

# BUK654R6-55C

## N-channel TrenchMOS intermediate level FET

Rev. 02 — 14 October 2010

Product data sheet

## 1. Product profile

### 1.1 General description

Intermediate level N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. This product has been designed and qualified to the appropriate AEC standard for use in automotive critical 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 and 24 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	$T_j \geq 25\text{ °C}$ ; $T_j \leq 175\text{ °C}$	-	-	55	V
$I_D$	drain current	$V_{GS} = 10\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; see <a href="#">Figure 1</a>	<a href="#">[1]</a>	-	100	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}$ ; see <a href="#">Figure 2</a>	-	-	204	W
<b>Static characteristics</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $T_j = 25\text{ °C}$ ; see <a href="#">Figure 11</a>	-	4.6	5.4	mΩ



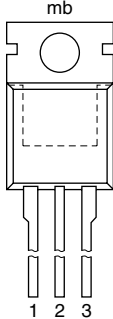
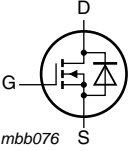
Table 1. Quick reference data ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 100\text{ A}$ ; $V_{sup} \leq 55\text{ V}$ ; $R_{GS} = 50\ \Omega$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(init)} = 25\text{ }^\circ\text{C}$	-	-	263	mJ
<b>Dynamic characteristics</b>						
$Q_{GD}$	gate-drain charge	$I_D = 25\text{ A}$ ; $V_{DS} = 44\text{ V}$ ; $V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 13</a> ; see <a href="#">Figure 14</a>	-	31.5	-	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	
BUK654R6-55C	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	DC <a href="#">[1]</a>	-16	16	V
		pulsed <a href="#">[2]</a>	-20	20	V
$I_D$	drain current	$T_{mb} = 25\text{ °C}; V_{GS} = 10\text{ V};$ see <a href="#">Figure 1</a> <a href="#">[3]</a>	-	100	A
		$T_{mb} = 100\text{ °C}; V_{GS} = 10\text{ V};$ see <a href="#">Figure 1</a>	-	92.6	A
$I_{DM}$	peak drain current	$T_{mb} = 25\text{ °C}; t_p \leq 10\text{ }\mu\text{s};$ pulsed; see <a href="#">Figure 3</a>	-	524	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C};$ see <a href="#">Figure 2</a>	-	204	W
$T_{stg}$	storage temperature		-55	175	°C
$T_j$	junction temperature		-55	175	°C
<b>Source-drain diode</b>					
$I_S$	source current	$T_{mb} = 25\text{ °C}$ <a href="#">[3]</a>	-	100	A
$I_{SM}$	peak source current	$t_p \leq 10\text{ }\mu\text{s};$ pulsed; $T_{mb} = 25\text{ °C}$	-	524	A
<b>Avalanche ruggedness</b>					
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$I_D = 100\text{ A}; V_{sup} \leq 55\text{ V}; R_{GS} = 50\text{ }\Omega;$ $V_{GS} = 10\text{ V}; T_{j(init)} = 25\text{ °C}$	-	263	mJ
$E_{DS(AL)R}$	repetitive drain-source avalanche energy	<a href="#">[4]</a> <a href="#">[5]</a> <a href="#">[6]</a>	-	-	J

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

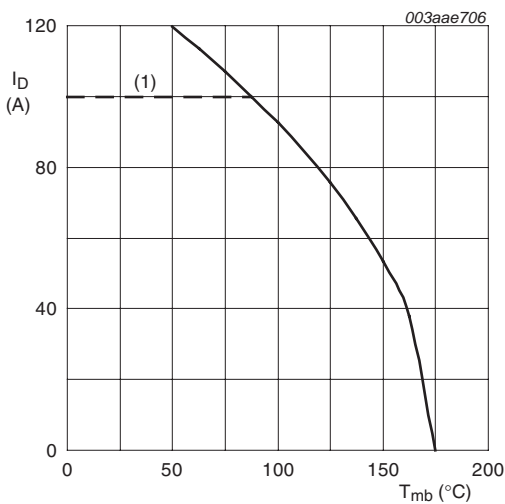
[2] Accumulated pulse duration not to exceed 5 mins.

[3] Continuous current is limited by package.

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

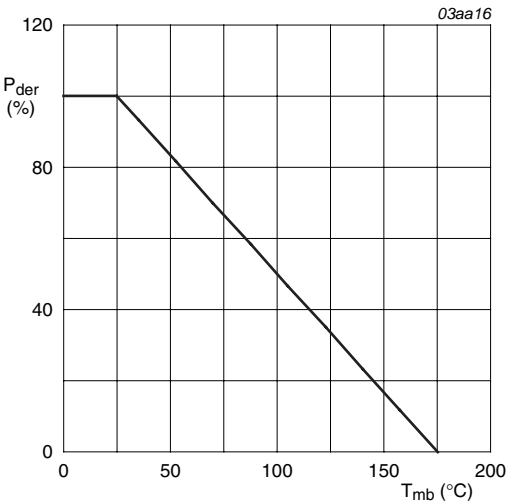
[5] Repetitive avalanche rating limited by an average junction temperature of 170 °C.

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



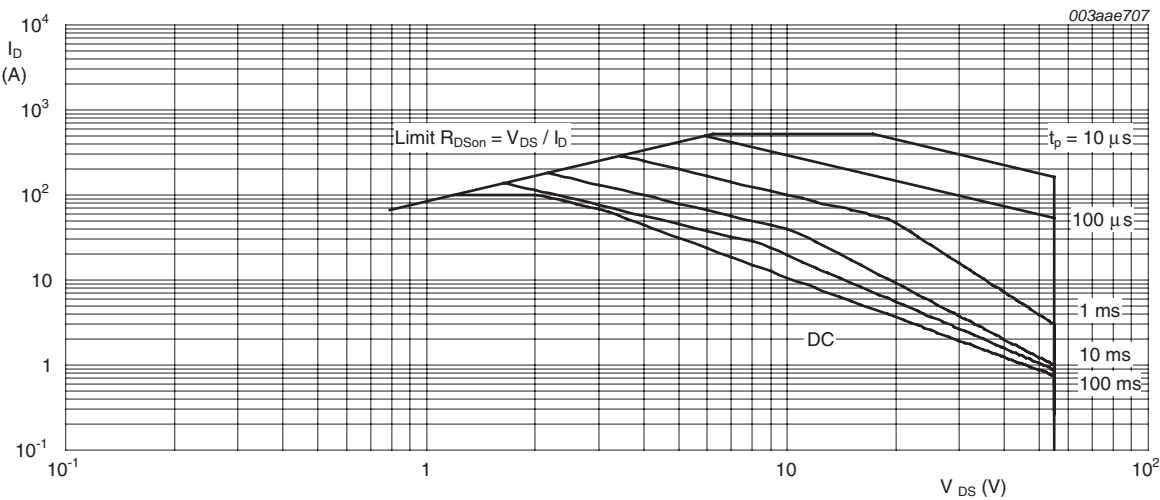
$V_{GS} \geq 10$  V  
(1) capped at 100 A due to package

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



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

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



$T_{mb} = 25$  °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 <a href="#">Figure 4</a>	-	-	0.74	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in free air	-	60	-	K/W

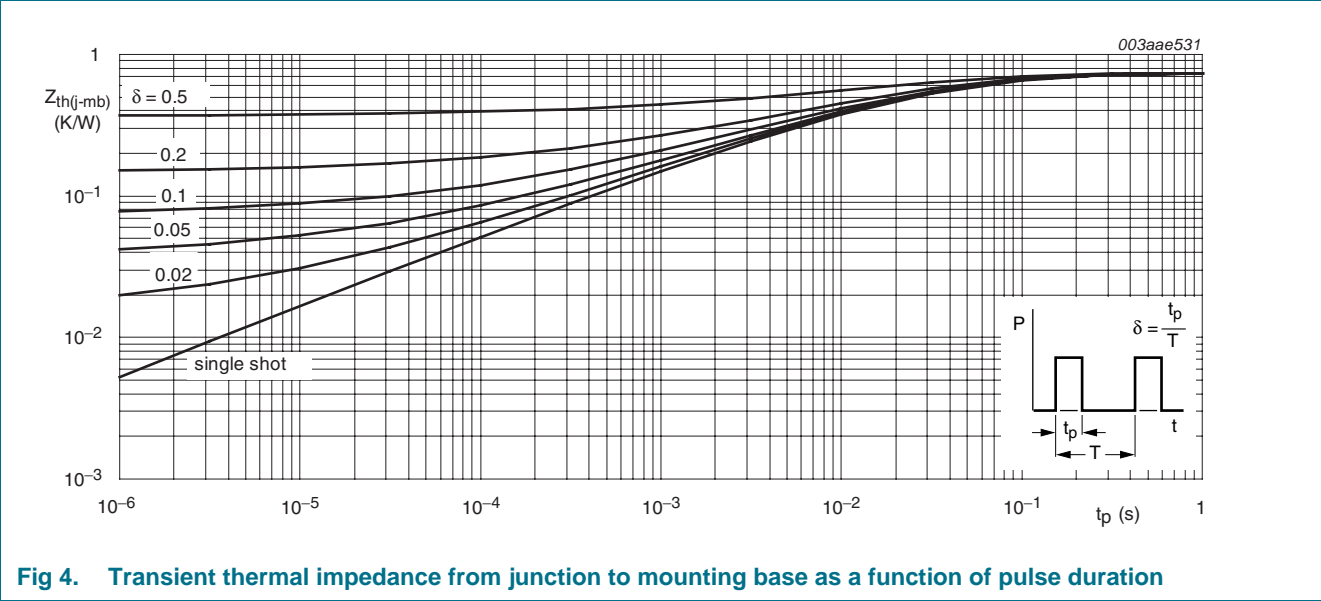


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 6. Characteristics

Table 6. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
V <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	55	-	-	V
		I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>J</sub> = -55 °C	50	-	-	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; see <a href="#">Figure 9</a> ; see <a href="#">Figure 10</a>	1.8	2.3	2.8	V
V <sub>GSth</sub>	gate-source threshold voltage	I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>J</sub> = -55 °C; see <a href="#">Figure 10</a>	-	-	3.3	V
		I <sub>D</sub> = 2.5 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>J</sub> = 175 °C; see <a href="#">Figure 10</a>	0.8	-	-	V
I <sub>DSS</sub>	drain leakage current	V <sub>DS</sub> = 55 V; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 25 °C	-	-	1	μA
		V <sub>DS</sub> = 55 V; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 175 °C	-	-	500	μA
I <sub>GSS</sub>	gate leakage current	V <sub>DS</sub> = 0 V; V <sub>GS</sub> = 20 V; T <sub>J</sub> = 25 °C	-	2	100	nA
		V <sub>DS</sub> = 0 V; V <sub>GS</sub> = -20 V; T <sub>J</sub> = 25 °C	-	2	100	nA
R <sub>DSon</sub>	drain-source on-state resistance	V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 25 °C; see <a href="#">Figure 11</a>	-	4.6	5.4	mΩ
		V <sub>GS</sub> = 5 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 25 °C; see <a href="#">Figure 11</a>	-	5.5	7	mΩ
		V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 25 °C; see <a href="#">Figure 11</a>	-	5.9	8	mΩ
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 175 °C; see <a href="#">Figure 12</a>	-	-	11.9	mΩ
Dynamic characteristics						
Q <sub>G(tot)</sub>	total gate charge	I <sub>D</sub> = 25 A; V <sub>DS</sub> = 44 V; V <sub>GS</sub> = 5 V; see <a href="#">Figure 13</a> ; see <a href="#">Figure 14</a>	-	67	-	nC
		I <sub>D</sub> = 25 A; V <sub>DS</sub> = 44 V; V <sub>GS</sub> = 10 V; see <a href="#">Figure 14</a> ; see <a href="#">Figure 13</a>	-	124	-	nC
Q <sub>GS</sub>	gate-source charge	I <sub>D</sub> = 25 A; V <sub>DS</sub> = 44 V; V <sub>GS</sub> = 10 V; see <a href="#">Figure 13</a> ; see <a href="#">Figure 14</a>	-	19	-	nC
Q <sub>GD</sub>	gate-drain charge		-	31.5	-	nC
C <sub>iss</sub>	input capacitance	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 25 V; f = 1 MHz; T <sub>J</sub> = 25 °C; see <a href="#">Figure 15</a>	-	5800	7750	pF
C <sub>oss</sub>	output capacitance		-	550	660	pF
C <sub>rss</sub>	reverse transfer capacitance		-	380	520	pF
t <sub>d(on)</sub>	turn-on delay time	V <sub>DS</sub> = 45 V; R <sub>L</sub> = 1.8 Ω; V <sub>GS</sub> = 10 V; R <sub>G(ext)</sub> = 10 Ω	-	25	-	ns
t <sub>r</sub>	rise time		-	65	-	ns
t <sub>d(off)</sub>	turn-off delay time		-	252	-	ns
t <sub>f</sub>	fall time		-	116	-	ns
L <sub>D</sub>	internal drain inductance	from source lead to source bond pad ; T <sub>J</sub> = 25 °C	-	7.5	-	nH
L <sub>S</sub>	internal source inductance	from drain lead 6 mm from package to centre of die ; T <sub>J</sub> = 25 °C	-	4.5	-	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	-	0.83	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 20\text{ A}$ ; $dI_S/dt = -100\text{ A}/\mu\text{s}$ ;	-	55	-	ns
$Q_r$	recovered charge	$V_{GS} = 0\text{ V}$ ; $V_{DS} = 25\text{ V}$	-	112	-	nC

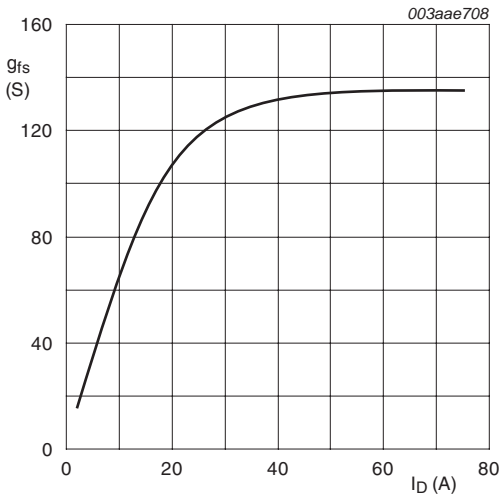


Fig 5. Forward transconductance as a function of drain current; typical values

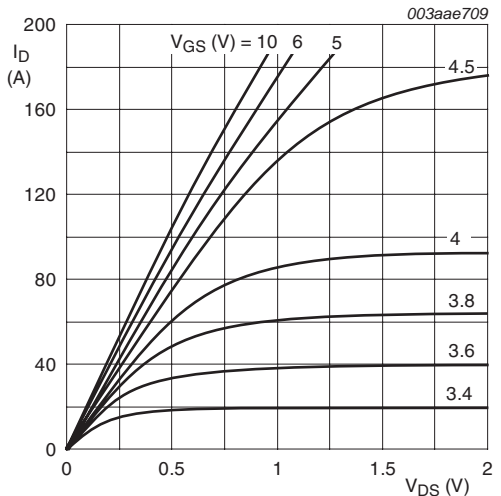


Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values

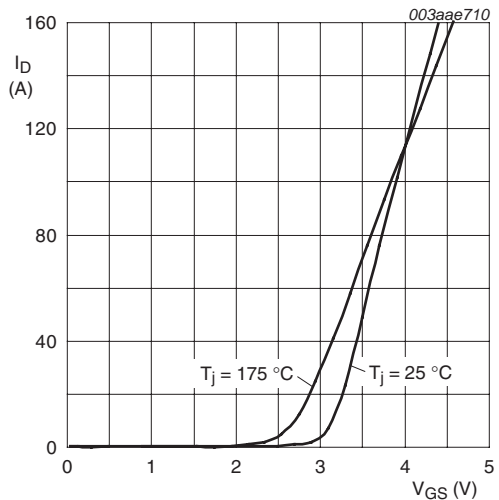


Fig 7. Transfer characteristics: drain current as a function of gate-source voltage; typical values

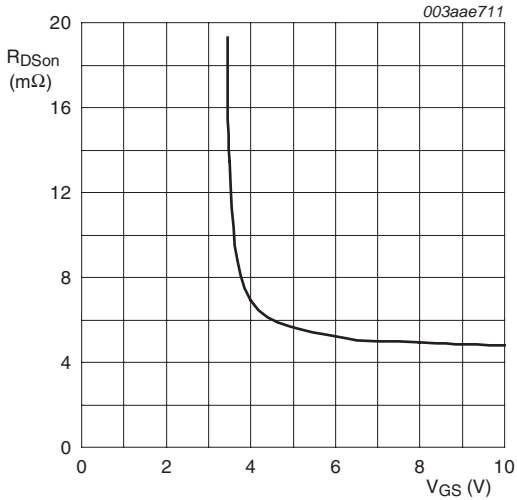


Fig 8. Drain-source on-state resistance as a function of gate-source voltage; typical values

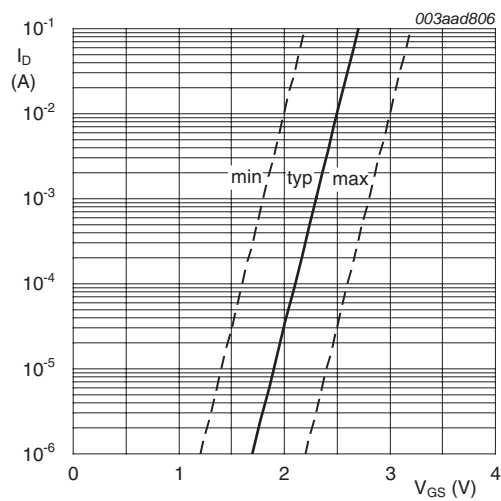


Fig 9. Sub-threshold drain current as a function of gate-source voltage

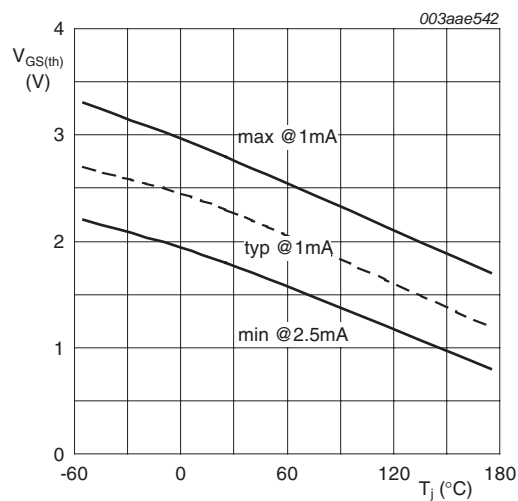


Fig 10. Gate-source threshold voltage as a function of junction temperature

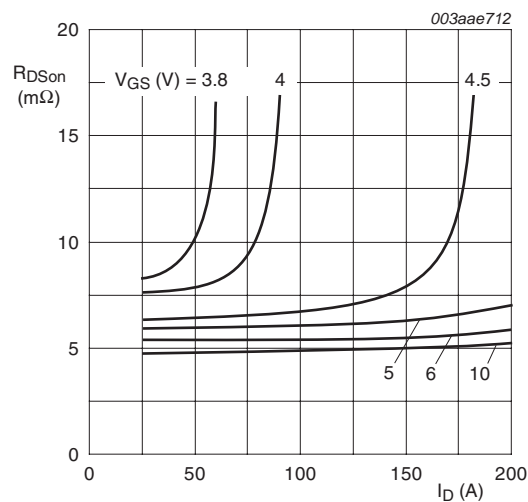


Fig 11. Drain-source on-state resistance as a function of drain current; typical values

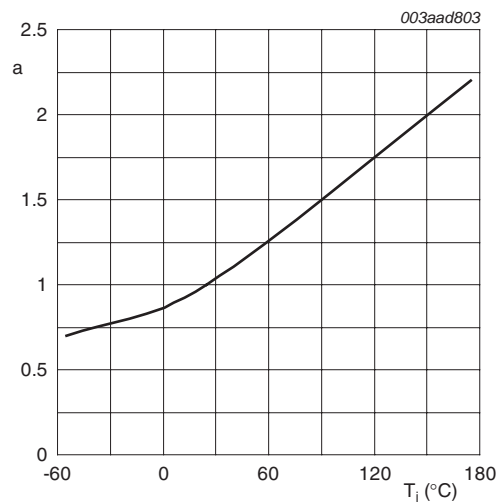
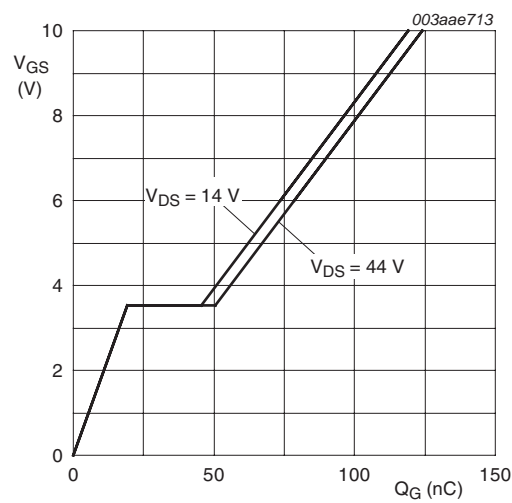


Fig 12. Normalized drain-source on-state resistance factor as a function of junction temperature





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

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

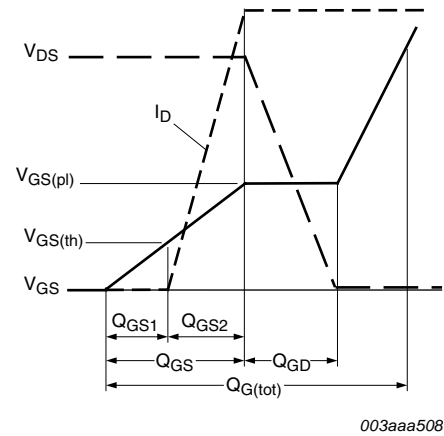
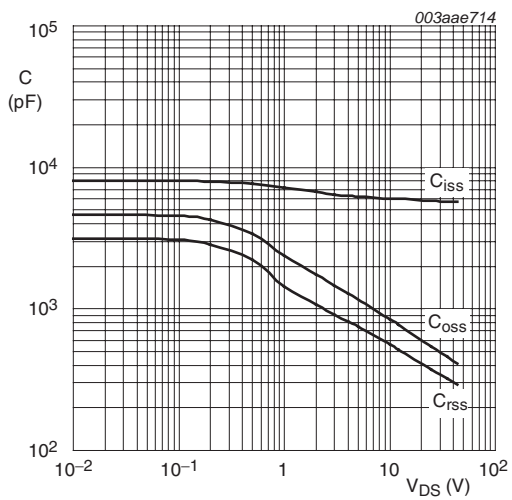
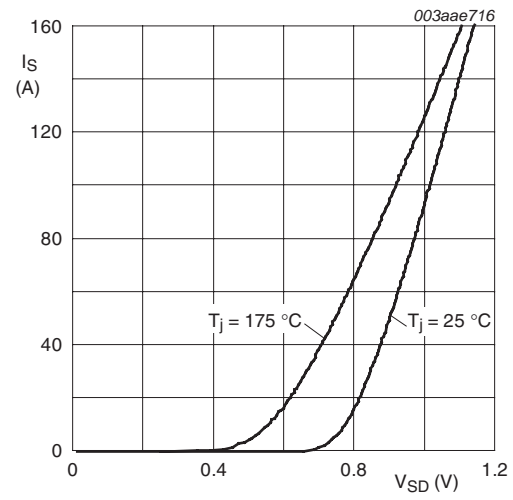


Fig 14. Gate charge waveform definitions



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

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

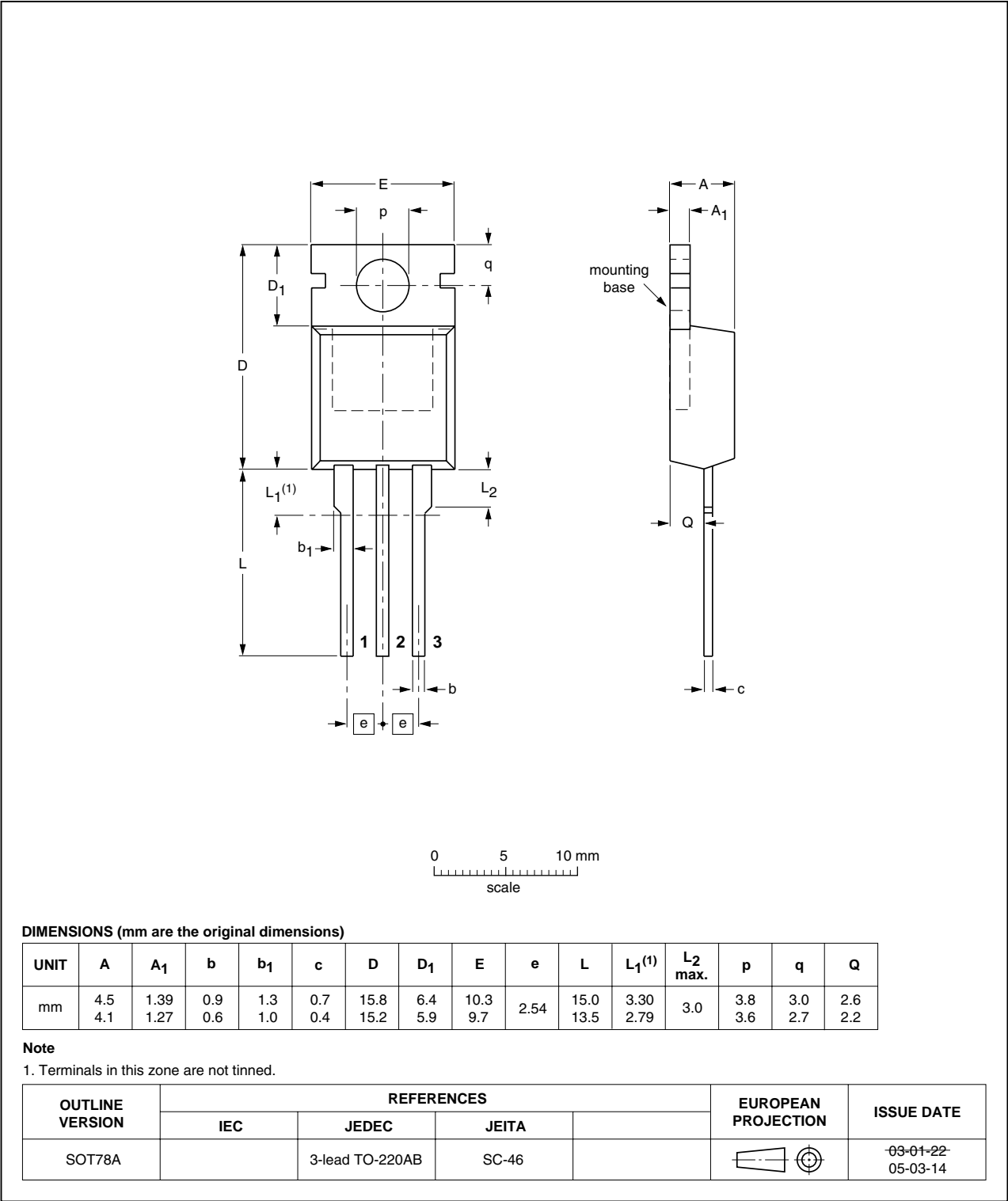


Fig 17. Package outline SOT78A (TO-220AB)

## 8. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BUK654R6-55C v.2	20101014	Product data sheet	-	BUK654R6-55C v.1
Modifications:	<ul style="list-style-type: none"><li>• Status changed from objective to product.</li><li>• Various changes to content.</li></ul>			
BUK654R6-55C v.1	20100921	Objective data sheet	-	-

## 9. Legal information

### 9.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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