

# BUK958R5-40E

## N-channel TrenchMOS logic level FET

11 September 2012

Product data sheet

## 1. Product profile

### 1.1 General description

Logic level N-channel MOSFET in a SOT78 package using TrenchMOS technology. This product has been designed and qualified to AEC Q101 standard for use in high performance automotive applications.

### 1.2 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

### 1.3 Applications

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

### 1.4 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                    | $V_{GS} = 5\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 1</a>   | [1] | -   | -   | 75  | A    |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 2</a>   |     | -   | -   | 96  | W    |
| <b>Static characteristics</b>  |                                  |  |     |     |     |     |      |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 5\text{ V}$ ; $I_D = 20\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 11</a>                             |     | -   | 6.4 | 8.1 | mΩ   |
| <b>Dynamic characteristics</b> |                                  |  |     |     |     |     |      |
| $Q_{GD}$                       | gate-drain charge                | $V_{GS} = 5\text{ V}$ ; $I_D = 20\text{ A}$ ; $V_{DS} = 32\text{ V}$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a> |     | -   | 7.3 | -   | nC   |

[1] Continuous current is limited by package.

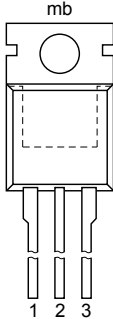
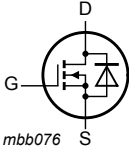


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## 2. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline   | Graphic symbol  |
|-----|--------|-----------------------------------|--|---|
| 1   | G      | gate                              | <br>TO-220AB (SOT78A) |  |
| 2   | D      | drain                             |  |   |
| 3   | S      | source                            |  |   |
| mb  | D      | mounting base; connected to drain |  |   |

## 3. Ordering information

Table 3. Ordering information

| Type number  | Package  |  |         |
|--------------|----------|--|---------|
|              | Name     | Description  | Version |
| BUK958R5-40E | TO-220AB | plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB | SOT78A  |

## 4. Marking

Table 4. Marking codes

| Type number  | Marking code |
|--------------|--------------|
| BUK958R5-40E | BUK958R5-40E |

## 5. Limiting values

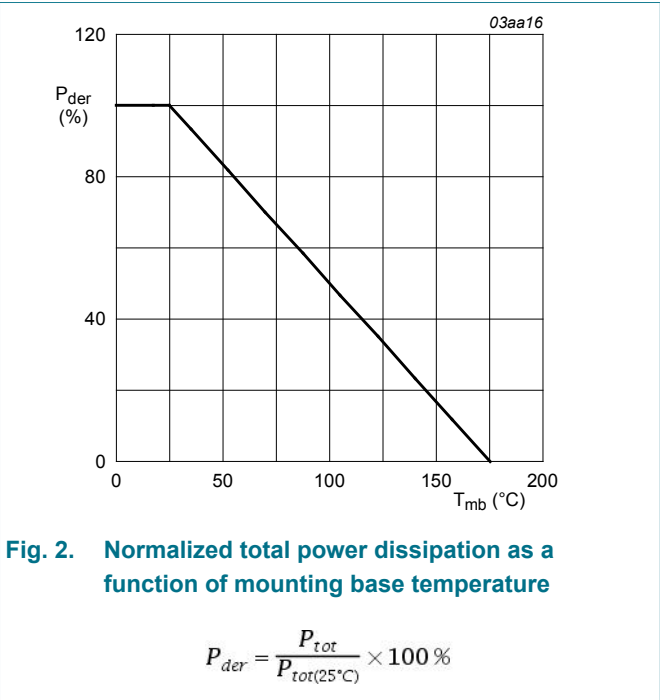
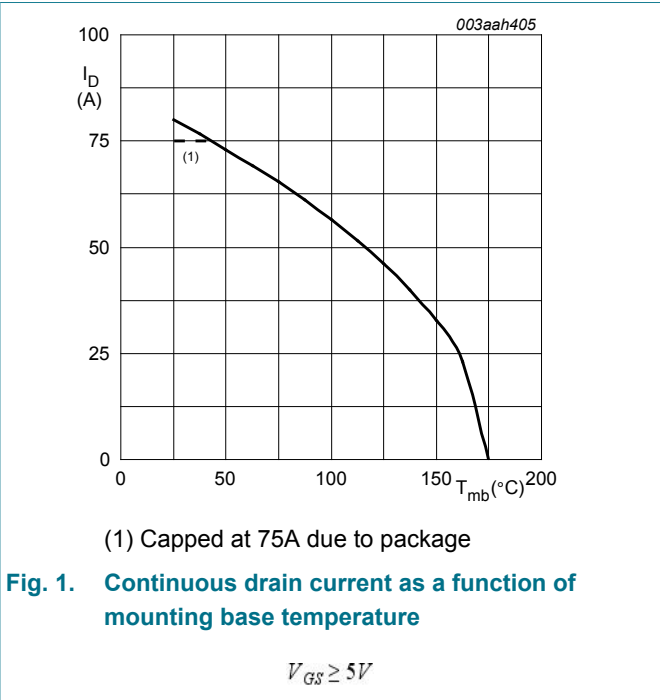
Table 5. Limiting values

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

| Symbol    | Parameter            | Conditions   |        | Min | Max | Unit |
|-----------|----------------------|--|--------|-----|-----|------|
| $V_{DS}$  | drain-source voltage | $T_j \geq 25\text{ }^{\circ}\text{C}$ ; $T_j \leq 175\text{ }^{\circ}\text{C}$ |        | -   | 40  | V    |
| $V_{DGR}$ | drain-gate voltage   | $R_{GS} = 20\text{ k}\Omega$   |        | -   | 40  | V    |
| $V_{GS}$  | gate-source voltage  | $T_j \leq 175\text{ }^{\circ}\text{C}$ ; DC                                    |        | -10 | 10  | V    |
|           |                      | $T_j \leq 175\text{ }^{\circ}\text{C}$ ; Pulsed                                | [1][2] | -15 | 15  | V    |
| $I_D$     | drain current        | $T_{mb} = 25\text{ }^{\circ}\text{C}$ ; $V_{GS} = 5\text{ V}$ ; Fig. 1         | [3]    | -   | 75  | A    |
|           |                      | $T_{mb} = 100\text{ }^{\circ}\text{C}$ ; $V_{GS} = 5\text{ V}$ ; Fig. 1        |        | -   | 56  | A    |

| Symbol               | Parameter                                    | Conditions   |                        | Min | Max | Unit |
|----------------------|--|--|------------------------|-----|-----|------|
| I <sub>DM</sub>      | peak drain current                           | T <sub>mb</sub> = 25 °C; pulsed; t <sub>p</sub> ≤ 10 μs; <a href="#">Fig. 4</a>  |                        | -   | 315 | A    |
| P <sub>tot</sub>     | total power dissipation                      | T <sub>mb</sub> = 25 °C; <a href="#">Fig. 2</a>  |                        | -   | 96  | W    |
| T <sub>stg</sub>     | storage temperature                          |  |                        | -55 | 175 | °C   |
| T <sub>j</sub>       | junction temperature                         |  |                        | -55 | 175 | °C   |
| Source-drain diode   |  |  |                        |     |     |      |
| I <sub>S</sub>       | source current                               | T <sub>mb</sub> = 25 °C  | <a href="#">[3]</a>    | -   | 75  | A    |
| I <sub>SM</sub>      | peak source current                          | pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C  |                        | -   | 315 | A    |
| Avalanche ruggedness |  |  |                        |     |     |      |
| E <sub>DS(AL)S</sub> | non-repetitive drain-source avalanche energy | I <sub>D</sub> = 75 A; V <sub>sup</sub> ≤ 40 V; R <sub>GS</sub> = 50 Ω; V <sub>GS</sub> = 5 V; T <sub>j(init)</sub> = 25 °C; unclamped; <a href="#">Fig. 3</a> | <a href="#">[4][5]</a> | -   | 44  | mJ   |

- [1] Accumulated pulse duration up to 50 hours delivers zero defect ppm
- [2] Significantly longer life times are achieved by lowering T<sub>j</sub> and or V<sub>GS</sub>
- [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.



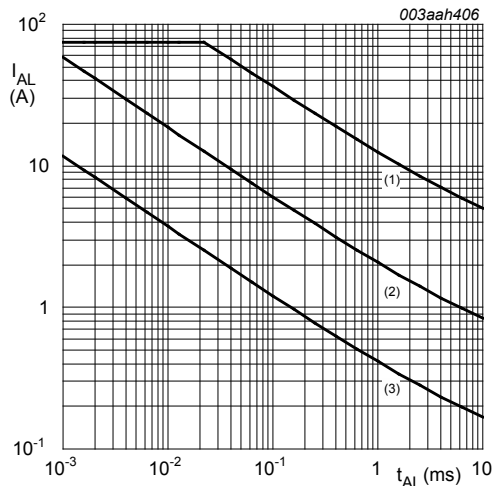


Fig. 3. Single pulse avalanche rating; avalanche current as a function of avalanche time

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

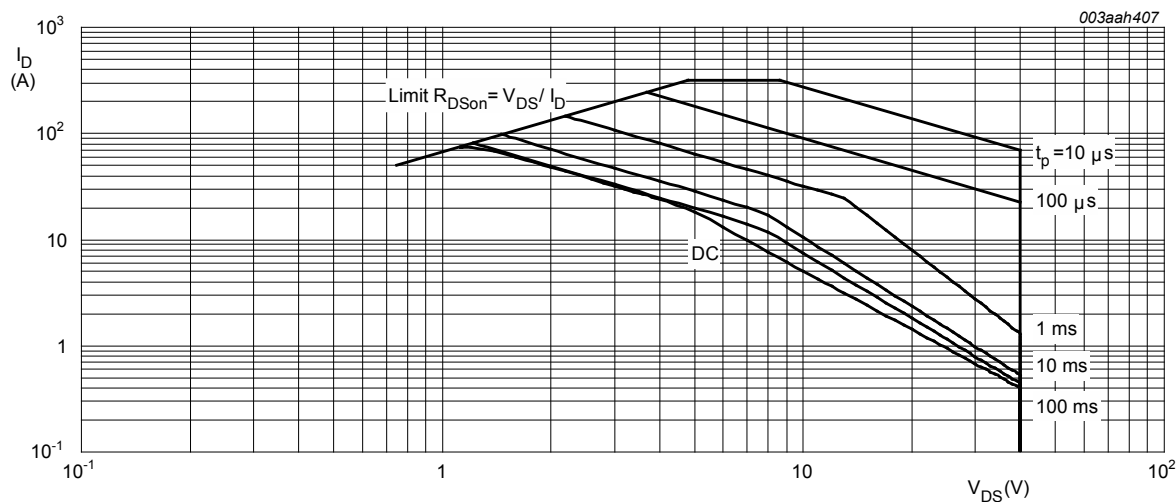


Fig. 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

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

6. 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                | -   | -   | 1.56 | K/W  |
| $R_{th(j-a)}$  | thermal resistance from junction to ambient       | vertical in still air | -   | 60  | -    | K/W  |

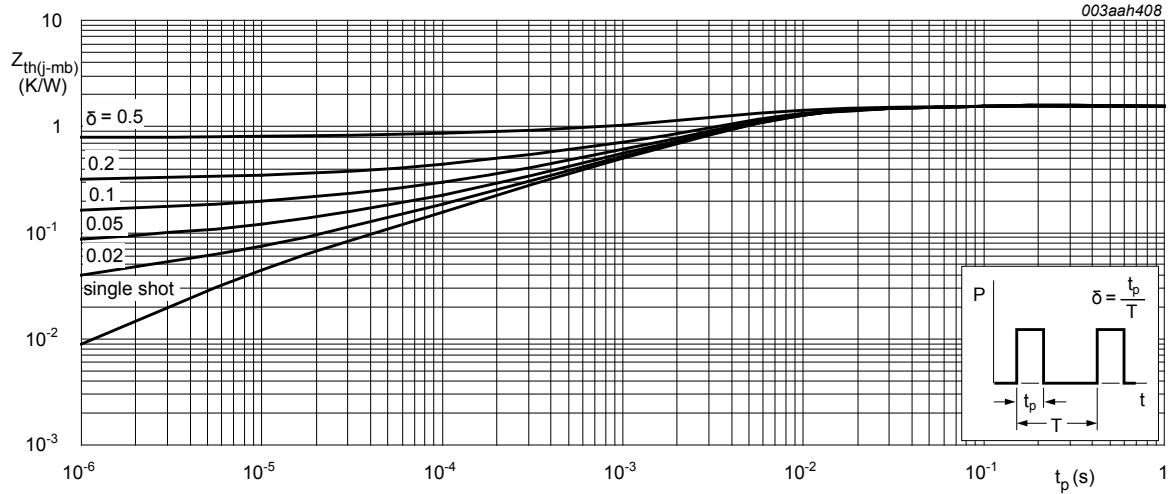


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 7. Characteristics

Table 7. Characteristics

| Symbol                  | Parameter                        | Conditions  |  | Min | Typ  | Max  | Unit |
|-------------------------|----------------------------------|---|--|-----|------|------|------|
| Static characteristics  |                                  |   |  |     |      |      |      |
| V <sub>(BR)DSS</sub>    | drain-source breakdown voltage   | I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C  |  | 40  | -    | -    | V    |
|                         |                                  | I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = -55 °C   |  | 36  | -    | -    | V    |
| V <sub>GS(th)</sub>     | gate-source threshold voltage    | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = 25 °C; <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a> |  | 1.4 | 1.7  | 2.1  | V    |
|                         |                                  | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = -55 °C; <a href="#">Fig. 9</a>                          |  | -   | -    | 2.45 | V    |
|                         |                                  | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = 175 °C; <a href="#">Fig. 9</a>                          |  | 0.5 | -    | -    | V    |
| I <sub>DSS</sub>        | drain leakage current            | V <sub>DS</sub> = 40 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C   |  | -   | 0.02 | 1    | μA   |
|                         |                                  | V <sub>DS</sub> = 40 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 175 °C  |  | -   | -    | 500  | μA   |
| I <sub>GSS</sub>        | gate leakage current             | V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C   |  | -   | 2    | 100  | nA   |
|                         |                                  | V <sub>GS</sub> = -10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C  |  | -   | 2    | 100  | nA   |
| R <sub>DSon</sub>       | drain-source on-state resistance | V <sub>GS</sub> = 5 V; I <sub>D</sub> = 20 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 11</a>                                       |  | -   | 6.4  | 8.1  | mΩ   |
|                         |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 20 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 11</a>                                      |  | -   | 5.3  | 6.6  | mΩ   |
|                         |                                  | V <sub>GS</sub> = 5 V; I <sub>D</sub> = 20 A; T <sub>j</sub> = 175 °C; <a href="#">Fig. 12</a> ; <a href="#">Fig. 11</a>            |  | -   | -    | 15.6 | mΩ   |
| Dynamic characteristics |                                  |   |  |     |      |      |      |
| Q <sub>G(tot)</sub>     | total gate charge                | I <sub>D</sub> = 20 A; V <sub>DS</sub> = 32 V; V <sub>GS</sub> = 5 V; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a>             |  | -   | 20.9 | -    | nC   |
| Q <sub>GS</sub>         | gate-source charge               |   |  | -   | 4.9  | -    | nC   |

| Symbol       | Parameter                    | Conditions  |  | Min | Typ  | Max  | Unit |
|--------------|------------------------------|---|--|-----|------|------|------|
| $Q_{GD}$     | gate-drain charge            |   |  | -   | 7.3  | -    | nC   |
| $C_{iss}$    | input capacitance            | $V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V}; f = 1\text{ MHz};$<br>$T_j = 25\text{ }^{\circ}\text{C};$ <a href="#">Fig. 15</a> |  | -   | 1936 | 2600 | pF   |
| $C_{oss}$    | output capacitance           |   |  | -   | 260  | 310  | pF   |
| $C_{rss}$    | reverse transfer capacitance |   |  | -   | 142  | 190  | pF   |
| $t_{d(on)}$  | turn-on delay time           | $V_{DS} = 30\text{ V}; R_L = 1.5\text{ }\Omega; V_{GS} = 5\text{ V};$<br>$R_{G(ext)} = 5\text{ }\Omega$                       |  | -   | 19   | -    | ns   |
| $t_r$        | rise time                    |   |  | -   | 27   | -    | ns   |
| $t_{d(off)}$ | turn-off delay time          |   |  | -   | 36   | -    | ns   |
| $t_f$        | fall time                    |   |  | -   | 21   | -    | 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  | $I_S = 20\text{ A}; V_{GS} = 0\text{ V}; T_j = 25\text{ }^{\circ}\text{C};$ <a href="#">Fig. 16</a>      |  | - | 0.85 | 1.2 | V  |
| $t_{rr}$ | reverse recovery time | $I_S = 20\text{ A}; dI_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V};$<br>$V_{DS} = 25\text{ V}$ |  | - | 20.8 | -   | ns |
| $Q_r$    | recovered charge      |  |  | - | 13.6 | -   | nC |

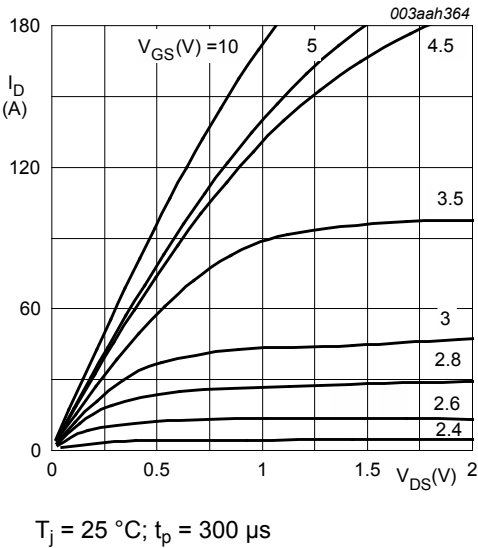


Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values

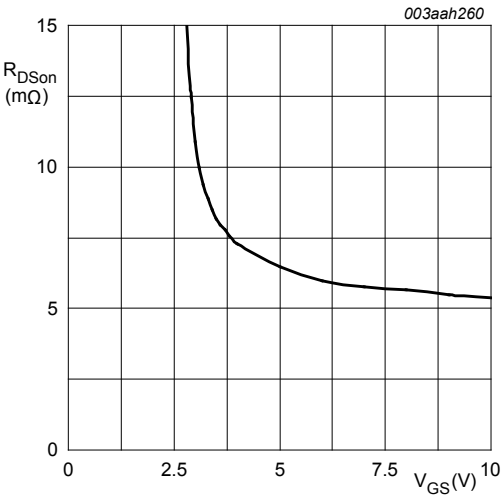


Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values

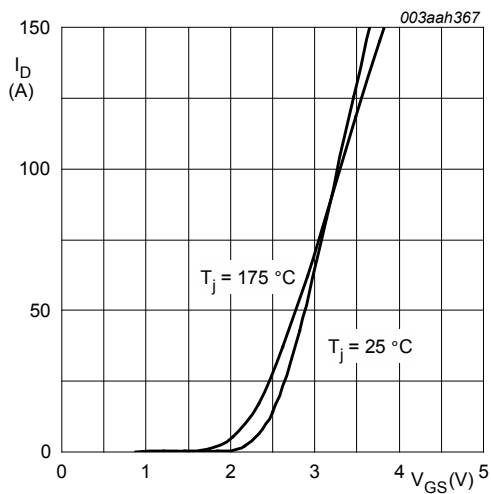


Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values

$V_{DS} = 10V$

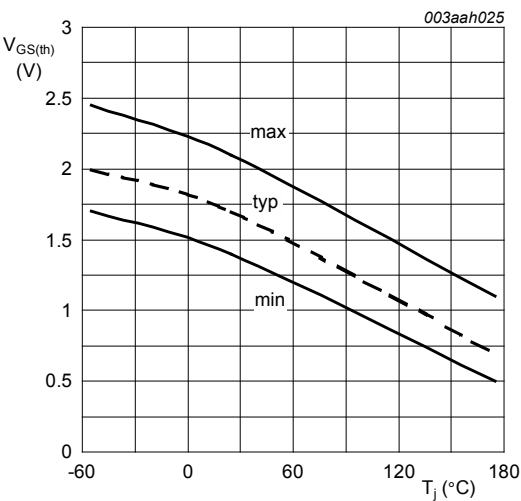


Fig. 9. Gate-source threshold voltage as a function of junction temperature

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

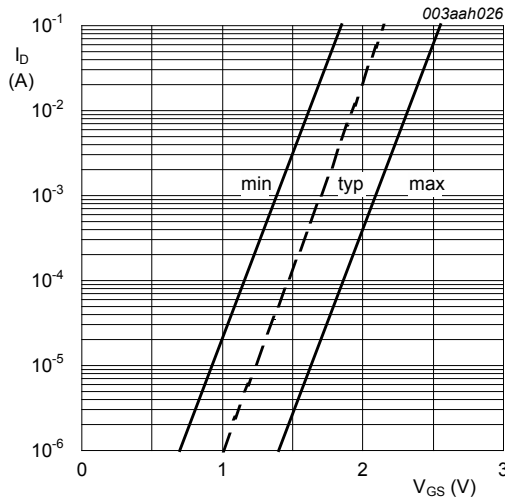


Fig. 10. Sub-threshold drain current as a function of gate-source voltage

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

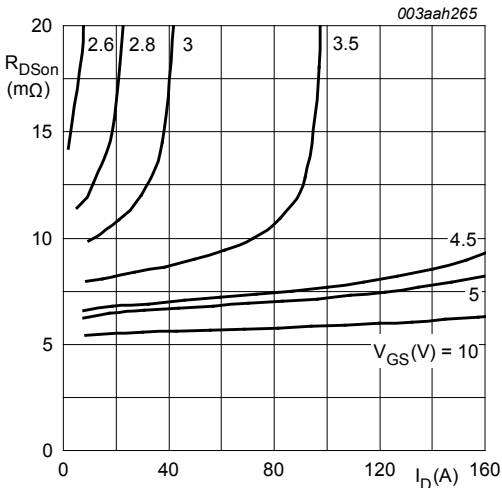


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values

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

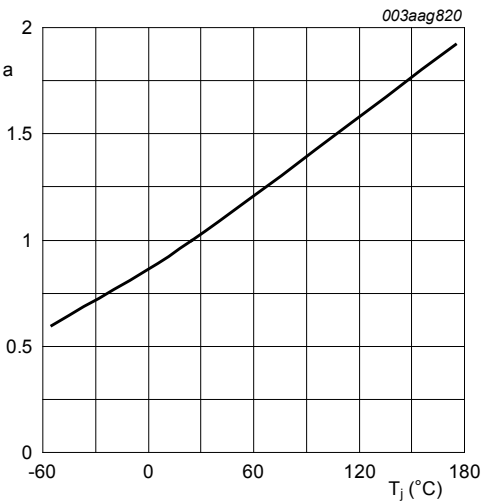


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

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

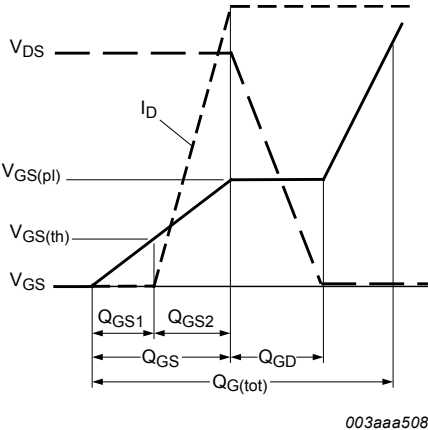


Fig. 13. Gate charge waveform definitions

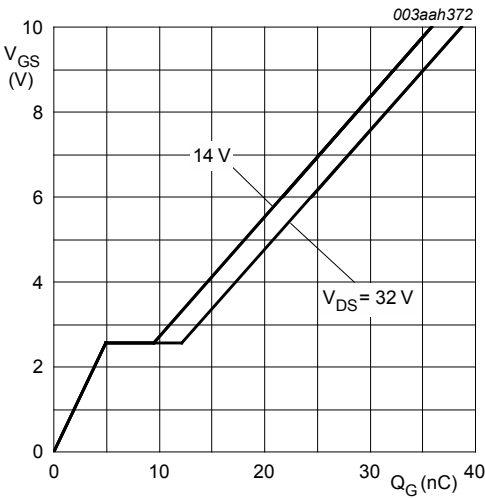


Fig. 14. Gate-source voltage as a function of gate charge; typical values

$$T_j = 25\text{ }^{\circ}\text{C}; I_D = 20\text{ A}$$

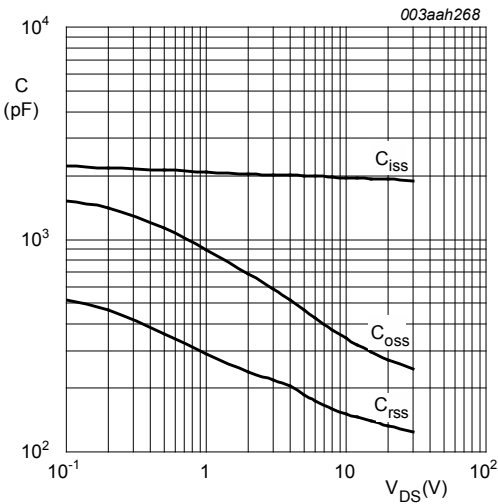


Fig. 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

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

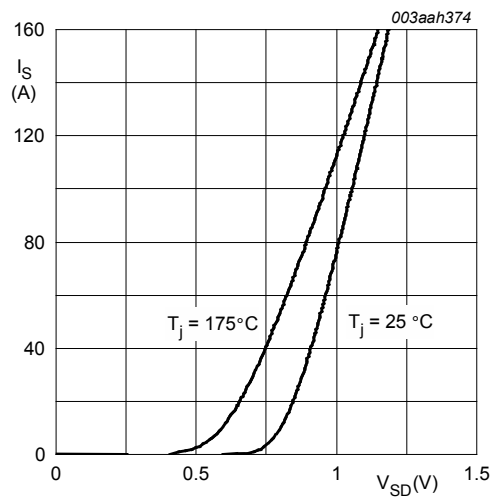


Fig. 16. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values

$V_{GS} = 0\text{ V}$

8. Package outline

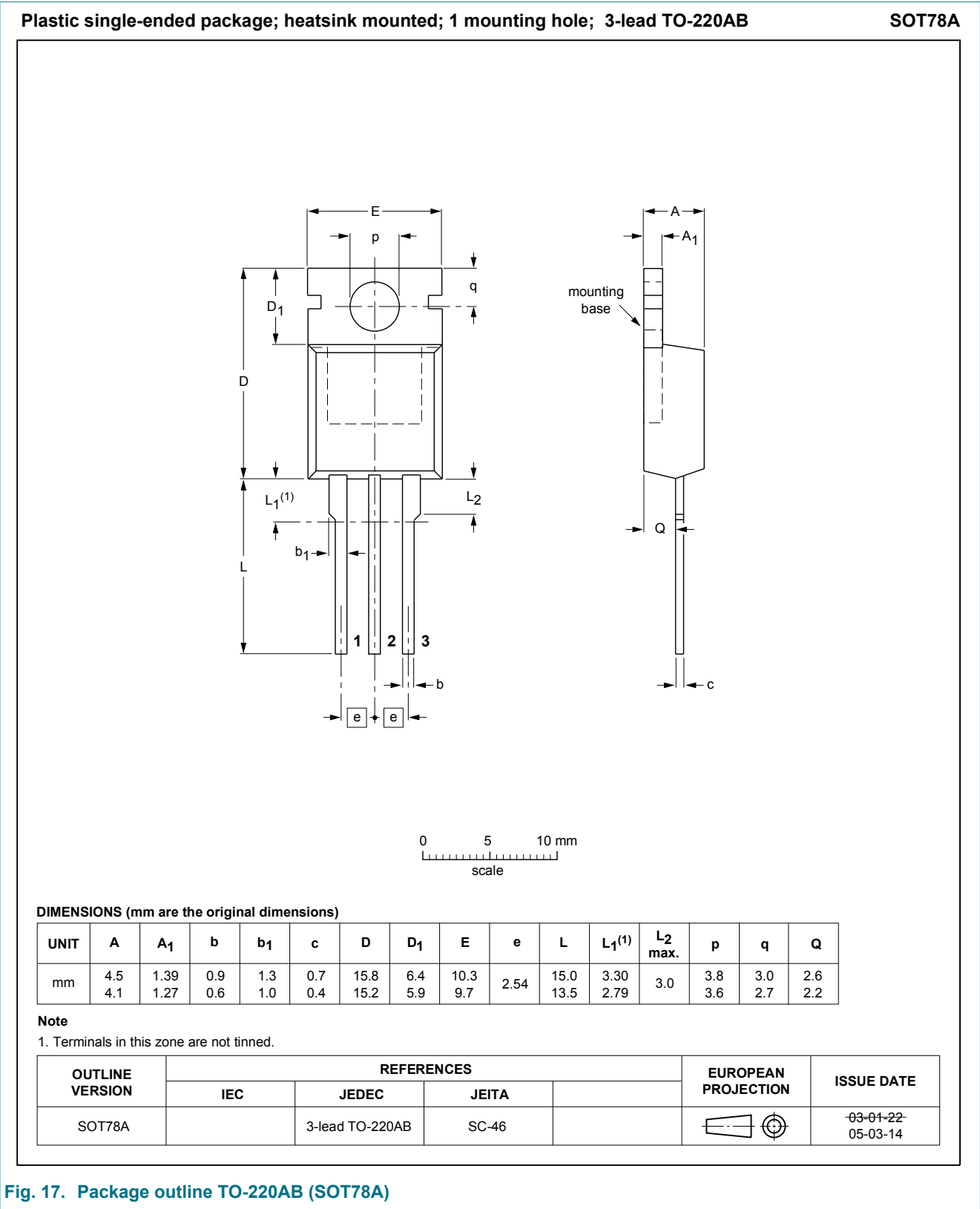


Fig. 17. Package outline TO-220AB (SOT78A)

## 9. Legal information

### 9.1 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.                       |
| Product [short] data sheet     | Production         | This document contains the product specification.                                     |

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
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## 10. Contents

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