

BUK652R3-40C

N-channel 40 V 2.3 mΩ intermediate level Automotive TrenchMOS FET

Rev. 01 — 20 May 2010

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

1.3 Applications

- 12 V Automotive systems
- Start-Stop micro-hybrid applications
- Electric and electro-hydraulic power steering
- Transmission control
- Motors, lamps and solenoid 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	$V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C};$ see Figure 1	11	-	120	A
P_{tot}	total power dissipation	$T_{mb} = 25\text{ °C};$ see Figure 2	-	-	306	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 12 ; see Figure 13	-	1.9	2.3	mΩ



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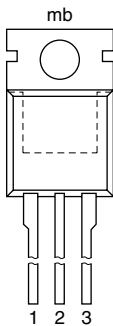
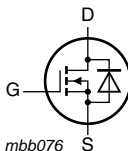
Table 1. Quick reference data ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 120\text{ A}$; $V_{sup} \leq 40\text{ V}$; $R_{GS} = 50\ \Omega$; $V_{GS} = 10\text{ V}$; $T_{j(\text{init})} = 25\text{ }^\circ\text{C}$; unclamped	-	-	1.02	J
Dynamic characteristics						
Q_{GD}	gate-drain charge	$I_D = 25\text{ A}$; $V_{DS} = 32\text{ V}$; $V_{GS} = 10\text{ V}$; see Figure 14 ; see Figure 15	-	72	-	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	
BUK652R3-40C	TO-220AB	plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB	SOT78A

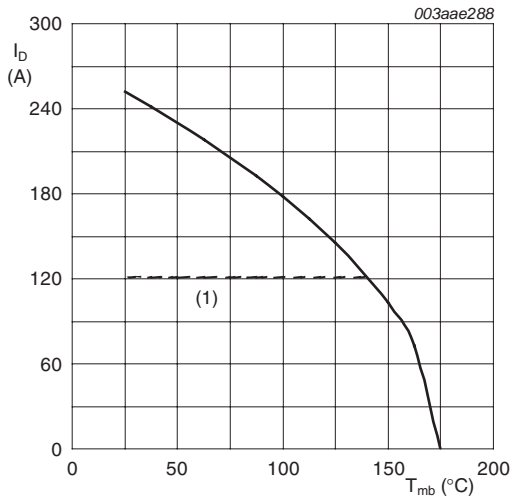
4. Limiting values

Table 4. Limiting values

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

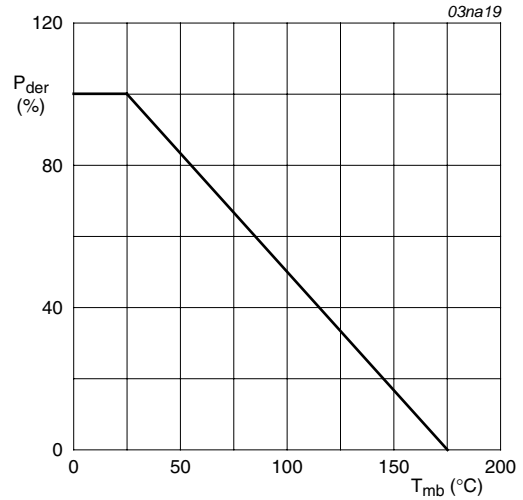
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
V_{DS}	drain-source voltage	$T_j \geq 25\text{ °C}$; $T_j \leq 175\text{ °C}$	-	-	40	V	
V_{GS}	gate-source voltage	Pulsed	[1] -20	-	20	V	
I_D	drain current	$T_{mb} = 25\text{ °C}$; $V_{GS} = 10\text{ V}$; see Figure 1	[2]	-	-	120	A
		$T_{mb} = 100\text{ °C}$; $V_{GS} = 10\text{ V}$; see Figure 1	[2]	-	-	120	A
I_{DM}	peak drain current	$T_{mb} = 25\text{ °C}$; $t_p \leq 10\text{ }\mu\text{s}$; pulsed; see Figure 4	-	-	1006	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	
V_{GS}	gate-source voltage	DC	-16	-	16	V	
Source-drain diode							
I_S	source current	$T_{mb} = 25\text{ °C}$	[2]	-	-	120	A
I_{SM}	peak source current	$t_p \leq 10\text{ }\mu\text{s}$; pulsed; $T_{mb} = 25\text{ °C}$	-	-	1006	A	
Avalanche ruggedness							
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 120\text{ A}$; $V_{sup} \leq 40\text{ V}$; $R_{GS} = 50\text{ }\Omega$; $V_{GS} = 10\text{ V}$; $T_{j(init)} = 25\text{ °C}$; unclamped	-	-	1.02	J	
$E_{DS(AL)R}$	repetitive drain-source avalanche energy	see Figure 3	[3][4][5]	-	-	J	

- [1] Accumulated pulse duration not to exceed 5mins.
 [2] Continuous current is limited by package.
 [3] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
 [4] Repetitive avalanche rating limited by an average junction temperature of 170 °C.
 [5] 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

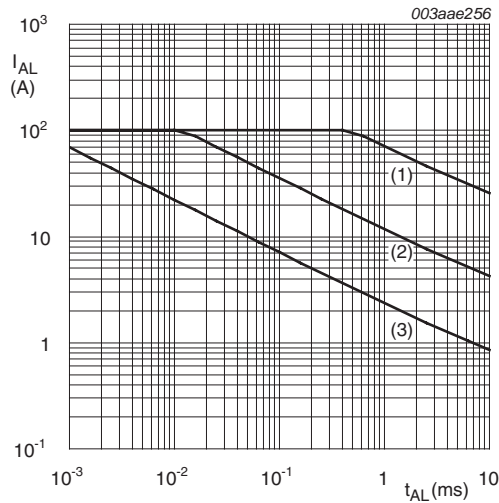
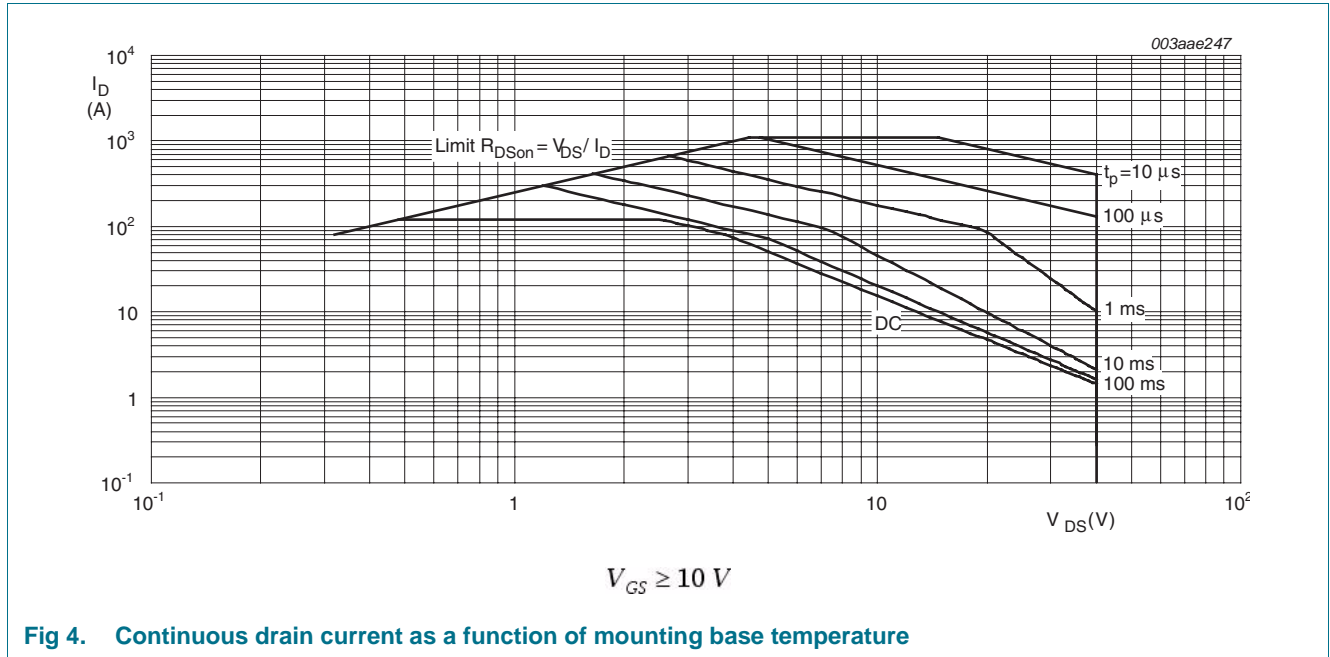


Fig 3. Single-pulse and repetitive avalanche rating; avalanche current as a function of avalanche time



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 5	-	-	0.45	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in free air	-	60	-	K/W

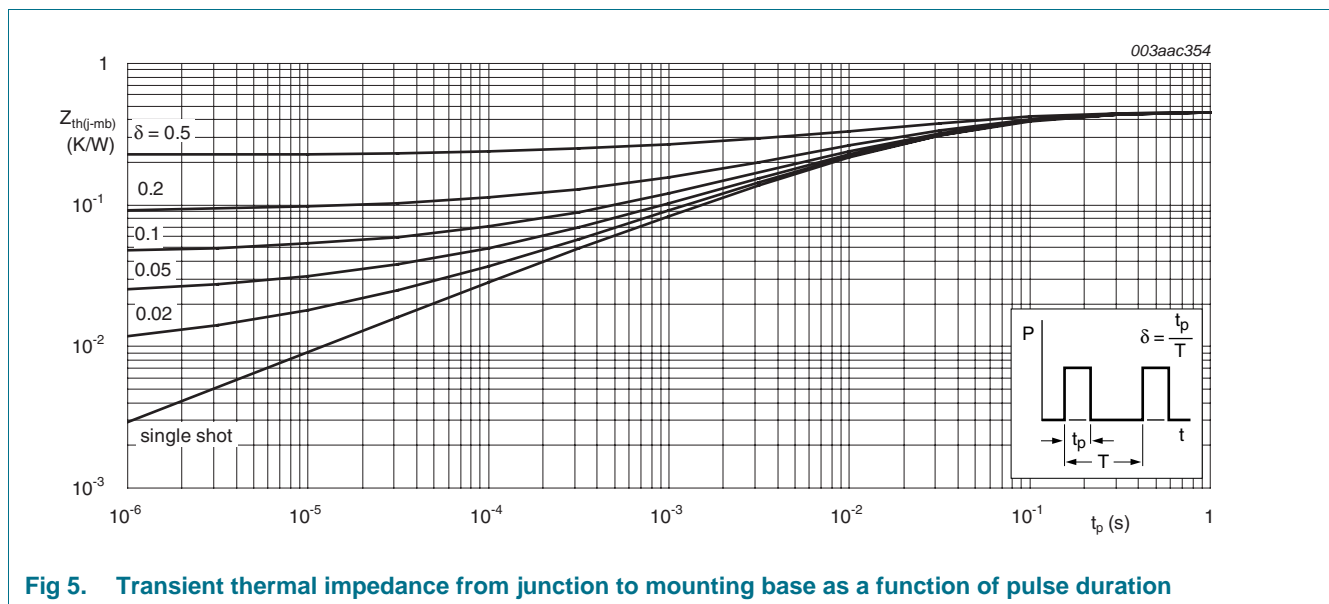


Fig 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

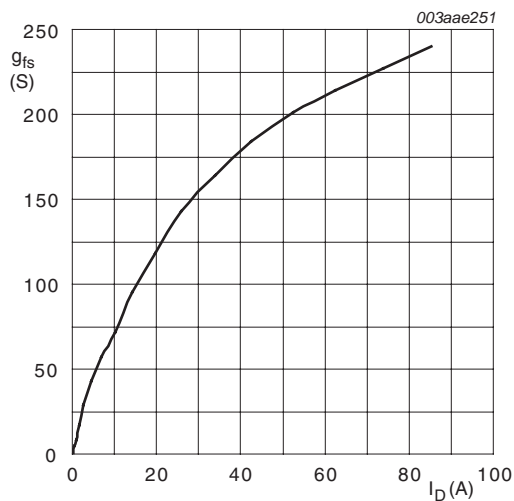
6. Characteristics

Table 6. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	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	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C$; see Figure 10 ; see Figure 11	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
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ C$; see Figure 10	0.8	-	-	V
I_{DSS}	drain leakage current	$V_{DS} = 40 V; V_{GS} = 0 V; T_j = 175 \text{ }^\circ C$	-	-	500	μA
		$V_{DS} = 40 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	-	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 12 ; see Figure 13	-	1.9	2.3	mΩ
		$V_{GS} = 5 V; I_D = 25 A; T_j = 25 \text{ }^\circ C$; see Figure 12 ; see Figure 13	-	2.4	3	mΩ
		$V_{GS} = 4.5 V; I_D = 25 A; T_j = 25 \text{ }^\circ C$; see Figure 12 ; see Figure 13	-	2.6	3.2	mΩ
		$V_{GS} = 10 V; I_D = 25 A; T_j = 175 \text{ }^\circ C$; see Figure 12	-	-	5	mΩ
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$I_D = 25 A; V_{DS} = 32 V; V_{GS} = 10 V$; see Figure 14 ; see Figure 15	-	260	-	nC
		$I_D = 25 A; V_{DS} = 32 V; V_{GS} = 5 V$; see Figure 14 ; see Figure 15	-	147	-	nC
Q_{GS}	gate-source charge	$I_D = 25 A; V_{DS} = 32 V; V_{GS} = 10 V$; see Figure 14 ; see Figure 15	-	38	-	nC
Q_{GD}	gate-drain charge	see Figure 14 ; see Figure 15	-	72	-	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 17	-	11.3	15.1	nF
C_{oss}	output capacitance	see Figure 17	-	1447	1750	pF
C_{rss}	reverse transfer capacitance	see Figure 17	-	1014	1390	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 30 V; R_L = 1.2 \text{ } \Omega; V_{GS} = 10 V$; $R_{G(ext)} = 10 \text{ } \Omega$	-	60	-	ns
t_r	rise time	see Figure 17	-	140	-	ns
$t_{d(off)}$	turn-off delay time	see Figure 17	-	234	-	ns
t_f	fall time	see Figure 17	-	416	-	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

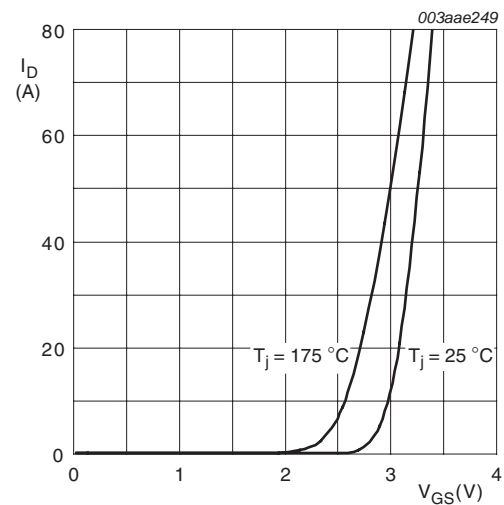
Table 6. Characteristics ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Source-drain diode						
V_{SD}	source-drain voltage	$I_S = 25 \text{ A}$; $V_{GS} = 0 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$; see Figure 16	-	0.8	1.2	V
t_{rr}	reverse recovery time	$I_S = 20 \text{ A}$; $di_S/dt = -100 \text{ A}/\mu\text{s}$; $V_{GS} = 0 \text{ V}$;	-	63	-	ns
Q_r	recovered charge	$V_{DS} = 25 \text{ V}$	-	127	-	nC



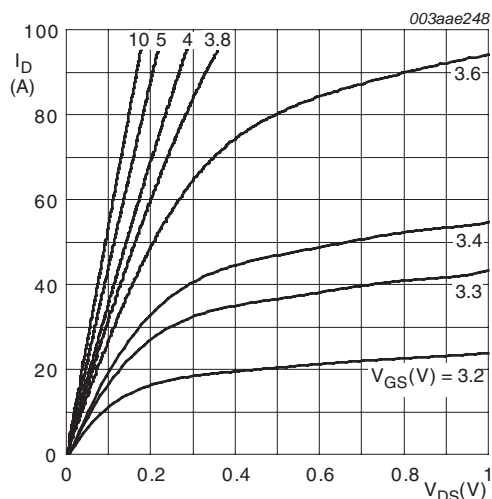
$$T_j = 25 \text{ }^\circ\text{C}; V_{DS} = 10 \text{ V}$$

Fig 6. Forward transconductance as a function of drain current; typical values



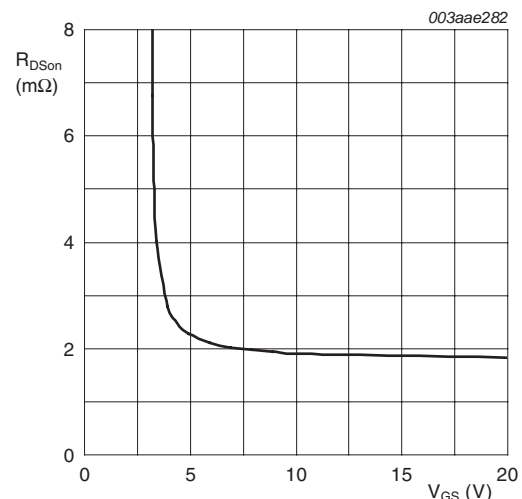
$$V_{DS} > I_D \times R_{DSon}$$

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



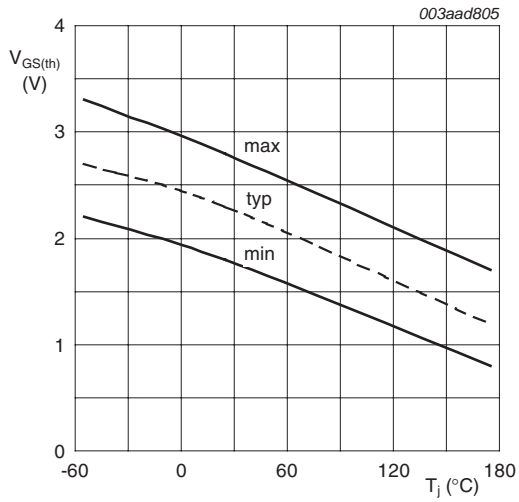
$$T_j = 25 \text{ }^\circ\text{C}$$

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



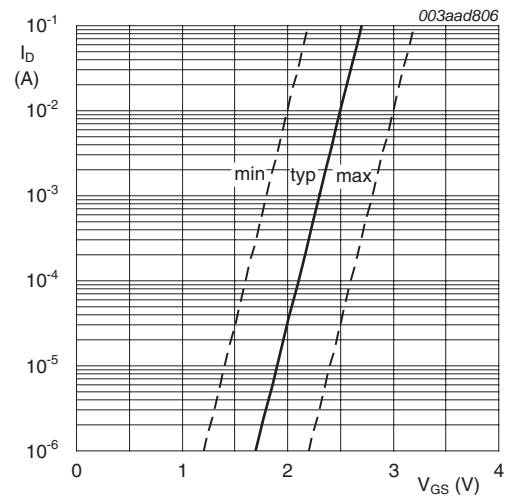
$$T_j = 25 \text{ }^\circ\text{C}; I_D = 25 \text{ A}$$

Fig 9. Drain-source on-state resistance as a function of gate-source voltage; typical values.



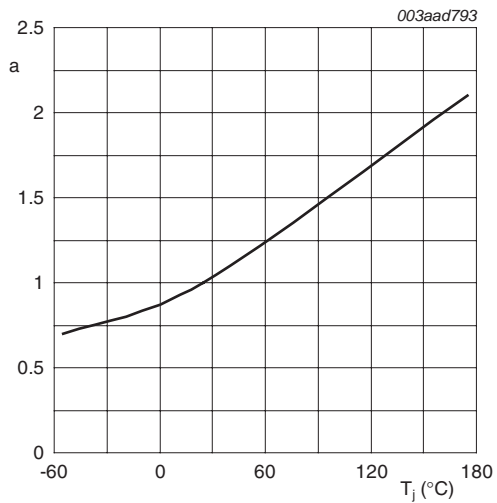
$I_D = 1mA; V_{DS} = V_{GS}$

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



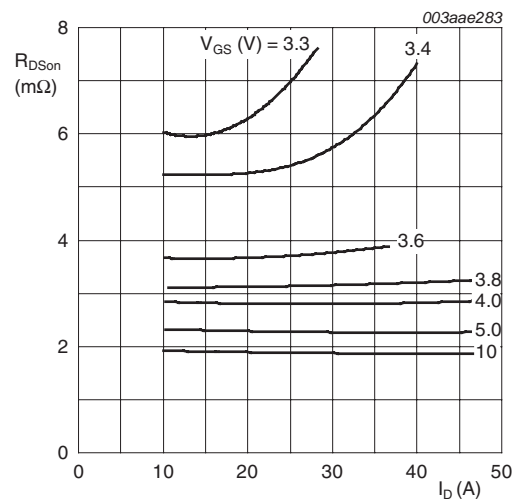
$T_j = 25^\circ C; V_{DS} = 5V$

Fig 11. Sub-threshold drain current as a function of gate-source voltage



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

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



$T_j = 25^\circ C$

Fig 13. Drain-source on-state resistance as a function of drain current; typical values

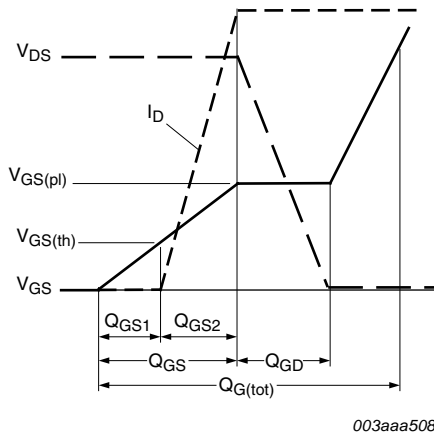
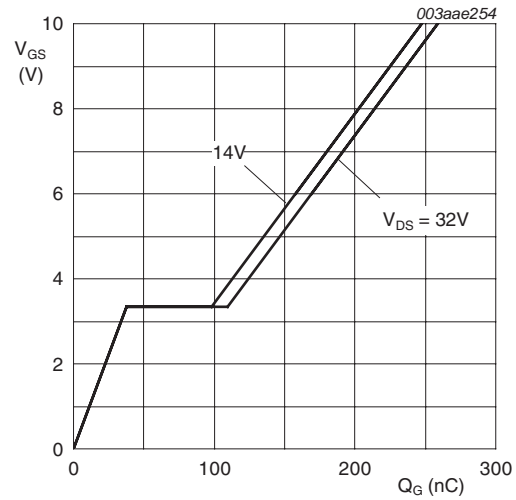
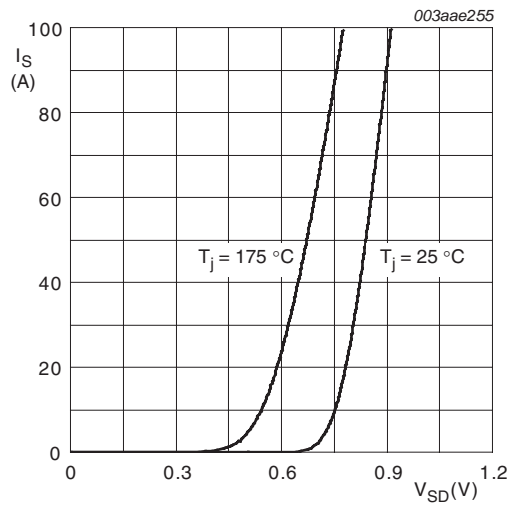


Fig 14. Gate charge waveform definitions



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

Fig 15. Gate-source voltage as a function of gate charge; typical values



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

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

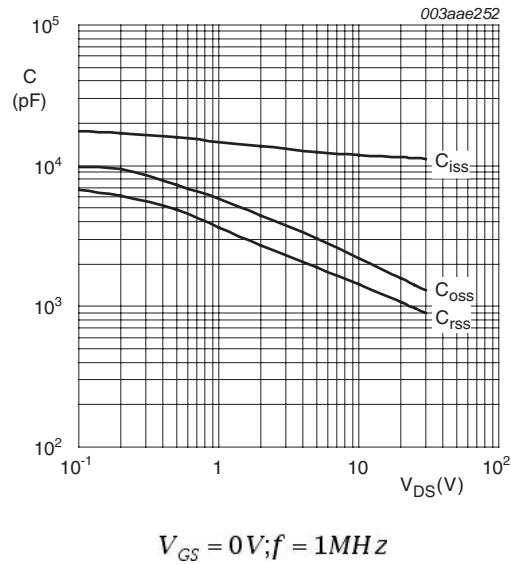


Fig 17. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

7. Package outline

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

SOT78A

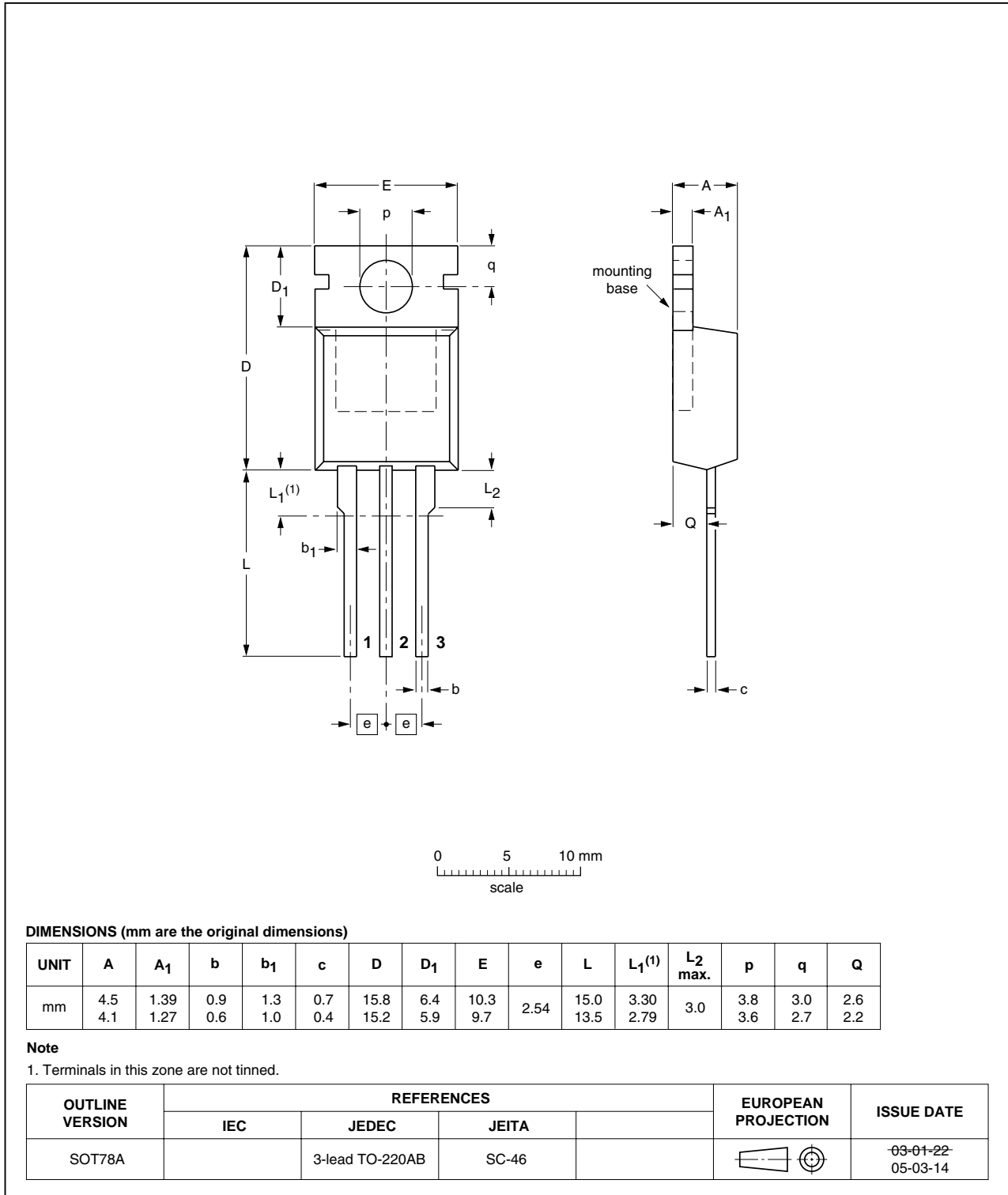


Fig 18. Package outline SOT78A (TO-220AB)

8. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BUK652R3-40C v.1	20100520	Objective 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.
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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