

BUK653R2-55C

N-channel TrenchMOS intermediate level FET

Rev. 01 — 6 September 2010

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 intermediate level gate drive sources
- Suitable for thermally demanding environments due to 175 °C rating

1.3 Applications

- 12 V and 24 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 | $T_j \geq 25\text{ °C}$; $T_j \leq 175\text{ °C}$ | - | - | 55 | V |
| I_D | drain current | $V_{GS} = 10\text{ V}$; $T_{mb} = 25\text{ °C}$; see Figure 1 | - | - | 120 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C}$; see Figure 2 | - | - | 306 | W |
| Static characteristics | | | | | | |
| R_{DSon} | drain-source on-state resistance | $V_{GS} = 10\text{ V}$; $I_D = 25\text{ A}$; $T_j = 25\text{ °C}$; see Figure 11 | - | 2.7 | 3.2 | mΩ |



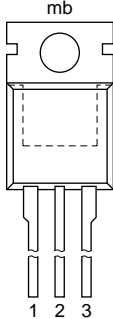
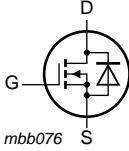
Table 1. Quick reference data ...continued

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|--|--|-----|-----|-----|------|
| Avalanche ruggedness | | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 120\text{ A}$; $V_{sup} \leq 55\text{ V}$; $R_{GS} = 50\ \Omega$; $V_{GS} = 10\text{ V}$; $T_{j(\text{init})} = 25\text{ }^\circ\text{C}$; unclamped | - | - | 724 | mJ |
| Dynamic characteristics | | | | | | |
| Q_{GD} | gate-drain charge | $I_D = 25\text{ A}$; $V_{DS} = 44\text{ V}$; $V_{GS} = 10\text{ V}$; see Figure 13 ; see Figure 14 | - | 75 | - | 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 | |
| BUK653R2-55C | 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 | $T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$ | - | 55 | V |
| V_{GS} | gate-source voltage | Pulsed [1] | -20 | 20 | V |
| | | DC [2] | -16 | 16 | V |
| I_D | drain current | $T_{mb} = 25\text{ °C}; V_{GS} = 10\text{ V};$ see Figure 1 [3] | - | 120 | A |
| | | $T_{mb} = 100\text{ °C}; V_{GS} = 10\text{ V};$ see Figure 1 [3] | - | 120 | A |
| I_{DM} | peak drain current | $T_{mb} = 25\text{ °C}; t_p \leq 10\text{ }\mu\text{s};$ pulsed; see Figure 3 | - | 861 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C};$ see Figure 2 | - | 306 | 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] | - | 120 | A |
| I_{SM} | peak source current | $t_p \leq 10\text{ }\mu\text{s};$ pulsed; $T_{mb} = 25\text{ °C}$ | - | 861 | A |
| Avalanche ruggedness | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 120\text{ A}; V_{sup} \leq 55\text{ V}; R_{GS} = 50\text{ }\Omega;$ $V_{GS} = 10\text{ V}; T_{j(init)} = 25\text{ °C};$ unclamped | - | 724 | mJ |
| $E_{DS(AL)R}$ | repetitive drain-source avalanche energy | | [4] [5] [6] | - | J |

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

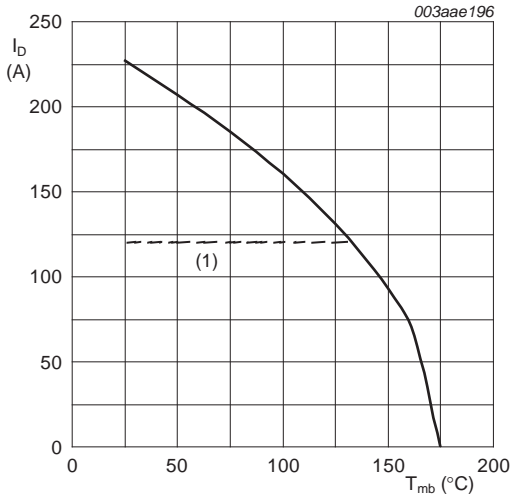
[2] -16V accumulated duration not to exceed 168 hrs.

[3] Continuous current is limited by package.

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

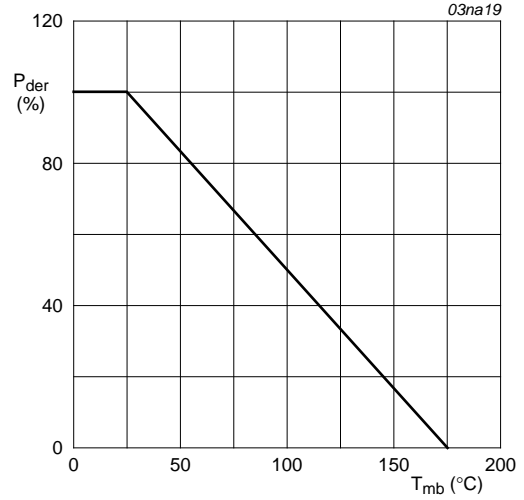
[5] Repetitive avalanche rating limited by an average junction temperature of 170 °C.

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



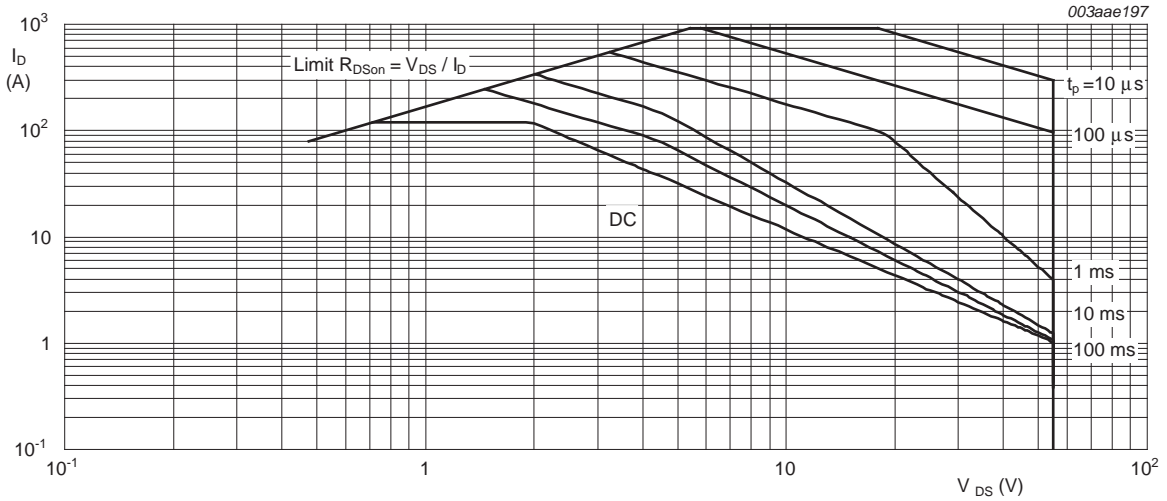
$V_{GS} \geq 10V$
 (1) Capped at 120 A due to package.

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



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

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



$T_{mb} = 25^{\circ}C$; 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 | - | - | 0.45 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | vertical in free air | - | 60 | - | K/W |

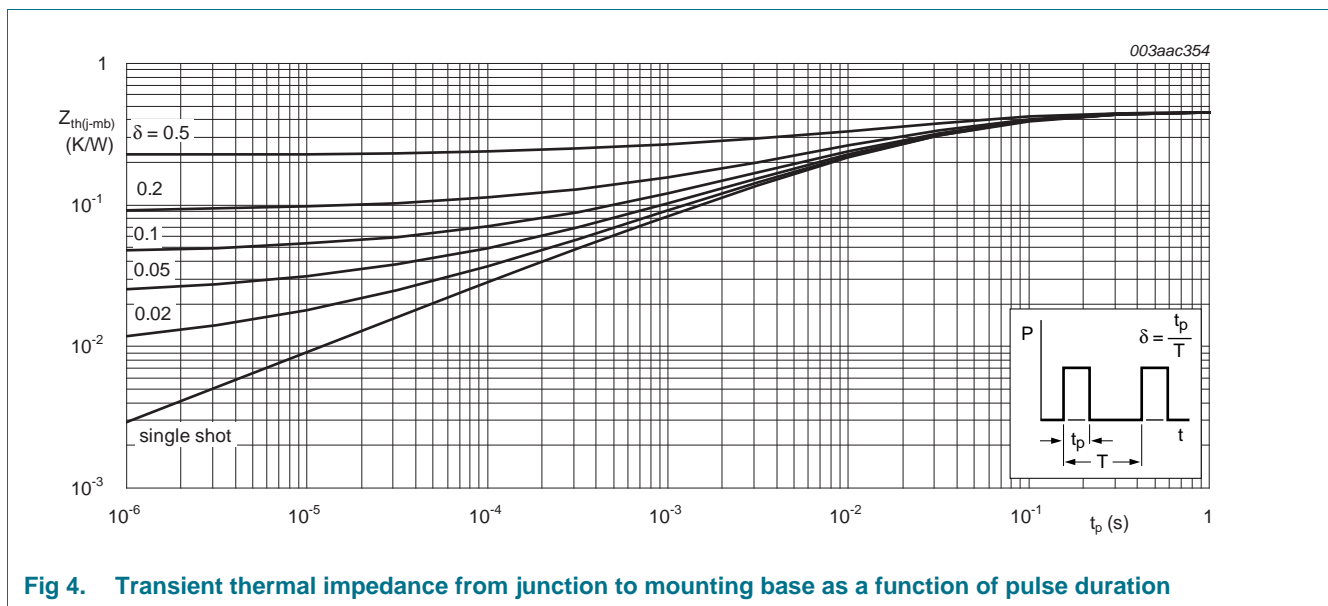


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

6. Characteristics

Table 6. Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|---|-----|-------|-------|------------|
| Static characteristics | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$ | 55 | - | - | V |
| | | $I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$ | 50 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C$; see Figure 9 ; see Figure 10 | 1.8 | 2.3 | 2.8 | V |
| | | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ C$; see Figure 10 | - | - | 3.3 | V |
| | | $I_D = 2.5 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ C$; see Figure 10 | 0.8 | - | - | V |
| I_{DSS} | drain leakage current | $V_{DS} = 55 V; V_{GS} = 0 V; T_j = 175 \text{ }^\circ C$ | - | - | 500 | μA |
| | | $V_{DS} = 55 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$ | - | 0.02 | 1 | μA |
| I_{GSS} | gate leakage current | $V_{DS} = 0 V; V_{GS} = 20 V; T_j = 25 \text{ }^\circ C$ | - | 2 | 100 | nA |
| | | $V_{DS} = 0 V; V_{GS} = -20 V; T_j = 25 \text{ }^\circ C$ | - | 2 | 100 | nA |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 10 V; I_D = 25 A; T_j = 25 \text{ }^\circ C$; see Figure 11 | - | 2.7 | 3.2 | m Ω |
| | | $V_{GS} = 5 V; I_D = 25 A; T_j = 25 \text{ }^\circ C$; see Figure 11 | - | 3.3 | 4.2 | m Ω |
| | | $V_{GS} = 4.5 V; I_D = 25 A; T_j = 25 \text{ }^\circ C$; see Figure 11 | - | 3.6 | 4.8 | m Ω |
| | | $V_{GS} = 10 V; I_D = 25 A; T_j = 175 \text{ }^\circ C$; see Figure 12 ; see Figure 11 | - | - | 7.1 | m Ω |
| Dynamic characteristics | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D = 25 A; V_{DS} = 44 V; V_{GS} = 5 V$; see Figure 13 ; see Figure 14 | - | 146 | - | nC |
| | | $I_D = 25 A; V_{DS} = 44 V; V_{GS} = 10 V$; see Figure 13 ; see Figure 14 | - | 258 | - | nC |
| Q_{GS} | gate-source charge | | - | 35 | - | nC |
| Q_{GD} | gate-drain charge | | - | 75 | - | nC |
| C_{iss} | input capacitance | $V_{GS} = 0 V; V_{DS} = 25 V; f = 1 \text{ MHz}$; $T_j = 25 \text{ }^\circ C$; see Figure 15 | - | 11430 | 15300 | pF |
| C_{oss} | output capacitance | | - | 1100 | 1320 | pF |
| C_{rss} | reverse transfer capacitance | | - | 772 | 1060 | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS} = 45 V; R_L = 1.8 \Omega; V_{GS} = 10 V$; $R_{G(ext)} = 10 \Omega$ | - | 61 | - | ns |
| t_r | rise time | | - | 101 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 450 | - | ns |
| t_f | fall time | | - | 186 | - | ns |
| L_D | internal drain inductance | from drain lead 6 mm from package to centre of die ; $T_j = 25 \text{ }^\circ C$ | - | 4.5 | - | nH |
| L_S | internal source inductance | from source lead to source bond pad ; $T_j = 25 \text{ }^\circ C$ | - | 7.5 | - | nH |

Table 6. Characteristics ...continued

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------------------|-----------------------|--|-----|------|-----|------|
| Source-drain diode | | | | | | |
| V_{SD} | source-drain voltage | $I_S = 25\text{ A}$; $V_{GS} = 0\text{ V}$; $T_j = 25\text{ °C}$; see Figure 16 | - | 0.85 | 1.2 | V |
| t_{rr} | reverse recovery time | $I_S = 20\text{ A}$; $di_S/dt = -100\text{ A}/\mu\text{s}$; $V_{GS} = 0\text{ V}$; | - | 67 | - | ns |
| Q_r | recovered charge | $V_{DS} = 25\text{ V}$ | - | 176 | - | nC |

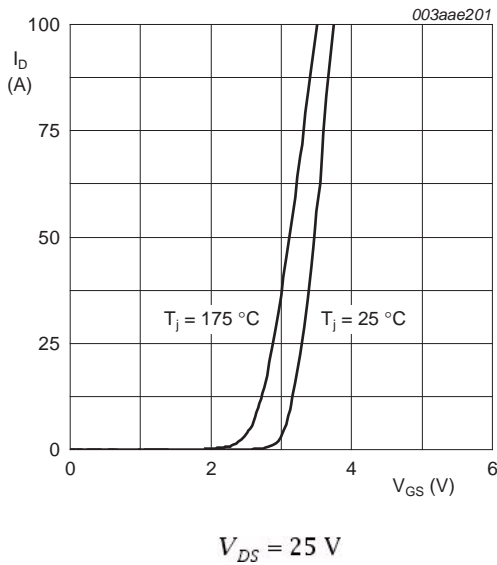


Fig 5. Transfer characteristics: drain current as a function of gate-source voltage; typical values

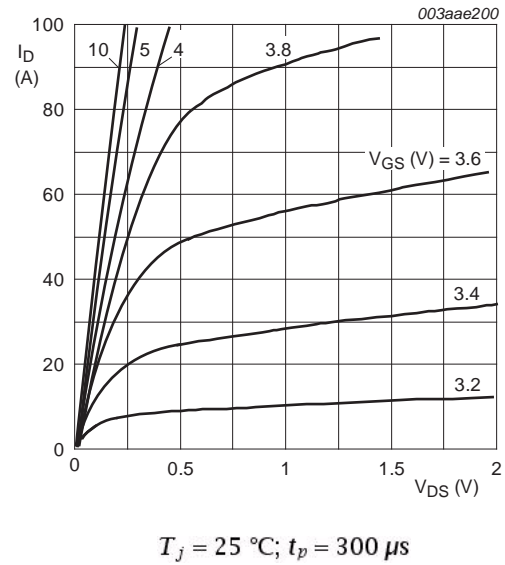


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

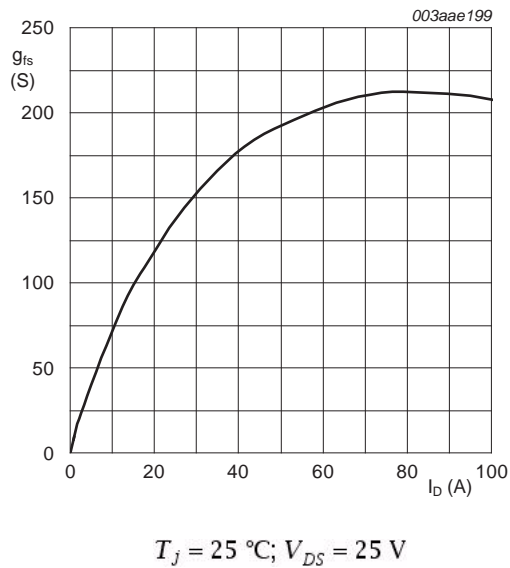


Fig 7. Forward transconductance as a function of drain current; typical values

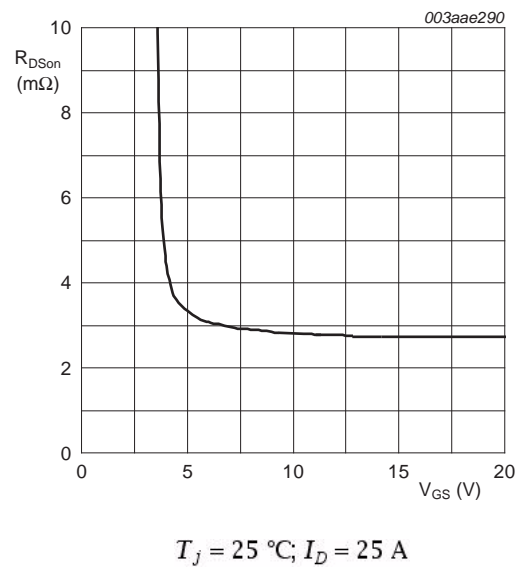
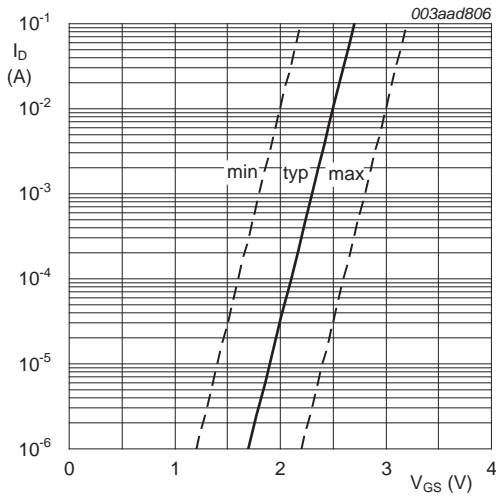
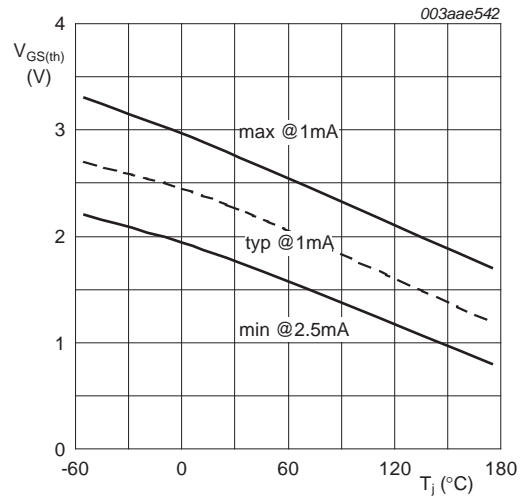


Fig 8. Drain-source on-state resistance as a function of gate-source voltage; typical values



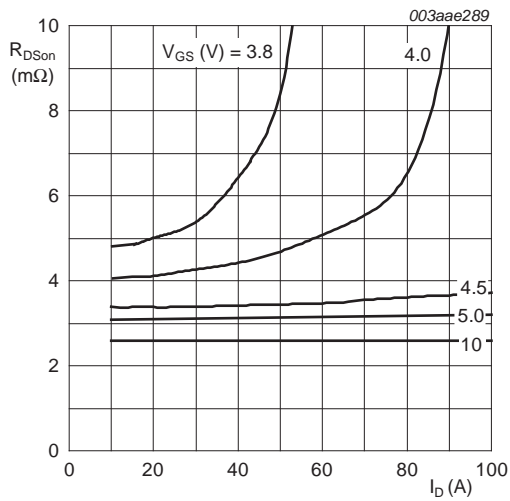
$T_j = 25\text{ }^\circ\text{C}; V_{DS} = 5\text{V}$

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



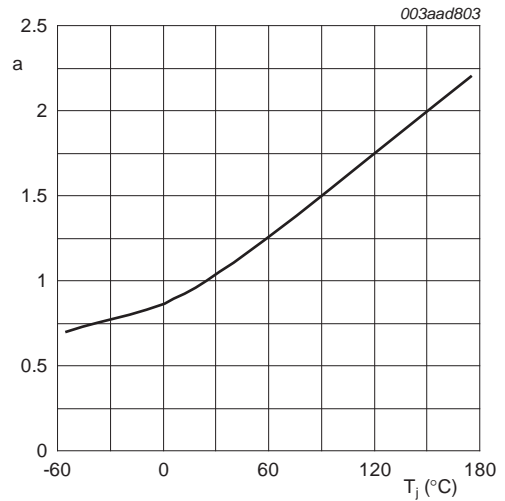
$I_D = 1\text{mA}; V_{DS} = V_{GS}$

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



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

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



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

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

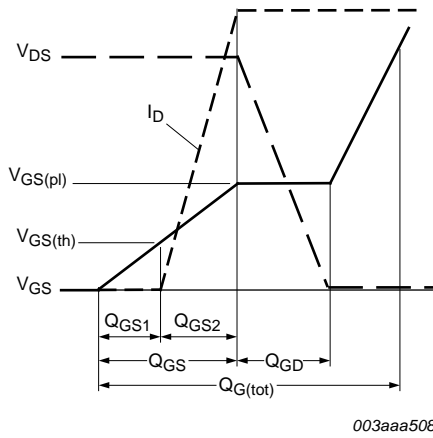
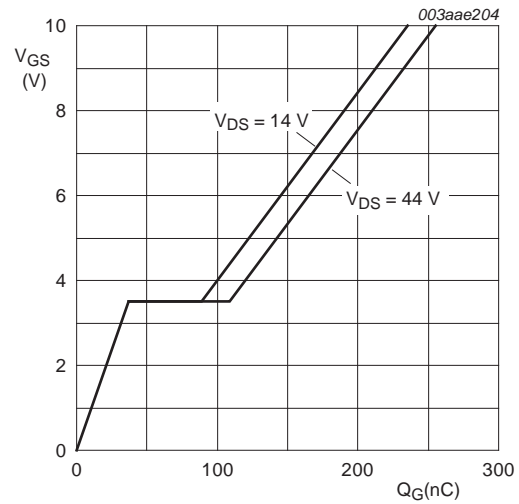
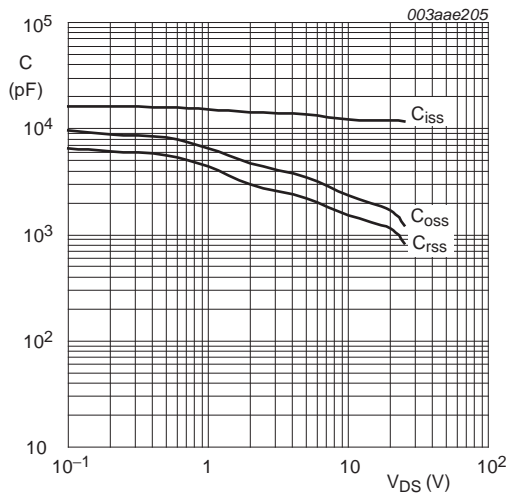


Fig 13. Gate charge waveform definitions



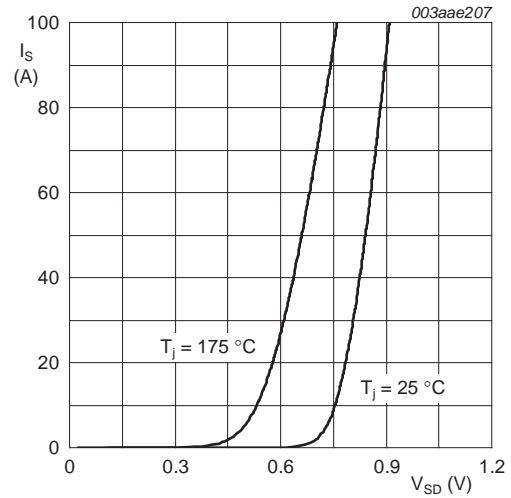
$T_j = 25\text{ }^\circ\text{C}; I_D = 25\text{ A}$

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



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

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

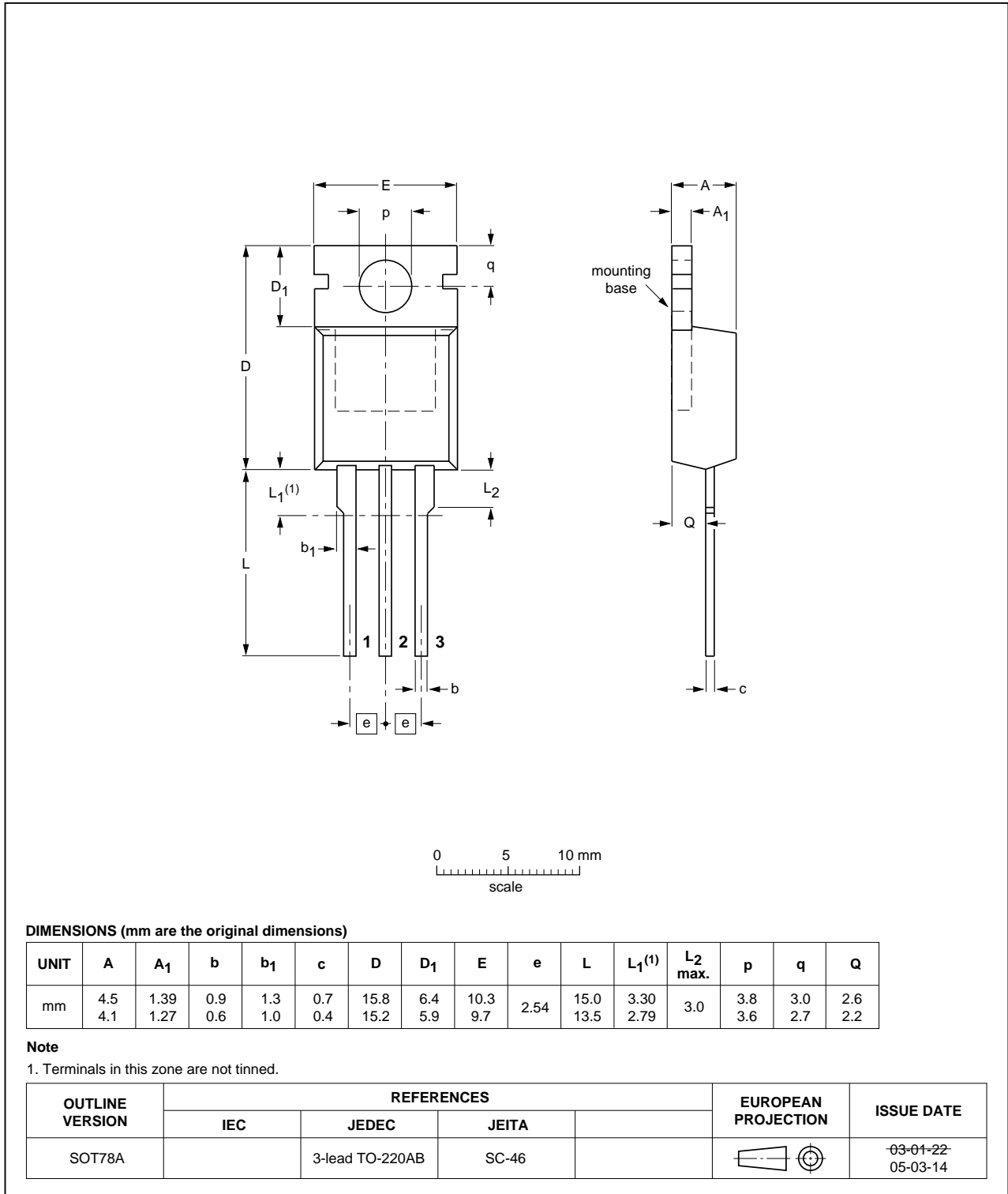


Fig 17. Package outline SOT78A (TO-220AB)

8. Revision history

Table 7. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|------------------|--------------|--------------------|---------------|------------|
| BUK653R2-55C v.1 | 20100906 | Product data sheet | - | - |

9. Legal information

9.1 Data sheet status

| Document status ^{[1][2]} | Product status ^[3] | Definition |
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[NTE6400](#) [JANTX2N6796U](#) [JANTX2N6784U](#) [JANTXV2N5416U4](#) [SQM110N05-06L-GE3](#) [SIHF35N60E-GE3](#)