



# PSMN1R5-40PS

N-channel 40 V 1.6 m $\Omega$  standard level MOSFET in TO220

15 July 2013

Product data sheet

## 1. General description

Standard level N-channel MOSFET in SOT78 (TO220) using TrenchMOS technology. Product design and manufacture has been optimized for use in battery operated power tools.

## 2. Features and benefits

- High efficiency due to low switching and conduction losses
- Robust construction for demanding applications
- Standard level gate

## 3. Applications

- Battery-powered tools
- Load switching
- Motor control
- Uninterruptible power supplies

## 4. Quick reference data

Table 1. Quick reference data

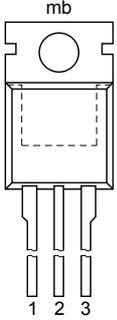
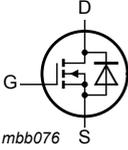
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V <sub>DS</sub>	drain-source voltage	T <sub>j</sub> ≥ 25 °C; T <sub>j</sub> ≤ 175 °C		-	-	40	V
I <sub>D</sub>	drain current	T <sub>mb</sub> = 25 °C; V <sub>GS</sub> = 10 V; <a href="#">Fig. 1</a>	[1]	-	-	150	A
P <sub>tot</sub>	total power dissipation	T <sub>mb</sub> = 25 °C; <a href="#">Fig. 2</a>		-	-	338	W
<b>Static characteristics</b>							
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> = 100 °C; <a href="#">Fig. 13</a>		-	1.9	2.3	m $\Omega$
		V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 14</a>	[2]	-	1.3	1.6	m $\Omega$
<b>Dynamic characteristics</b>							
Q <sub>GD</sub>	gate-drain charge	V <sub>GS</sub> = 10 V; I <sub>D</sub> = 75 A; V <sub>DS</sub> = 20 V;		-	32	-	nC
Q <sub>G(tot)</sub>	total gate charge	T <sub>j</sub> = 25 °C; <a href="#">Fig. 15</a> ; <a href="#">Fig. 16</a>		-	136	-	nC

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$V_{GS} = 10\text{ V}$ ; $T_{j(\text{init})} = 25\text{ °C}$ ; $I_D = 150\text{ A}$ ; $V_{sup} \leq 40\text{ V}$ ; unclamped; $R_{GS} = 50\text{ }\Omega$ ; $t_p = 0.1\text{ ms}$ ; <a href="#">Fig. 3</a>	-	-	1.1	J

- [1] Continuous current is limited by package  
 [2] Measured 3 mm from package.

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 <p style="text-align: center;">TO-220AB (SOT78)</p>	 <p style="text-align: center;"><i>mbb076</i></p>
2	D	drain		
3	S	source		
mb	D	drain		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PSMN1R5-40PS	TO-220AB	plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB	SOT78

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PSMN1R5-40PS	PSMN1R5-40PS

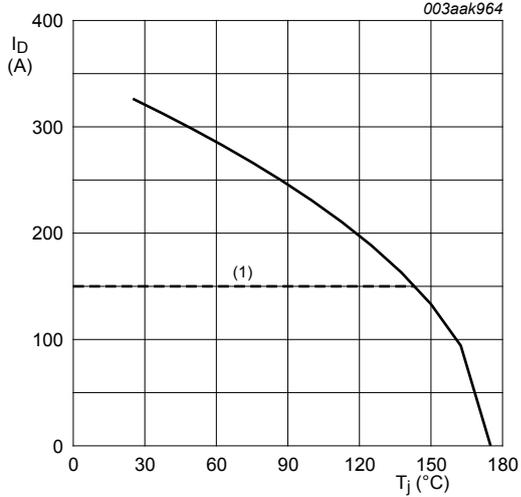
## 8. Limiting values

**Table 5. Limiting values**

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

Symbol	Parameter	Conditions		Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$		-	40	V
$V_{DGR}$	drain-gate voltage	$T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}; R_{GS} = 20\text{ k}\Omega$		-	40	V
$V_{GS}$	gate-source voltage			-20	20	V
$I_D$	drain current	$V_{GS} = 10\text{ V}; T_{mb} = 100\text{ °C}; \text{Fig. 1}$	[1]	-	150	A
		$V_{GS} = 10\text{ V}; T_{mb} = 25\text{ °C}; \text{Fig. 1}$	[1]	-	150	A
$I_{DM}$	peak drain current	pulsed; $t_p \leq 10\text{ }\mu\text{s}; T_{mb} = 25\text{ °C}; \text{Fig. 4}$		-	1301	A
$P_{tot}$	total power dissipation	$T_{mb} = 25\text{ °C}; \text{Fig. 2}$		-	338	W
$T_{stg}$	storage temperature			-55	175	°C
$T_j$	junction temperature			-55	175	°C
$T_{sld(M)}$	peak soldering temperature			-	260	°C
<b>Source-drain diode</b>						
$I_S$	source current	$T_{mb} = 25\text{ °C}$	[1]	-	150	A
$I_{SM}$	peak source current	pulsed; $t_p \leq 10\text{ }\mu\text{s}; T_{mb} = 25\text{ °C}$		-	1301	A
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$V_{GS} = 10\text{ V}; T_{j(\text{init})} = 25\text{ °C}; I_D = 150\text{ A}; V_{sup} \leq 40\text{ V}; \text{unclamped}; R_{GS} = 50\text{ }\Omega; t_p = 0.1\text{ ms}; \text{Fig. 3}$		-	1.1	J

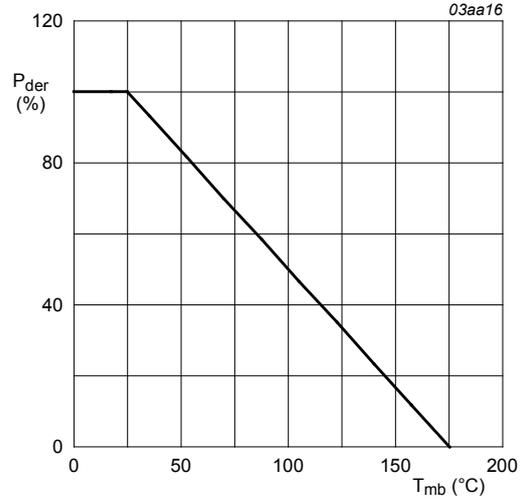
[1] Continuous current is limited by package



(1) Capped at 150A due to package

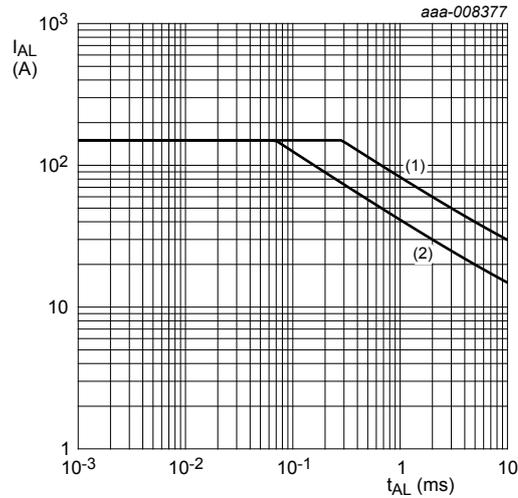
**Fig. 1. Normalized continuous drain current as a function of mounting base temperature**

$$V_{GS} \geq 10V$$



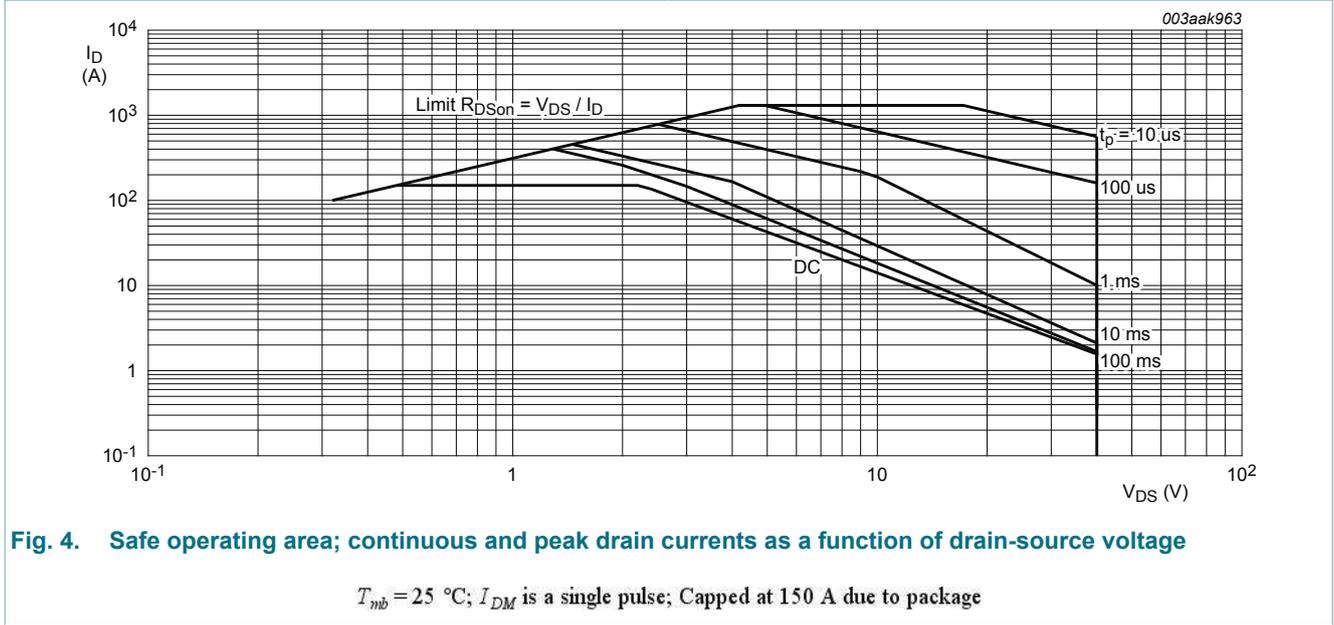
**Fig. 2. Normalized total power dissipation as a function of mounting base temperature**

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



**Fig. 3. Single pulse avalanche rating; avalanche current as a function of avalanche time**

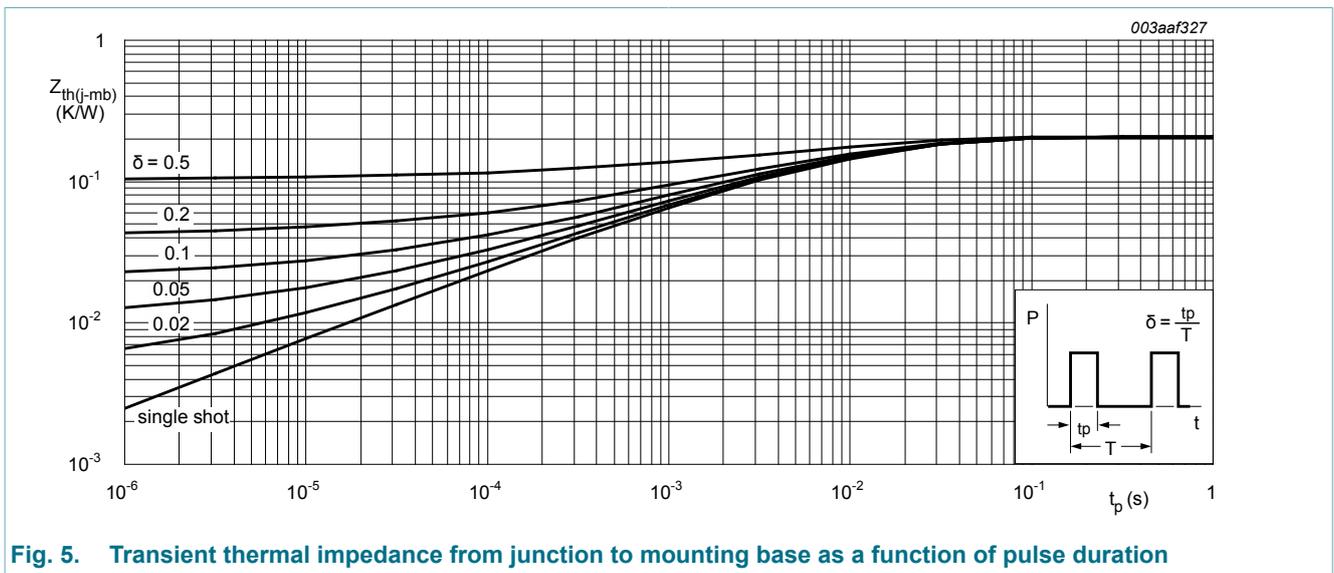
(1)  $T_{j(int)} = 25^{\circ}C$ ; (2)  $T_{j(int)} = 100^{\circ}C$



## 9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	Fig. 5	-	0.22	0.44	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	Vertical in free air	-	60	-	K/W



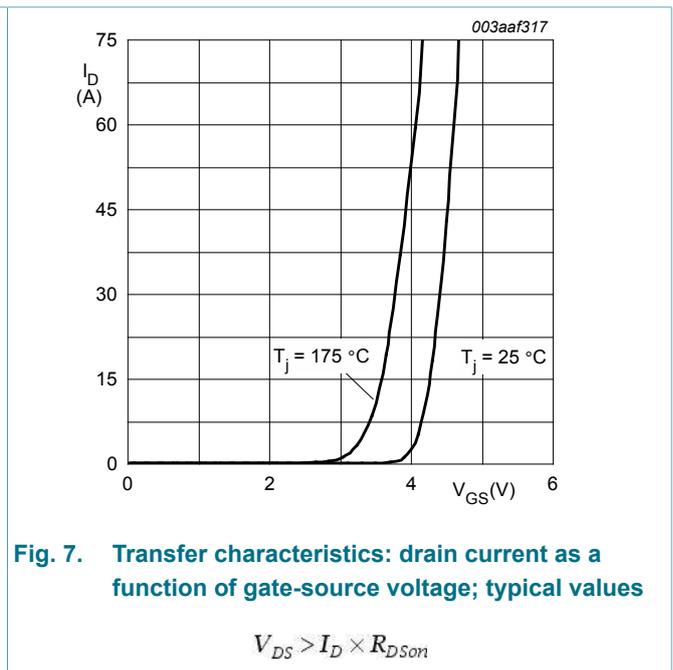
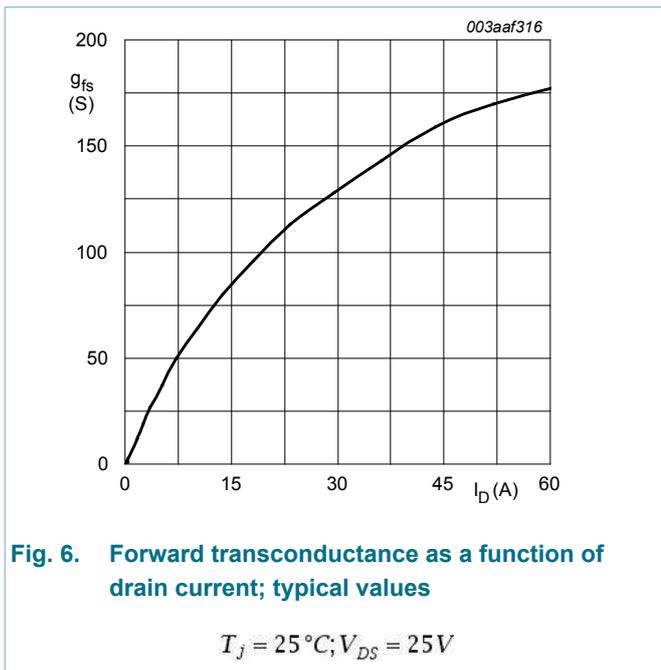
## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$	36	-	-	V
		$I_D = 250 \mu\text{A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	40	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ\text{C};$ <a href="#">Fig. 11</a>	-	-	4.6	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ\text{C};$ <a href="#">Fig. 11</a>	1	-	-	V
		$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 12; Fig. 11</a>	2	3	4	V
$I_{DSS}$	drain leakage current	$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	0.02	10	$\mu\text{A}$
		$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$	-	250	500	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = 20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	2	100	nA
		$V_{GS} = -20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	2	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 100 \text{ }^\circ\text{C};$ <a href="#">Fig. 13</a>	-	1.9	2.3	mΩ
		$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$ <a href="#">Fig. 13</a>	-	2.6	3.2	mΩ
		$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 14</a>	[1]	-	1.3	1.6
$R_G$	internal gate resistance (AC)	$f = 1 \text{ MHz}$	-	1.1	-	Ω
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$I_D = 0 \text{ A}; V_{DS} = 0 \text{ V}; V_{GS} = 10 \text{ V}$	-	133	-	nC
		$I_D = 75 \text{ A}; V_{DS} = 20 \text{ V}; V_{GS} = 10 \text{ V};$ $T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 15; Fig. 16</a>	-	136	-	nC
$Q_{GS}$	gate-source charge		-	52	-	nC
$Q_{GS(th)}$	pre-threshold gate-source charge		-	30	-	nC
$Q_{GS(th-pl)}$	post-threshold gate-source charge		-	22.5	-	nC
$Q_{GD}$	gate-drain charge		-	32	-	nC
$V_{GS(pl)}$	gate-source plateau voltage		$I_D = 75 \text{ A}; V_{DS} = 20 \text{ V}; T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 15; Fig. 16</a>	-	6.1	-
$C_{iss}$	input capacitance	$V_{DS} = 20 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz};$ $T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 17</a>	-	9710	-	pF
$C_{oss}$	output capacitance		-	2042	-	pF

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$C_{rSS}$	reverse transfer capacitance		-	994	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 20\text{ V}; R_L = 0.8\ \Omega; V_{GS} = 10\text{ V}; R_{G(ext)} = 4.7\ \Omega; T_j = 25\text{ }^\circ\text{C}$	-	45	-	ns
$t_r$	rise time		-	66	-	ns
$t_{d(off)}$	turn-off delay time		-	111	-	ns
$t_f$	fall time		-	53	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 25\text{ A}; V_{GS} = 0\text{ V}; T_j = 25\text{ }^\circ\text{C}; \text{Fig. 18}$	-	0.8	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 25\text{ A}; di_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V}; V_{DS} = 20\text{ V}; T_j = 25\text{ }^\circ\text{C}$	-	64	-	ns
$Q_r$	recovered charge	$I_S = 25\text{ A}; di_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V}; V_{DS} = 20\text{ V}; T_j = 25\text{ }^\circ\text{C}$	-	117	-	nC

[1] Measured 3 mm from package.



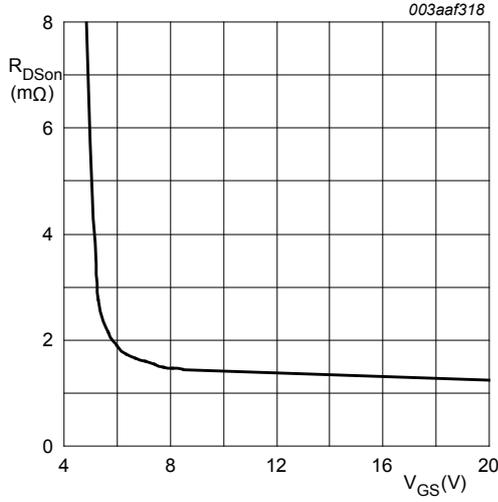


Fig. 8. Drain-source on-state resistance as a function of gate-source voltage; typical values.

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

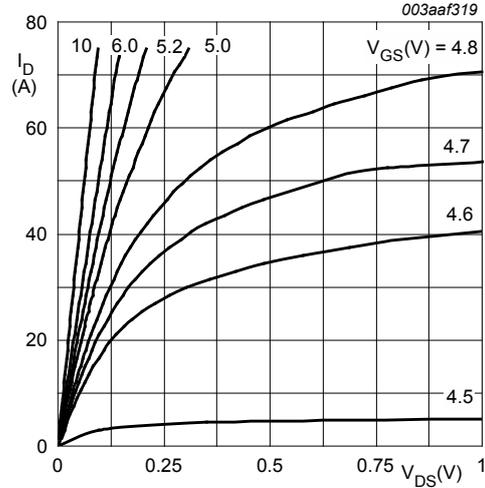


Fig. 9. Output characteristics: drain current as a function of drain-source voltage; typical values

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

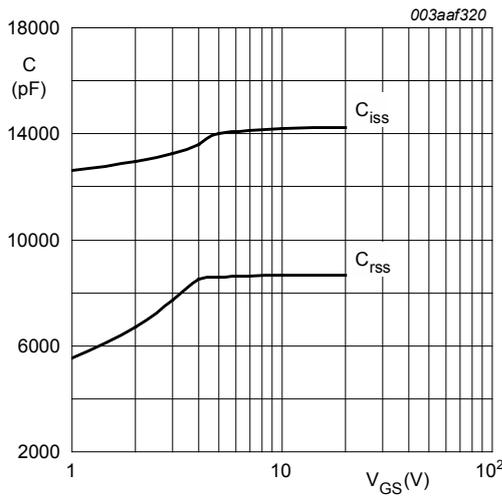


Fig. 10. Input and reverse transfer capacitances as a function of gate-source voltage; typical values

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

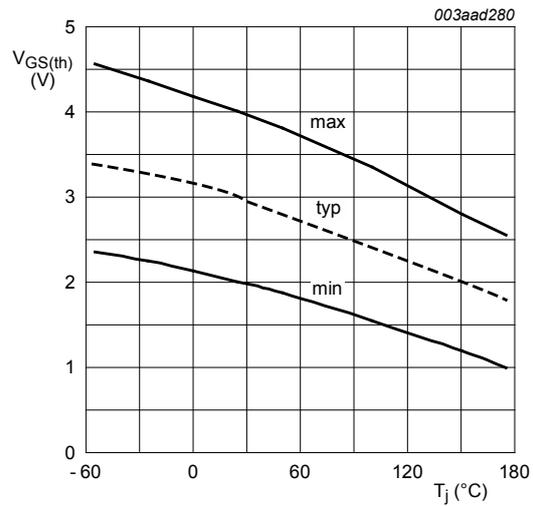
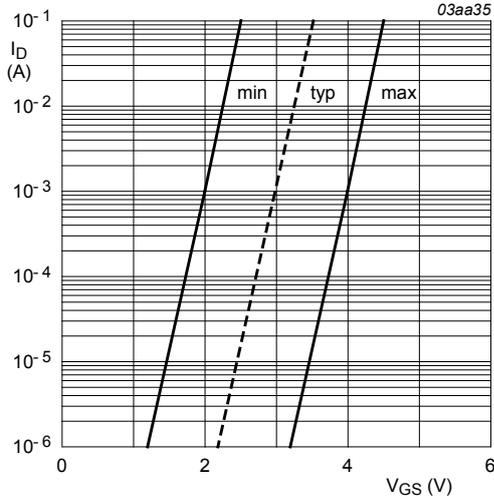


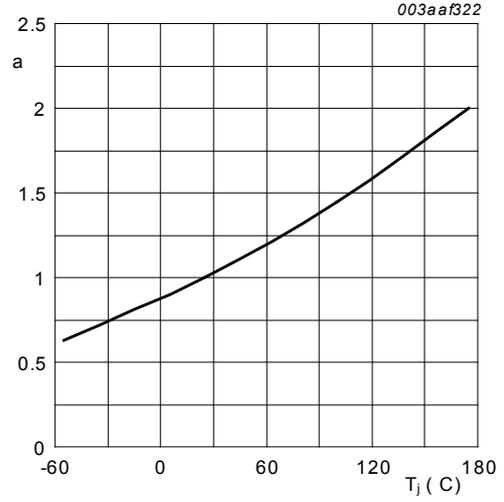
Fig. 11. Gate-source threshold voltage as a function of junction temperature

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



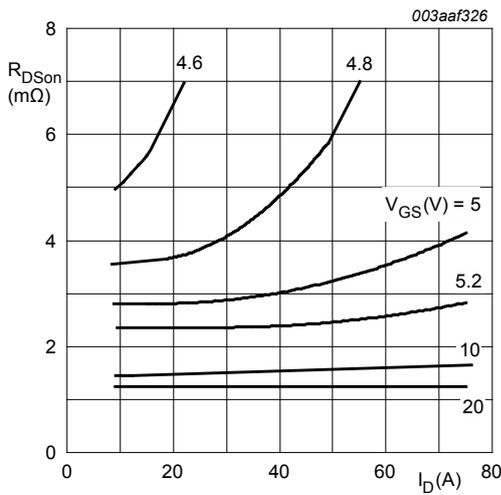
**Fig. 12. Sub-threshold drain current as a function of gate-source voltage**

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



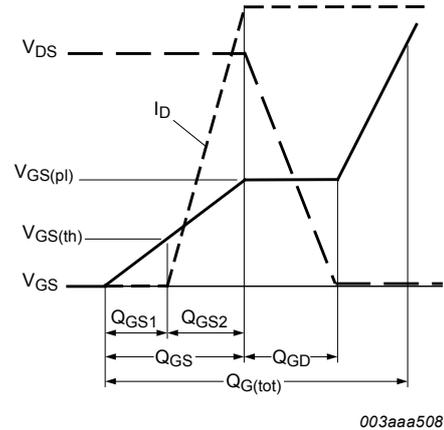
**Fig. 13. Normalized drain-source on state resistance factor as a function of junction temperature**

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



**Fig. 14. Drain-source on-state resistance as a function of drain current; typical values**

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



**Fig. 15. Gate charge waveform definitions**

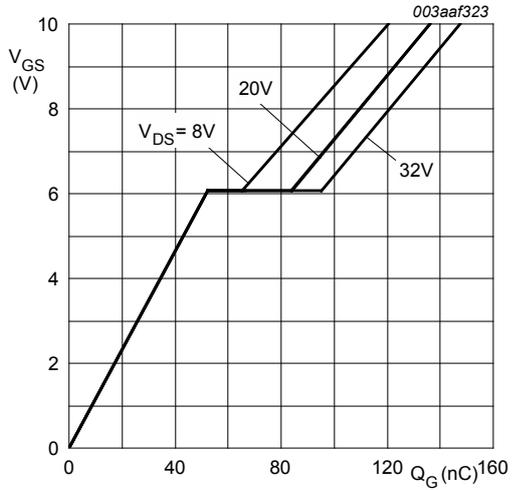


Fig. 16. Gate-source voltage as a function of gate charge; typical values

$$I_D = 75A$$

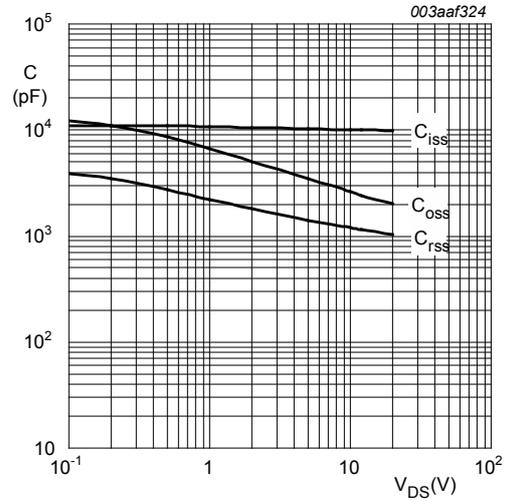


Fig. 17. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

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

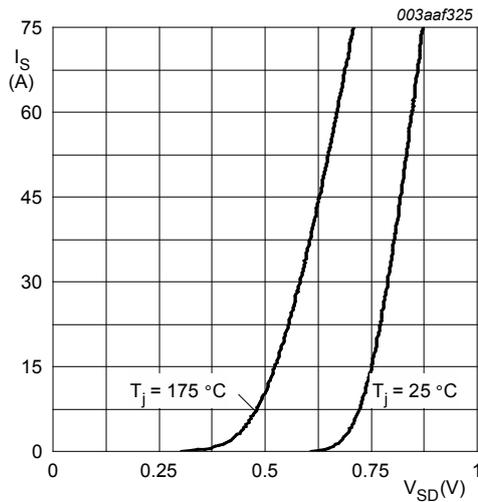


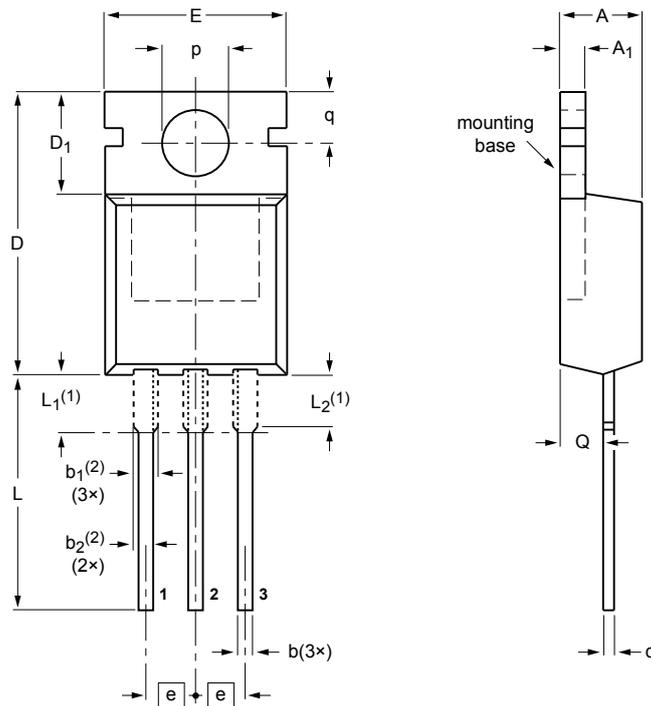
Fig. 18. Source current as a function of source-drain voltage; typical values

$$V_{GS} = 0V$$

### 11. Package outline

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

SOT78



**DIMENSIONS** (mm are the original dimensions)

UNIT	A	A <sub>1</sub>	b	b <sub>1</sub> (2)	b <sub>2</sub> (2)	c	D	D <sub>1</sub>	E	e	L	L <sub>1</sub> (1)	L <sub>2</sub> (1) max.	p	q	Q
mm	4.7 4.1	1.40 1.25	0.9 0.6	1.6 1.0	1.3 1.0	0.7 0.4	16.0 15.2	6.6 5.9	10.3 9.7	2.54	15.0 12.8	3.30 2.79	3.0	3.8 3.5	3.0 2.7	2.6 2.2

**Notes**

- 1. Lead shoulder designs may vary.
- 2. Dimension includes excess dambar.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT78		3-lead TO-220AB	SC-46			08-04-23 08-06-13

Fig. 19. Package outline TO-220AB (SOT78)

## 12. Legal information

### 12.1 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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