

BUK652R0-30C

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 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	$T_j \geq 25 \text{ }^\circ\text{C}; T_j \leq 175 \text{ }^\circ\text{C}$	-	-	30	V
I_D	drain current	$V_{GS} = 10 \text{ V}; T_{mb} = 25 \text{ }^\circ\text{C};$ see Figure 1	[1]	-	-	120 A
P_{tot}	total power dissipation	$T_{mb} = 25 \text{ }^\circ\text{C};$ see Figure 2	-	-	306	W
Static characteristics						
R_{DSon}	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A};$ $T_j = 25 \text{ }^\circ\text{C};$ see Figure 16	-	1.9	2.2	$\text{m}\Omega$



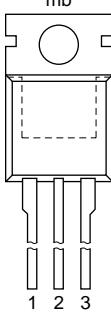
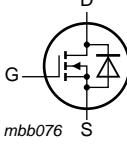
Table 1. Quick reference data ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 120 \text{ A}$; $V_{sup} \leq 30 \text{ V}$; $R_{GS} = 50 \Omega$; $V_{GS} = 10 \text{ V}$; $T_{j(init)} = 25 \text{ }^\circ\text{C}$; unclamped	-	-	1.7	J
Dynamic characteristics						
Q_{GD}	gate-drain charge	$I_D = 25 \text{ A}$; $V_{DS} = 24 \text{ V}$; $V_{GS} = 10 \text{ V}$; see Figure 12 ; see Figure 13	-	63	-	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		
BUK652R0-30C	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	$T_j \geq 25^\circ\text{C}; T_j \leq 175^\circ\text{C}$	-	30	V
V_{GS}	gate-source voltage	DC	[1]	-16	V
		Pulsed		-20	V
I_D	drain current	$T_{mb} = 25^\circ\text{C}; V_{GS} = 10\text{ V}$; see Figure 1	[3]	-	120 A
		$T_{mb} = 100^\circ\text{C}; V_{GS} = 10\text{ V}$; see Figure 1		-	120 A
I_{DM}	peak drain current	$T_{mb} = 25^\circ\text{C}; t_p \leq 10\ \mu\text{s}$; pulsed; see Figure 3	-	1082	A
P_{tot}	total power dissipation	$T_{mb} = 25^\circ\text{C}$; 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	$T_{mb} = 25^\circ\text{C}$	[3]	-	120 A
I_{SM}	peak source current	$t_p \leq 10\ \mu\text{s}$; pulsed; $T_{mb} = 25^\circ\text{C}$		-	1082 A
Avalanche ruggedness					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 120\text{ A}; V_{sup} \leq 30\text{ V}; R_{GS} = 50\ \Omega$; $V_{GS} = 10\text{ V}; T_{j(init)} = 25^\circ\text{C}$; unclamped	-	1.7	J
$E_{DS(AL)R}$	repetitive drain-source avalanche energy		[4][5][6]	-	J

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

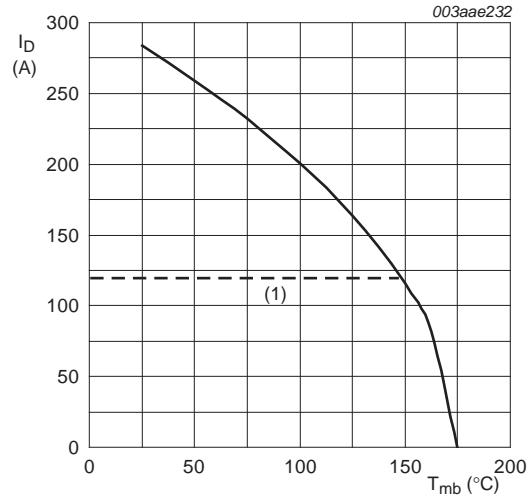
[2] Accumulated pulse duration not to exceed 5 mins.

[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 120 A due to package.

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

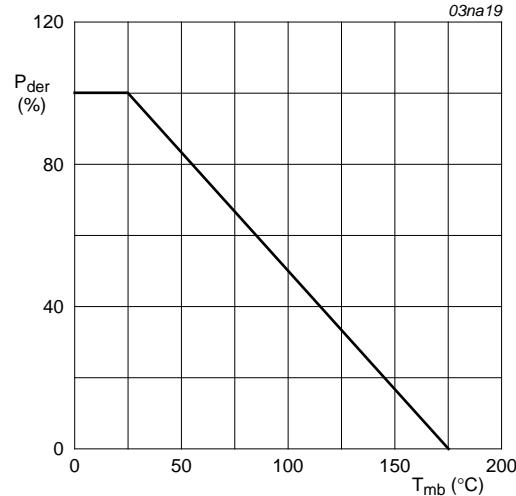
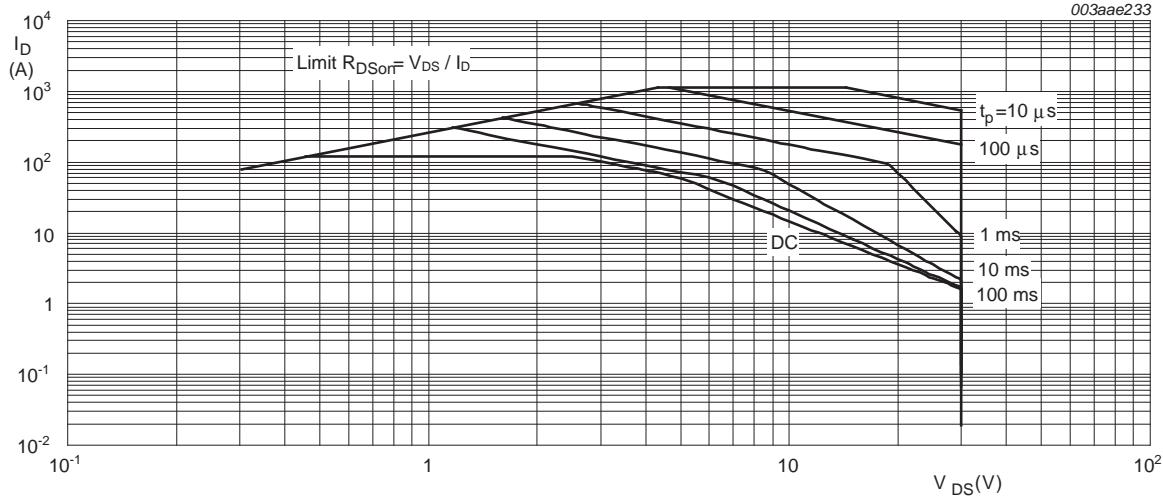


Fig 2. Normalized total power dissipation as a function of mounting base temperature



$T_{mb} = 25^\circ\text{C}$; I_{DM} is 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	-	-	0.49	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in free air	-	60	-	K/W

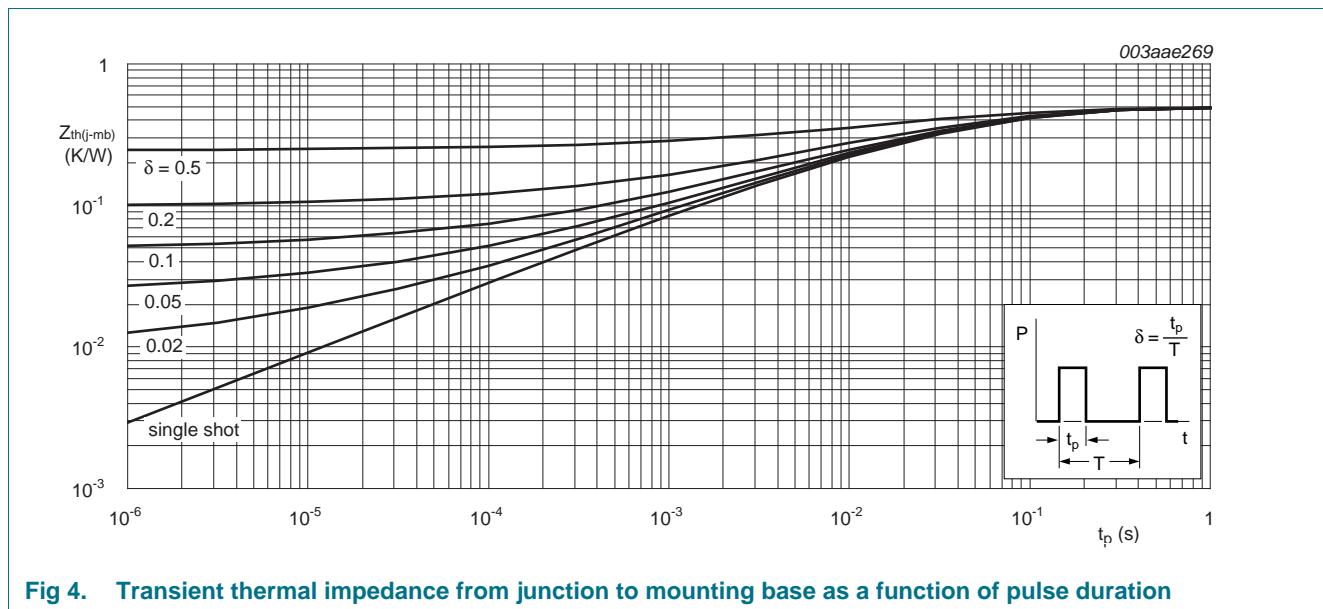


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

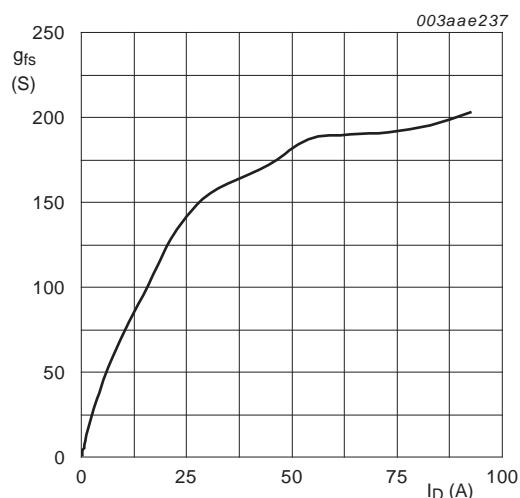
6. Characteristics

Table 6. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25^\circ C$ $I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55^\circ C$	30	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25^\circ C$; see Figure 9 ; see Figure 10 $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55^\circ C$; see Figure 10 $I_D = 2.5 \text{ mA}; V_{DS} = V_{GS}; T_j = 175^\circ C$; see Figure 10	1.8	2.3	2.8	V
I_{DSS}	drain leakage current	$V_{DS} = 30 V; V_{GS} = 0 V; T_j = 25^\circ C$ $V_{DS} = 30 V; V_{GS} = 0 V; T_j = 175^\circ C$	-	0.02	1	μA
I_{GSS}	gate leakage current	$V_{DS} = 0 V; V_{GS} = 20 V; T_j = 25^\circ C$ $V_{DS} = 0 V; V_{GS} = -20 V; T_j = 25^\circ C$	-	2	100	nA
R_{DSon}	drain-source on-state resistance	$V_{GS} = 10 V; I_D = 25 A; T_j = 25^\circ C$; see Figure 16 $V_{GS} = 4.5 V; I_D = 25 A; T_j = 25^\circ C$; see Figure 16 $V_{GS} = 10 V; I_D = 25 A; T_j = 175^\circ C$; see Figure 11 ; see Figure 16 $V_{GS} = 5 V; I_D = 25 A; T_j = 25^\circ C$; see Figure 16	-	1.9	2.2	$m\Omega$
Dynamic characteristics						
$Q_{G(tot)}$	total gate charge	$I_D = 25 A; V_{DS} = 24 V; V_{GS} = 5 V$; see Figure 12 ; see Figure 13 $I_D = 25 A; V_{DS} = 24 V; V_{GS} = 10 V$; see Figure 12 ; see Figure 13	-	131	-	nC
Q_{GS}	gate-source charge	-	38	-	-	nC
Q_{GD}	gate-drain charge	-	63	-	-	nC
C_{iss}	input capacitance	$V_{GS} = 0 V; V_{DS} = 25 V; f = 1 \text{ MHz}$	-	11223	14964	pF
C_{oss}	output capacitance	$T_j = 25^\circ C$; see Figure 14	-	1780	2136	pF
C_{rss}	reverse transfer capacitance	-	1085	1486	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 25 V; R_L = 1 \Omega; V_{GS} = 10 V$	-	53	-	ns
t_r	rise time	$R_{G(ext)} = 10 \Omega$	-	114	-	ns
$t_{d(off)}$	turn-off delay time	-	363	-	-	ns
t_f	fall time	-	192	-	-	ns
L_D	internal drain inductance	from drain lead 6 mm from package to centre of die ; $T_j = 25^\circ C$	-	4.5	-	nH
L_S	internal source inductance	from source lead to source bond pad ; $T_j = 25^\circ C$	-	7.5	-	nH

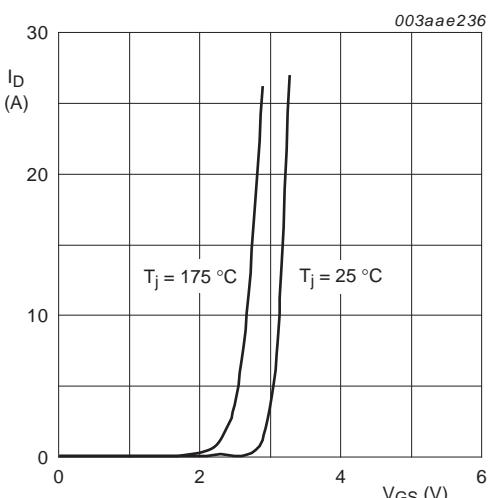
Table 6. Characteristics ...continued

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 15	-	0.8	1.2	V
t_{rr}	reverse recovery time	$I_S = 20 \text{ A}$; $dI_S/dt = -100 \text{ A}/\mu\text{s}$	-	70	-	ns
Q_r	recovered charge	$V_{GS} = -10 \text{ V}$; $V_{DS} = 25 \text{ V}$	-	138	-	nC



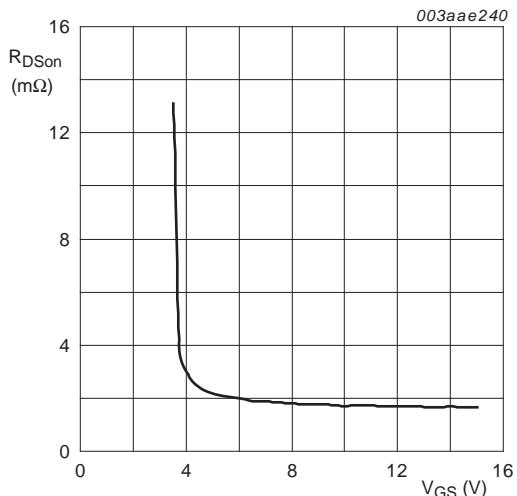
$T_j = 25 \text{ }^\circ\text{C}$; $V_{DS} = 25 \text{ V}$

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



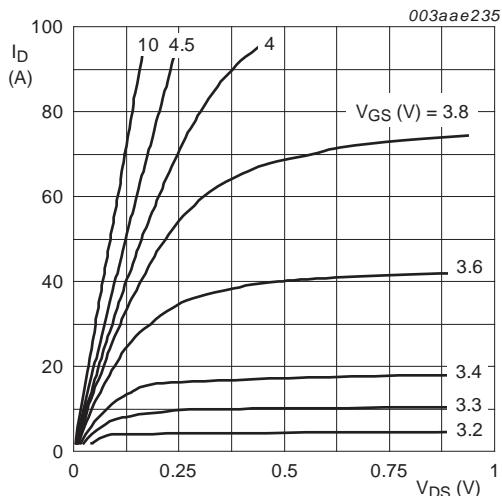
$V_{DS} > I_D \times R_{DSon}$

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



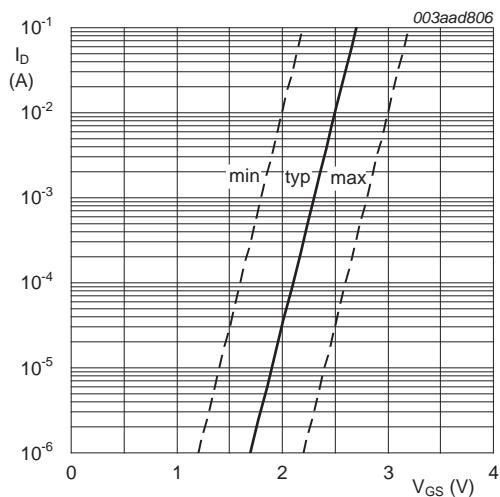
$T_j = 25 \text{ }^\circ\text{C}$; $I_D = 25 \text{ A}$

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



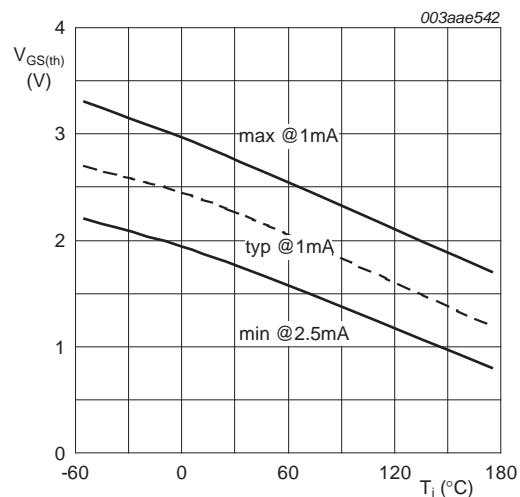
$T_j = 25 \text{ }^\circ\text{C}$

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



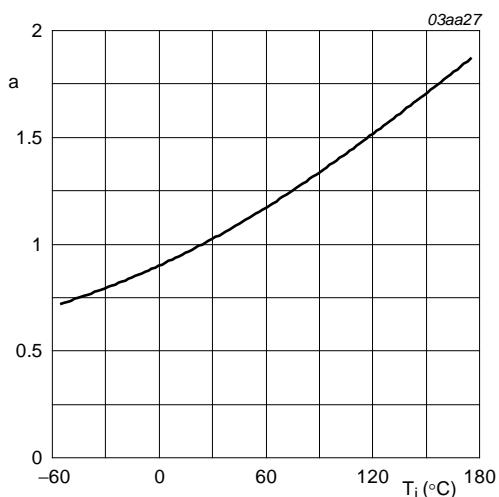
$T_j = 25^\circ\text{C}; V_{DS} = 5\text{V}$

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

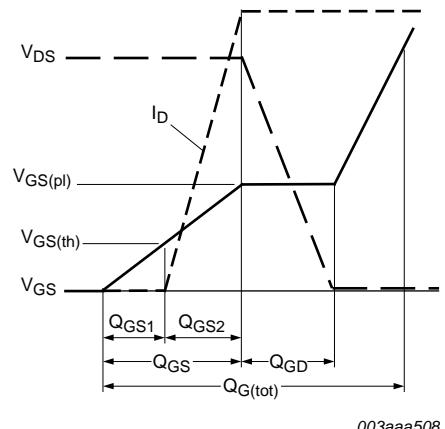
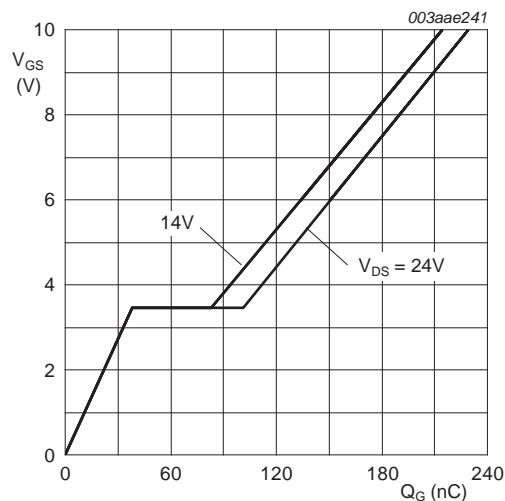
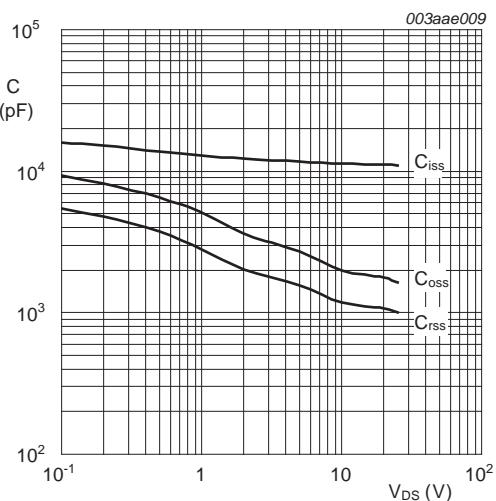


Fig 12. Gate charge waveform definitions



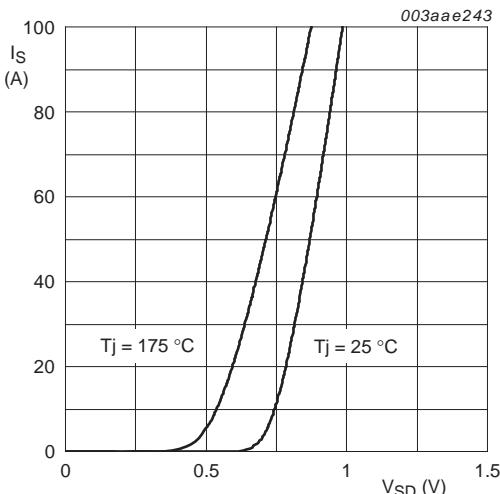
$T_j = 25^\circ C; I_D = 25A$

Fig 13. Gate-source voltage as a function of gate charge; typical values



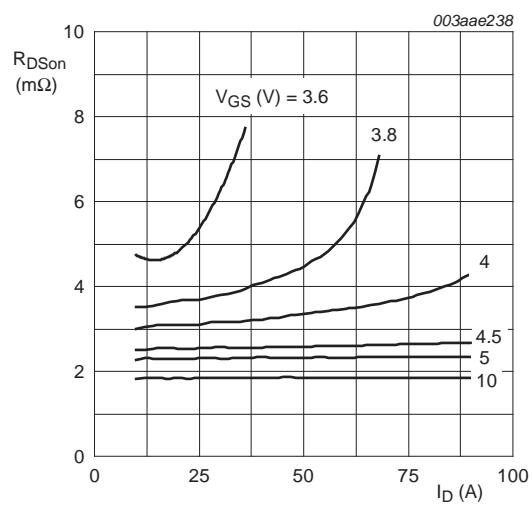
$V_{GS} = 0V; f = 1MHz$

Fig 14. Input, output and reverse transfer capacitance as a function of drain-source voltage; typical values



$V_{GS} = 0V$

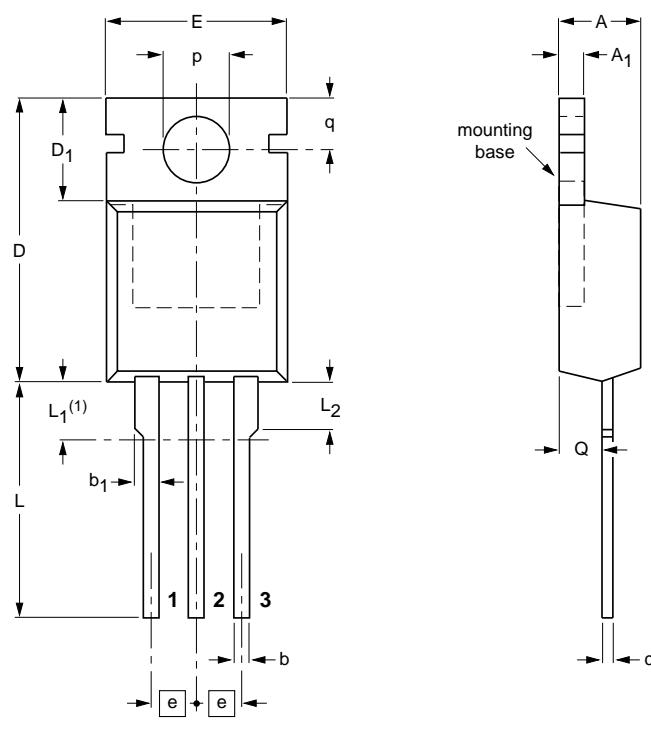
Fig 15. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values

 $T_j = 25^\circ C$ **Fig 16. Drain-source on-state resistance as a function of drain current; typical values**

7. Package outline

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

SOT78A



0 5 10 mm
scale

DIMENSIONS (mm are the original dimensions)

UNIT	A	A ₁	b	b ₁	c	D	D ₁	E	e	L	L ₁₍₁₎	L ₂ max.	p	q	Q
mm	4.5	1.39	0.9	1.3	0.7	15.8	6.4	10.3	2.54	15.0	3.30	3.0	3.8	3.0	2.6
	4.1	1.27	0.6	1.0	0.4	15.2	5.9	9.7		13.5	2.79	3.0	3.6	2.7	2.2

Note

1. Terminals in this zone are not tinned.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT78A		3-lead TO-220AB	SC-46			-03-01-22- 05-03-14

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

8. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BUK652R0-30C v.1	20100906	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.
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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