



BUK653R3-30C

N-channel TrenchMOS intermediate level FET

Rev. 1 — 13 July 2011

Product data sheet

1. Product profile

1.1 General description

Intermediate level gate drive N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using advanced TrenchMOS technology. This product has been designed and qualified to the appropriate AEC Q101 standard for use in high performance automotive applications.

1.2 Features and benefits

- AEC Q101 compliant
- Suitable for standard and logic level gate drive sources
- Suitable for thermally demanding environments due to 175 °C rating

1.3 Applications

- 12 V Automotive systems
- Electric and electro-hydraulic power steering
- 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 | $T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$ | - | - | 30 | V |
| I_D | drain current | $V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C};$ see Figure 1 | 11 | - | 100 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C};$ see Figure 2 | - | - | 204 | W |
| Static characteristics | | | | | | |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 25\text{ A};$ $T_j = 25\text{ °C};$ see Figure 11 ; see Figure 12 | - | 2.72 | 3.3 | mΩ |



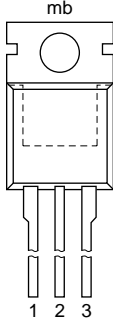
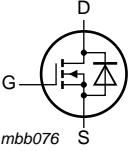
Table 1. Quick reference data ...continued

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|--|---|-----|------|-----|------|
| Avalanche ruggedness | | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 100\text{ A}$; $V_{sup} \leq 30\text{ V}$; $R_{GS} = 50\ \Omega$; $V_{GS} = 10\text{ V}$; $T_{j(init)} = 25\text{ }^\circ\text{C}$; unclamped | - | - | 501 | mJ |
| Dynamic characteristics | | | | | | |
| Q_{GD} | gate-drain charge | $I_D = 25\text{ A}$; $V_{DS} = 24\text{ V}$; $V_{GS} = 10\text{ V}$; see Figure 13 ; see Figure 14 | - | 33.3 | - | nC |

[1] Continuous current is limited by package.

2. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|--------------------------------------|--|--|
| 1 | G | gate |  |  |
| 2 | D | drain | | |
| 3 | S | source | | |
| mb | D | mounting base; connected to drain | | |

SOT78A (TO-220AB)

3. Ordering information

Table 3. Ordering information

| Type number | Package | | Version |
|--------------|----------|--|---------|
| | Name | Description | |
| BUK653R3-30C | TO-220AB | plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB | SOT78A |

4. Limiting values

Table 4. Limiting values

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

| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------------------------|--|---|-------------|-----|------|
| V_{DS} | drain-source voltage | $T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$ | - | 30 | V |
| V_{GS} | gate-source voltage | DC | [1] -16 | 16 | V |
| | | Pulsed | [2] -20 | 20 | V |
| I_D | drain current | $T_{mb} = 25\text{ °C}; V_{GS} = 10\text{ V};$ see Figure 1 | [3] - | 100 | A |
| | | $T_{mb} = 100\text{ °C}; V_{GS} = 10\text{ V};$ see Figure 1 | [3] - | 100 | A |
| I_{DM} | peak drain current | $T_{mb} = 25\text{ °C};$ pulsed; $t_p \leq 10\text{ }\mu\text{s};$ see Figure 3 | - | 721 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C};$ see Figure 2 | - | 204 | W |
| T_{stg} | storage temperature | | -55 | 175 | °C |
| T_j | junction temperature | | -55 | 175 | °C |
| Source-drain diode | | | | | |
| I_S | source current | $T_{mb} = 25\text{ °C}$ | [3] - | 100 | A |
| I_{SM} | peak source current | pulsed; $t_p \leq 10\text{ }\mu\text{s}; T_{mb} = 25\text{ °C}$ | - | 721 | A |
| Avalanche ruggedness | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 100\text{ A}; V_{sup} \leq 30\text{ V}; R_{GS} = 50\text{ }\Omega;$ $V_{GS} = 10\text{ V}; T_{j(init)} = 25\text{ °C};$ unclamped | - | 501 | mJ |
| $E_{DS(AL)R}$ | repetitive drain-source avalanche energy | | [4][5][6] - | - | J |

[1] -16V accumulated duration not to exceed 168 hrs

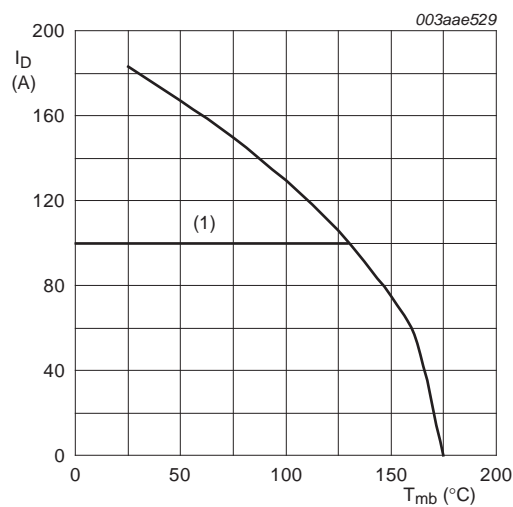
[2] Accumulated pulse duration not to exceed 5mins.

[3] Continuous current is limited by package.

[4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.

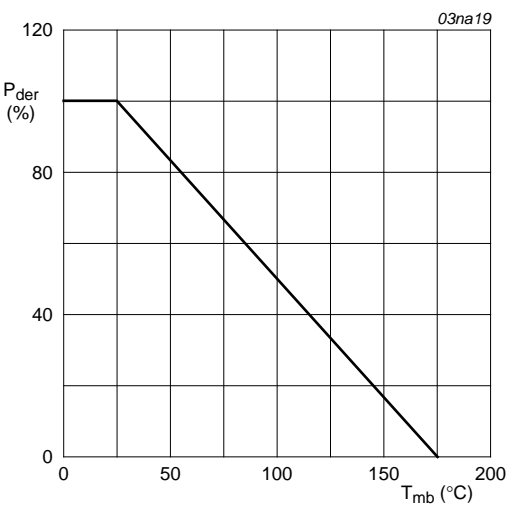
[5] Repetitive avalanche rating limited by an average junction temperature of 170 °C.

[6] Refer to application note AN10273 for further information.



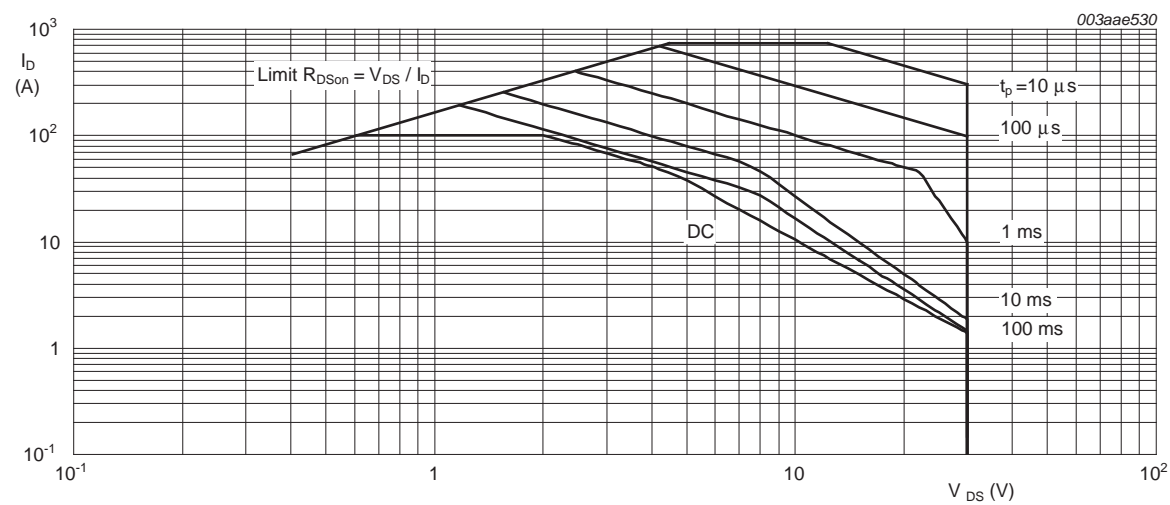
$V_{GS} \geq 10\text{ V}$
(1) capped at 100 A due to package

Fig 1. Continuous drain current as a function of mounting base temperature



$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ\text{C})}} \times 100\%$$

Fig 2. Normalized total power dissipation as a function of mounting base temperature



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

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

5. Thermal characteristics

Table 5. Thermal characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------|---|------------------------------|-----|-----|------|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | see Figure 4 | - | - | 0.74 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | vertical in free air | - | 60 | - | K/W |

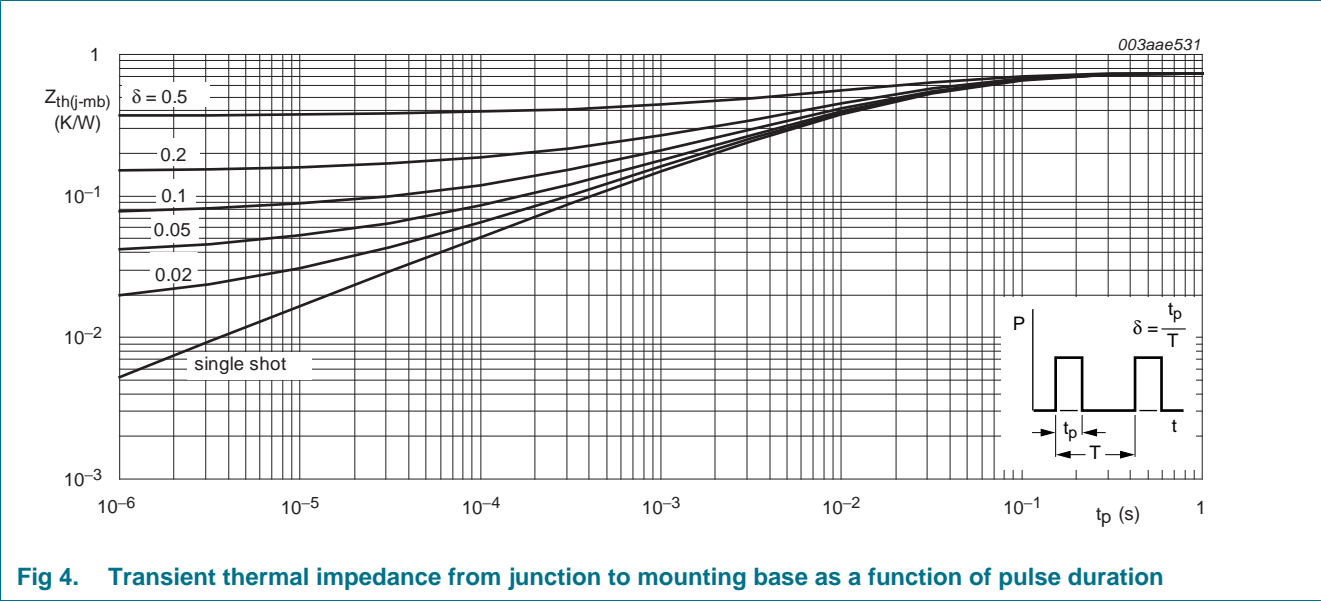


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

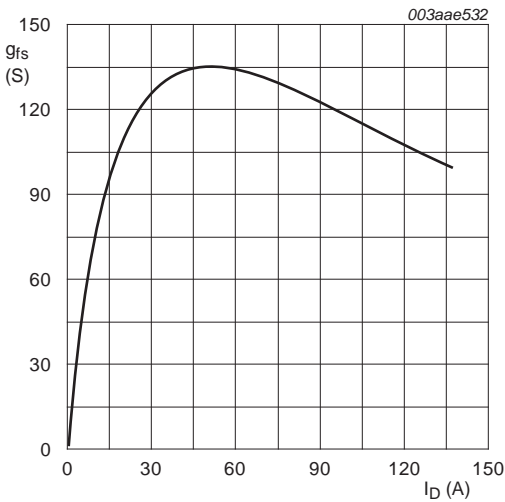
6. Characteristics

Table 6. Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------------------|----------------------------------|---|-----|------|------|------|
| Static characteristics | | | | | | |
| V _{(BR)DSS} | drain-source breakdown voltage | I _D = 250 μA; V _{GS} = 0 V; T _j = 25 °C | 30 | - | - | V |
| | | I _D = 250 μA; V _{GS} = 0 V; T _j = -55 °C | 27 | - | - | V |
| V _{GS(th)} | gate-source threshold voltage | I _D = 1 mA; V _{DS} = V _{GS} ; T _j = 25 °C; see Figure 9 ; see Figure 10 | 1.8 | 2.3 | 2.8 | V |
| | | I _D = 1 mA; V _{DS} = V _{GS} ; T _j = -55 °C; see Figure 10 | - | - | 3.3 | V |
| | | I _D = 2.5 mA; V _{DS} = V _{GS} ; T _j = 175 °C; see Figure 10 | 0.8 | - | - | V |
| I _{DSS} | drain leakage current | V _{DS} = 30 V; V _{GS} = 0 V; T _j = 25 °C | - | 0.02 | 1 | μA |
| | | V _{DS} = 30 V; V _{GS} = 0 V; T _j = 175 °C | - | - | 500 | μA |
| I _{GSS} | gate leakage current | V _{GS} = 20 V; V _{DS} = 0 V; T _j = 25 °C | - | 2 | 100 | nA |
| | | V _{GS} = -20 V; V _{DS} = 0 V; T _j = 25 °C | - | 2 | 100 | nA |
| R _{DSon} | drain-source on-state resistance | V _{GS} = 10 V; I _D = 25 A; T _j = 25 °C; see Figure 11 ; see Figure 12 | - | 2.72 | 3.3 | mΩ |
| | | V _{GS} = 4.5 V; I _D = 25 A; T _j = 25 °C; see Figure 11 ; see Figure 12 | - | 3.9 | 5.3 | mΩ |
| | | V _{GS} = 5 V; I _D = 25 A; T _j = 25 °C; see Figure 11 | - | 3.45 | 4.4 | mΩ |
| | | V _{GS} = 10 V; I _D = 25 A; T _j = 175 °C; see Figure 11 | - | 5.75 | 6.3 | mΩ |
| Dynamic characteristics | | | | | | |
| Q _{G(tot)} | total gate charge | I _D = 25 A; V _{DS} = 24 V; V _{GS} = 10 V; see Figure 13 ; see Figure 14 | - | 114 | - | nC |
| | | I _D = 25 A; V _{DS} = 24 V; V _{GS} = 5 V; see Figure 13 ; see Figure 14 | - | 66 | - | nC |
| Q _{GS} | gate-source charge | I _D = 25 A; V _{DS} = 24 V; V _{GS} = 10 V; see Figure 13 ; see Figure 14 | - | 18 | - | nC |
| Q _{GD} | gate-drain charge | | - | 33.3 | - | nC |
| C _{iss} | input capacitance | V _{GS} = 0 V; V _{DS} = 25 V; f = 1 MHz; T _j = 25 °C; see Figure 15 | - | 5216 | 6960 | pF |
| C _{oss} | output capacitance | | - | 896 | 1100 | pF |
| C _{rss} | reverse transfer capacitance | | - | 537 | 740 | pF |
| t _{d(on)} | turn-on delay time | V _{DS} = 25 V; R _L = 1 Ω; V _{GS} = 10 V; R _{G(ext)} = 10 Ω | - | 22 | - | ns |
| t _r | rise time | | - | 59 | - | ns |
| t _{d(off)} | turn-off delay time | | - | 209 | - | ns |
| t _f | fall time | | - | 113 | - | ns |
| L _D | internal drain inductance | from drain lead 6 mm from package to centre of die; T _j = 25 °C | - | 4.5 | - | nH |
| L _S | internal source inductance | from source lead to source bond pad; T _i = 25 °C | - | 7.5 | - | nH |

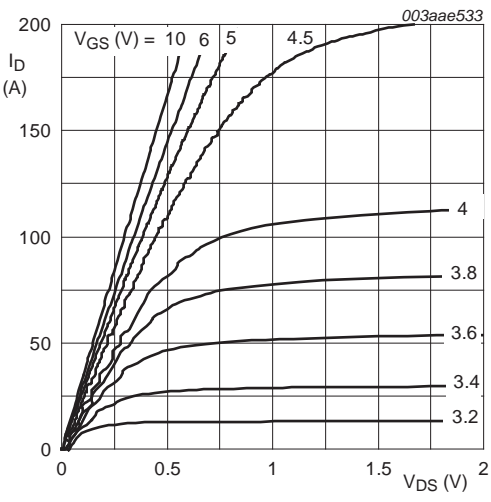
Table 6. Characteristics ...continued

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------|-----------------------|--|-----|-----|-----|------|
| Source-drain diode | | | | | | |
| V_{SD} | source-drain voltage | $I_S = 25\text{ A}$; $V_{GS} = 0\text{ V}$; $T_J = 25\text{ }^{\circ}\text{C}$; see Figure 16 | - | 0.8 | 1.2 | V |
| t_{rr} | reverse recovery time | $I_S = 20\text{ A}$; $dI_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$; | - | 50 | - | ns |
| Q_r | recovered charge | $V_{DS} = 25\text{ V}$ | - | 73 | - | nC |



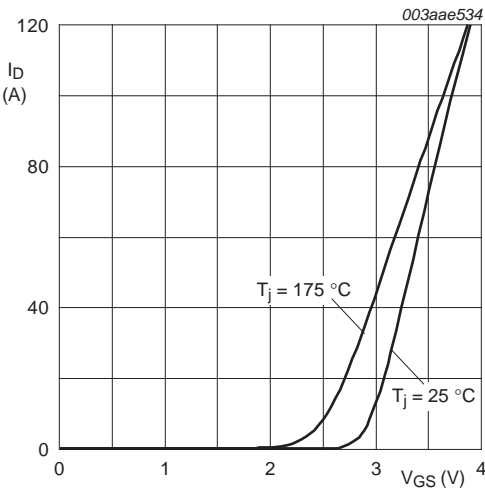
$T_J = 25\text{ }^{\circ}\text{C}$; $V_{DS} = 25\text{ V}$

Fig 5. Forward transconductance as a function of drain current; typical values



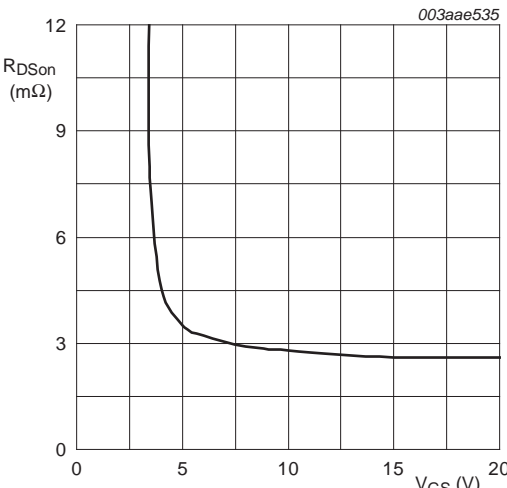
$T_J = 25\text{ }^{\circ}\text{C}$ and $t_p = 300\text{ }\mu\text{s}$

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



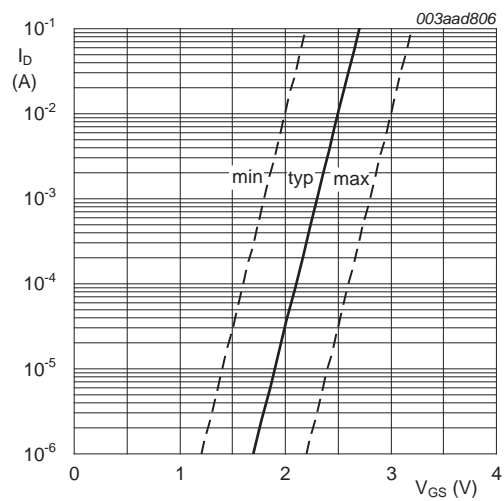
$V_{DS} = 25\text{ V}$

Fig 7. Transfer characteristics: drain current as a function of gate-source voltage; typical values



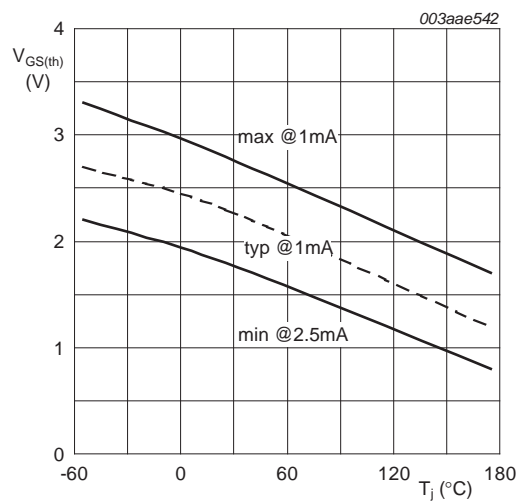
$T_J = 25\text{ }^{\circ}\text{C}$; $I_D = 25\text{ A}$

Fig 8. Drain-source on-state resistance as a function of gate-source voltage; typical values



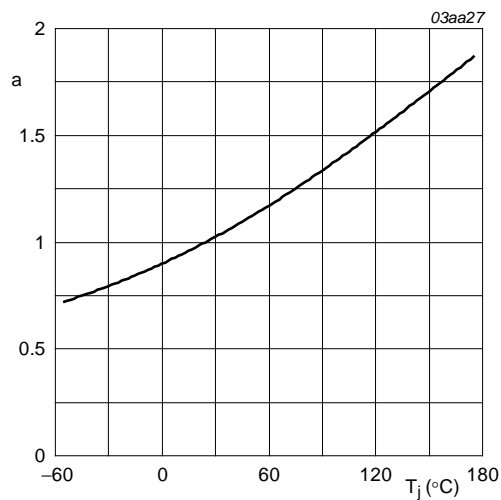
$T_j = 25^{\circ}\text{C}; V_{DS} = 5\text{V}$

Fig 9. Sub-threshold drain current as a function of gate-source voltage



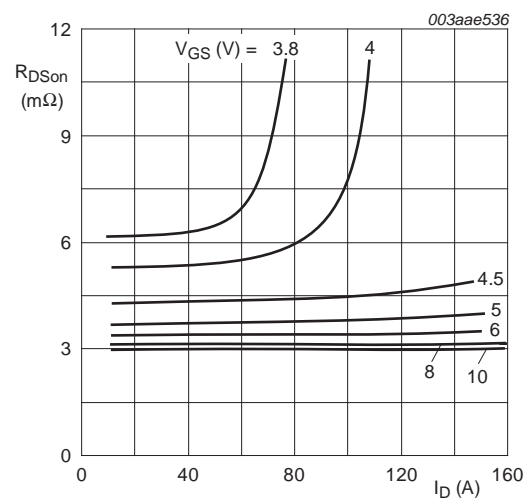
$I_D = 1\text{mA}; V_{DS} = V_{GS}$

Fig 10. Gate-source threshold voltage as a function of junction temperature



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

Fig 11. Normalized drain-source on-state resistance factor as a function of junction temperature



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

Fig 12. Drain-source on-state resistance as a function of drain current; typical values

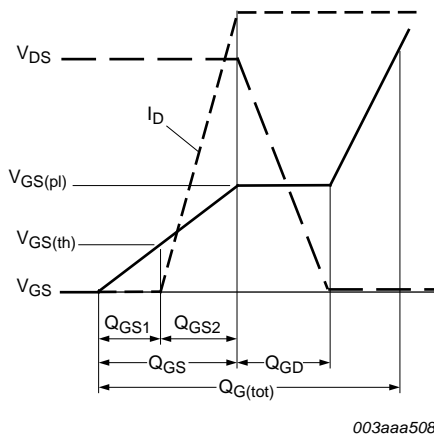
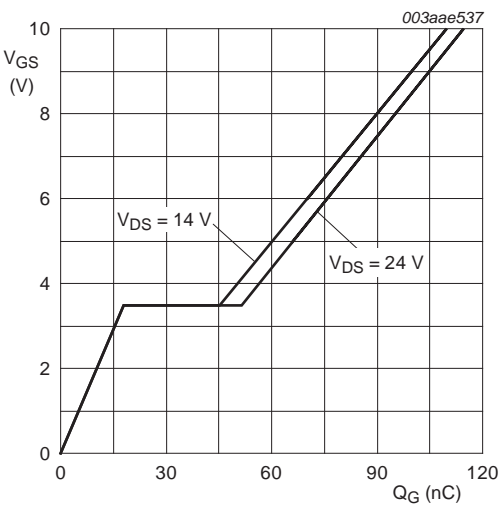
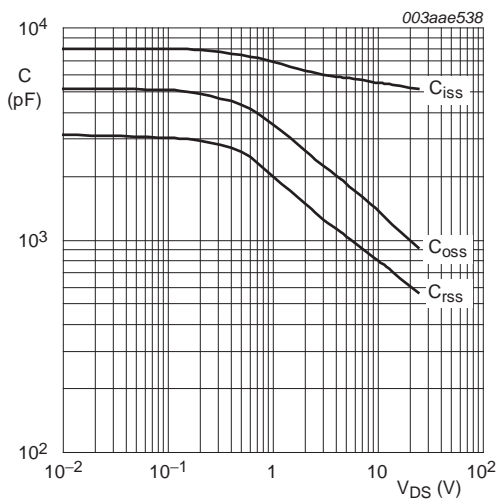


Fig 13. Gate charge waveform definitions



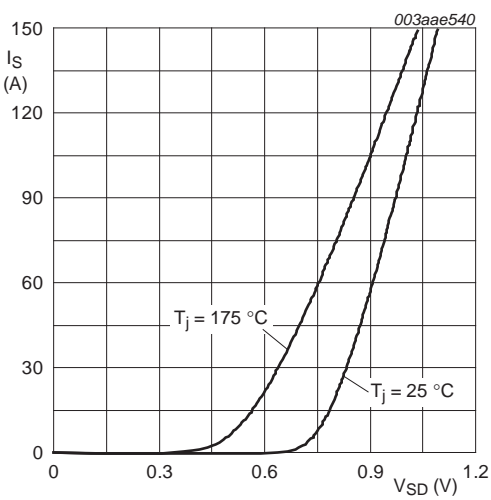
$T_j = 25^\circ\text{C}$ and $I_D = 25\text{ A}$

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



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

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

7. Package outline

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB

SOT78A

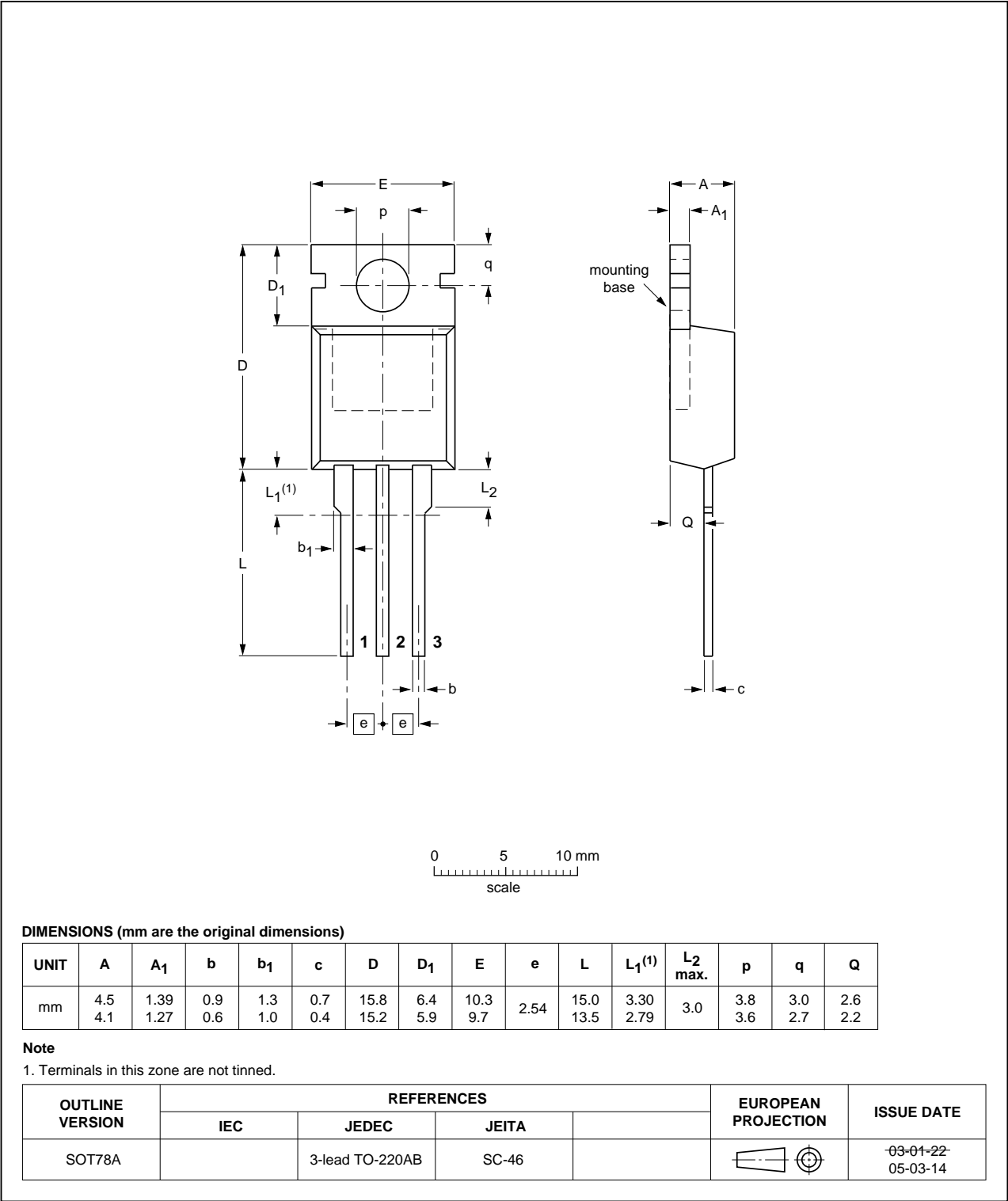


Fig 17. Package outline SOT78A (TO-220AB)

8. Revision history

Table 7. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|------------------|--------------|--------------------|---------------|------------|
| BUK653R3-30C v.1 | 20110713 | Product data sheet | - | - |

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. |
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