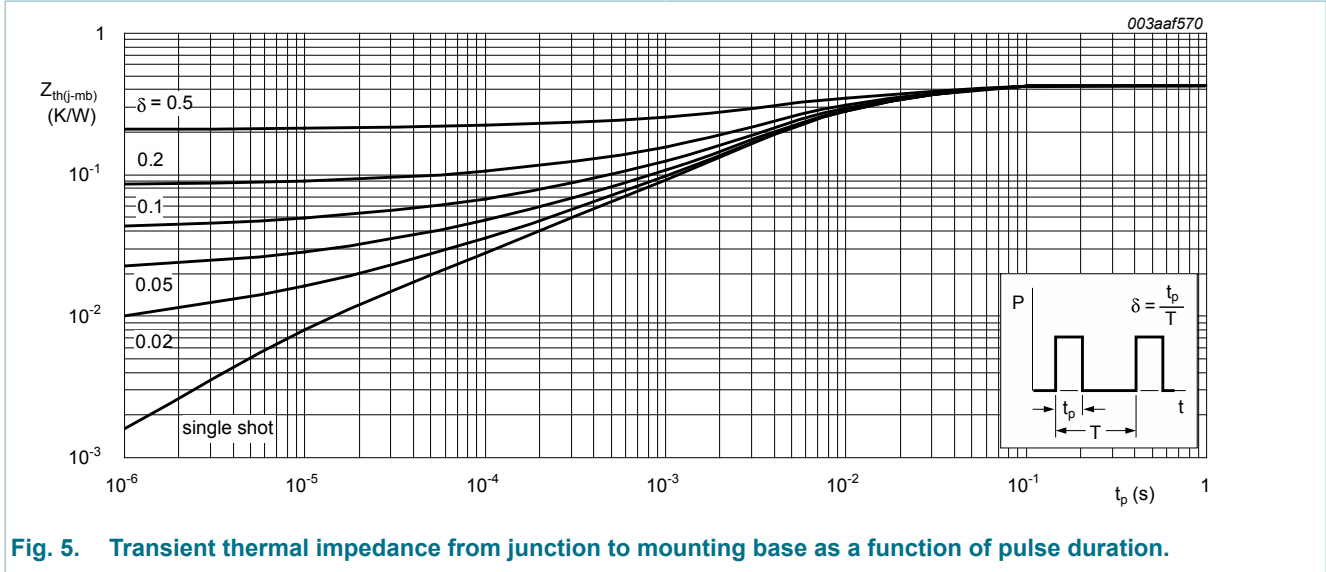


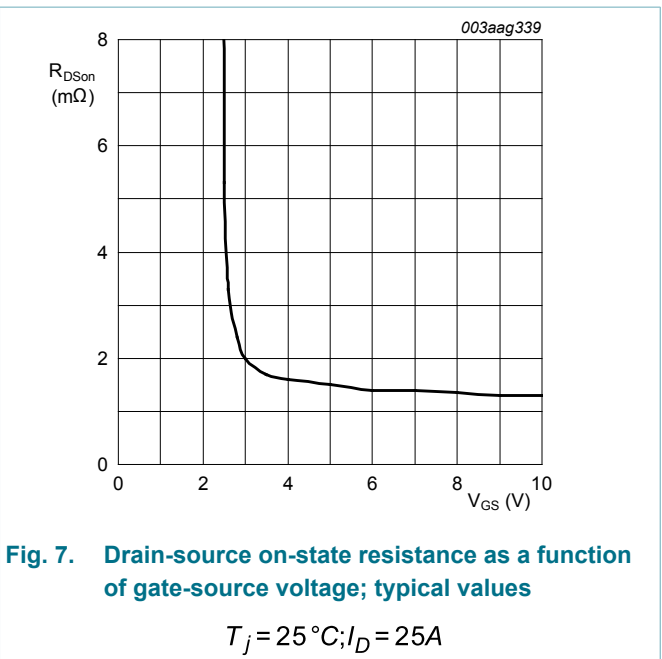
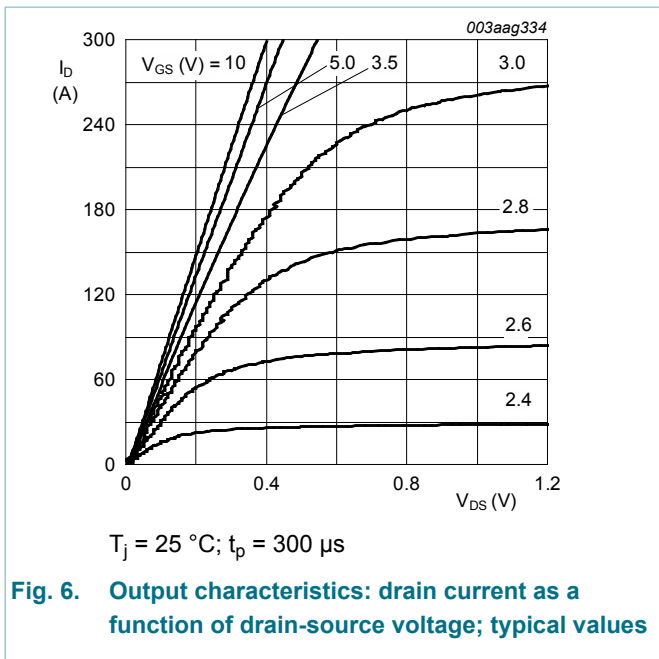
Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration.

10. Characteristics

Table 7. Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|---|-----|------|------|------------|
| Static characteristics | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D = 250 \mu A; V_{GS} = 0 V; T_J = 25 \text{ }^\circ C$ | 40 | - | - | V |
| | | $I_D = 250 \mu A; V_{GS} = 0 V; T_J = -55 \text{ }^\circ C$ | 36 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_J = 25 \text{ }^\circ C;$ Fig. 9; Fig. 10 | 1.4 | 1.7 | 2.1 | V |
| | | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_J = -55 \text{ }^\circ C;$ Fig. 9 | - | - | 2.45 | V |
| | | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_J = 175 \text{ }^\circ C;$ Fig. 9 | 0.5 | - | - | V |
| I_{DSS} | drain leakage current | $V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_J = 25 \text{ }^\circ C$ | - | 0.13 | 1 | μA |
| | | $V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_J = 175 \text{ }^\circ C$ | - | - | 500 | μA |
| I_{GSS} | gate leakage current | $V_{GS} = 10 \text{ V}; V_{DS} = 0 \text{ V}; T_J = 25 \text{ }^\circ C$ | - | 2 | 100 | nA |
| | | $V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_J = 25 \text{ }^\circ C$ | - | 2 | 100 | nA |
| R_{DSon} | drain-source on-state resistance | $V_{GS} = 5 \text{ V}; I_D = 25 \text{ A}; T_J = 25 \text{ }^\circ C;$ Fig. 11 | - | 1.35 | 1.6 | m Ω |
| | | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_J = 25 \text{ }^\circ C;$ Fig. 11 | - | 1.17 | 1.4 | m Ω |
| | | $V_{GS} = 5 \text{ V}; I_D = 25 \text{ A}; T_J = 175 \text{ }^\circ C;$ Fig. 12; Fig. 11 | - | - | 3.1 | m Ω |
| Dynamic characteristics | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 5 \text{ V};$ Fig. 13; Fig. 14 | - | 120 | - | nC |
| Q_{GS} | gate-source charge | | - | 26.9 | - | nC |

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------------------|------------------------------|---|-----|-------|-------|------|
| Q_{GD} | gate-drain charge | | - | 40.9 | - | nC |
| C_{iss} | input capacitance | $V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V}; f = 1\text{ MHz}; T_j = 25\text{ }^\circ\text{C}; \text{Fig. 15}$ | - | 12300 | 16400 | pF |
| C_{oss} | output capacitance | | - | 1530 | 1840 | pF |
| C_{rss} | reverse transfer capacitance | | - | 740 | 1020 | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS} = 30\text{ V}; R_L = 1.2\text{ }\Omega; V_{GS} = 5\text{ V}; R_{G(ext)} = 5\text{ }\Omega$ | - | 95 | - | ns |
| t_r | rise time | | - | 118 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 195 | - | ns |
| t_f | fall time | | - | 119 | - | ns |
| L_D | internal drain inductance | from upper edge of drain mounting base to center of die | - | 2.5 | - | nH |
| L_S | internal source inductance | from source lead to source bonding pad | - | 7.5 | - | nH |
| Source-drain diode | | | | | | |
| V_{SD} | source-drain voltage | $I_S = 25\text{ A}; V_{GS} = 0\text{ V}; T_j = 25\text{ }^\circ\text{C}; \text{Fig. 16}$ | - | 0.77 | 1.2 | V |
| t_{rr} | reverse recovery time | $I_S = 20\text{ A}; di_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V}$ | - | 57 | - | ns |
| Q_r | recovered charge | | - | 97 | - | nC |



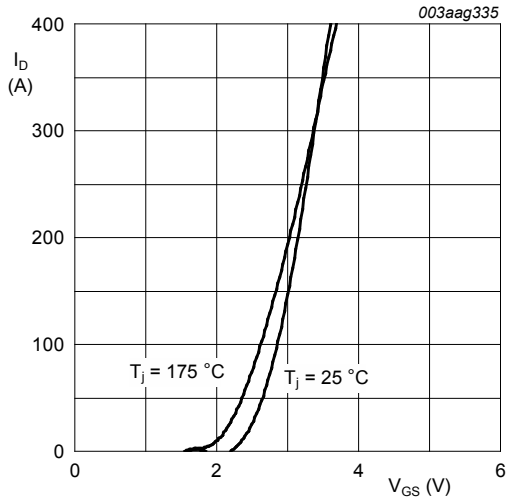


Fig. 8. Transfer characteristics: drain current as a function of gate-source voltage; typical values

$V_{DS} = 12\text{ V}$

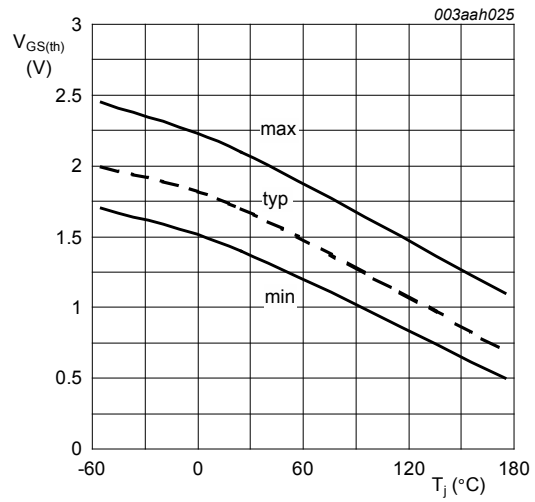


Fig. 9. Gate-source threshold voltage as a function of junction temperature

$I_D = 1\text{ mA}; V_{DS} = V_{GS}$

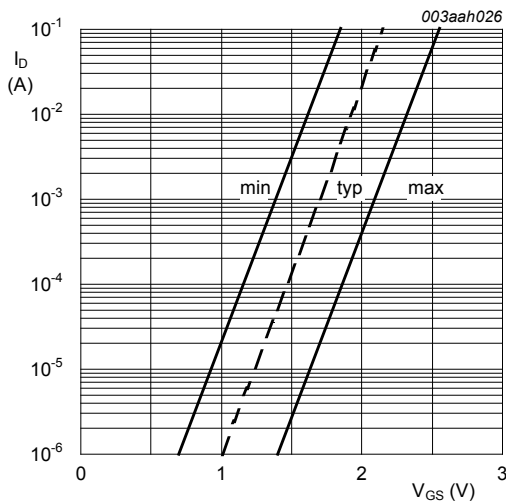


Fig. 10. Sub-threshold drain current as a function of gate-source voltage

$T_j = 25\text{ }^\circ\text{C}; V_{DS} = 5\text{ V}$

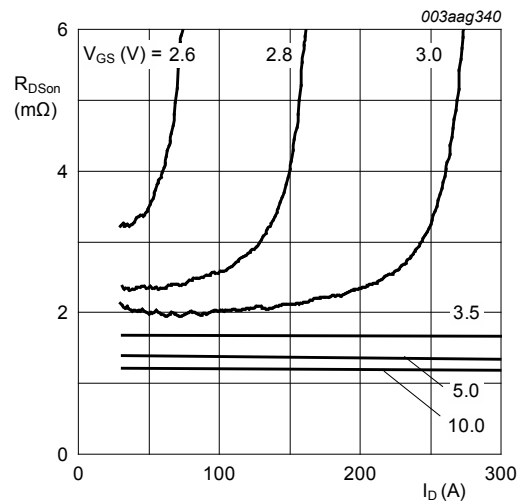


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values

$T_j = 25\text{ }^\circ\text{C}; t_p = 300\text{ }\mu\text{s}$

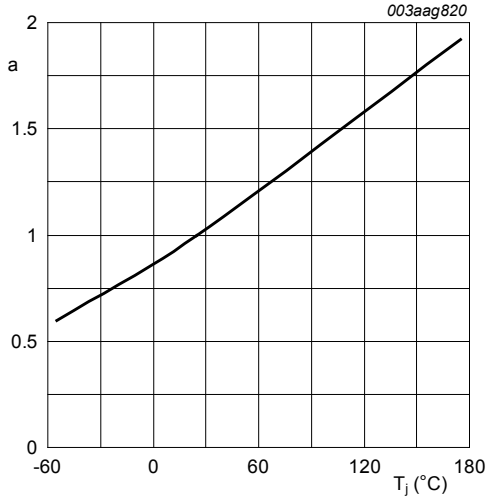


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

$$a = \frac{R_{DSon}}{R_{DSon(25^\circ\text{C})}}$$

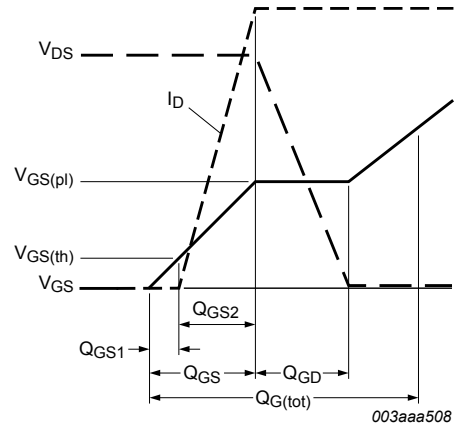
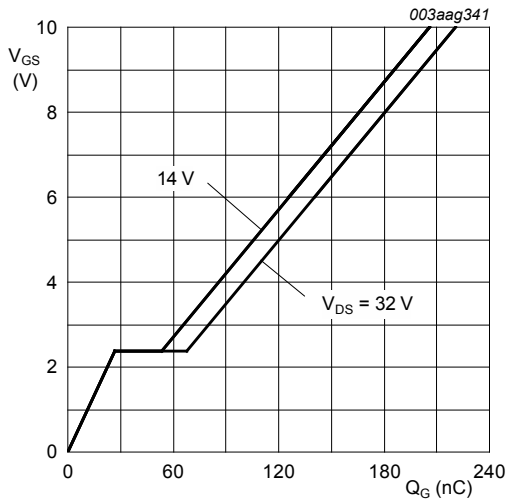
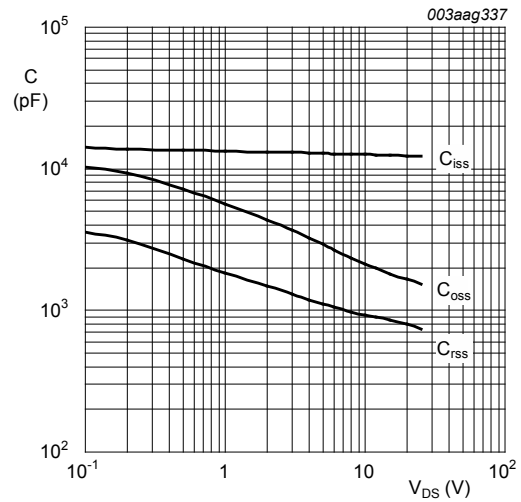


Fig. 13. Gate charge waveform definitions



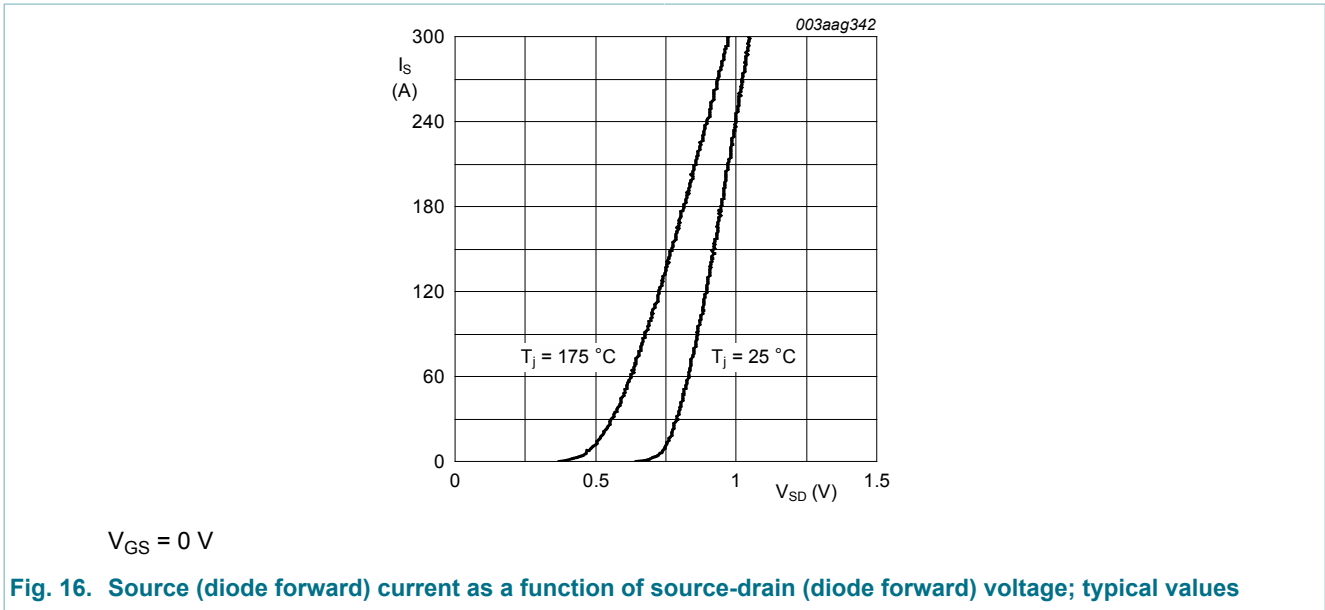
$T_j = 25^\circ\text{C}; I_D = 25\text{ A}$

Fig. 14. Gate-source voltage as a function of gate charge; typical values



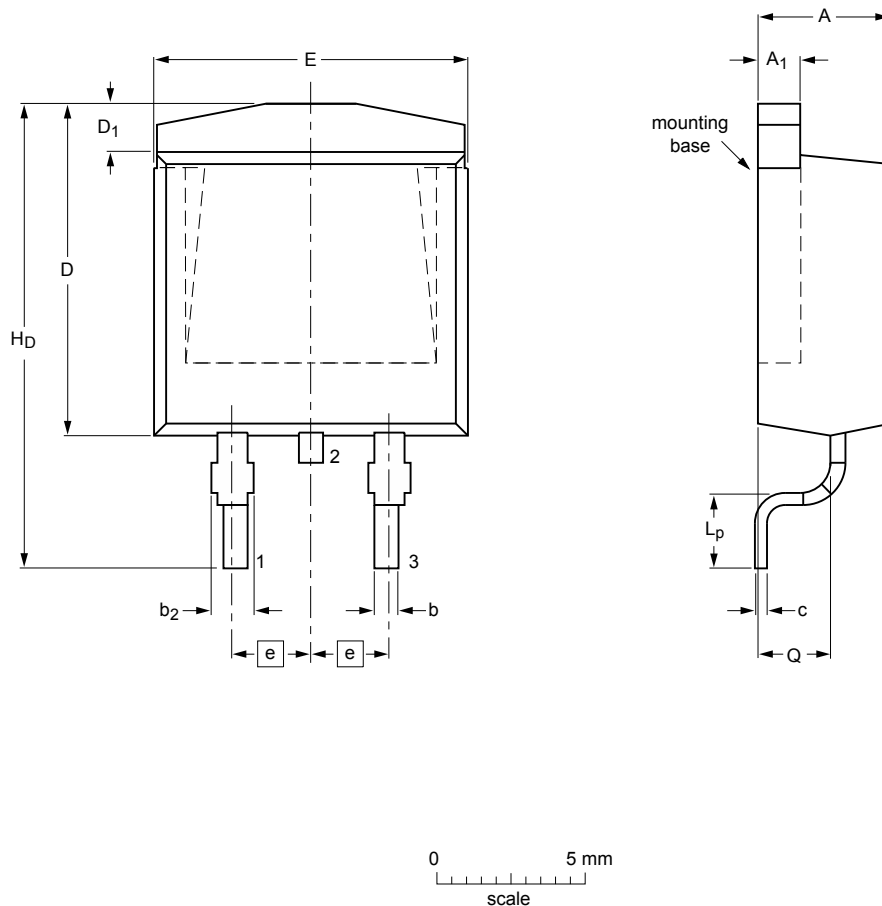
$V_{GS} = 0\text{ V}; f = 1\text{ MHz}$

Fig. 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



11. Package outline

Plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped) SOT404



Dimensions (mm are the original dimensions)

| Unit | A | A ₁ | b | b ₂ | c | D | D ₁ | E | e | H _D | L _p | Q |
|------|-----|----------------|------|----------------|------|------|----------------|-----|------|----------------|----------------|-----|
| mm | max | 4.5 | 1.40 | 0.85 | 1.45 | 0.64 | 11 | 1.6 | 10.3 | 15.8 | 2.9 | 2.6 |
| | nom | | | | | | | | 2.54 | | | |
| | min | 4.1 | 1.27 | 0.60 | 1.05 | 0.46 | | 1.2 | 9.7 | 14.8 | 2.1 | 2.2 |

sot404_po

| Outline version | References | | | European projection | Issue date |
|-----------------|------------|-------|-------|---------------------|------------------------|
| | IEC | JEDEC | JEITA | | |
| SOT404 | | | | | -06-03-16- 13-02-25 |

Fig. 17. Package outline D2PAK (SOT404)

12. Legal information

12.1 Data sheet status

| Document status [1][2] | Product status [3] | Definition |
|--------------------------------|--------------------|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
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- [2] The term 'short data sheet' is explained in section "Definitions".
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Date of release: 28 July 2016

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