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Kind regards,

Team Nexperia



# PSMN7R6-60XS

**N-channel 60 V 7.8 mΩ standard level MOSFET in TO220F (SOT186A)**

16 December 2014

Product data sheet

## 1. General description

Standard level N-channel MOSFET in a TO-220F (SOT186A) package qualified to 175 °C. This product is designed and qualified for use in a wide range of industrial, communications and power supply equipment.

## 2. Features and benefits

- High efficiency due to low switching and conduction losses
- Isolated TO220F package
- Suitable for standard level gate drive

## 3. Applications

- AC-to-DC power supply equipment
- Synchronous rectification
- Motor control

## 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$25^{\circ}\text{C} \leq T_j \leq 175^{\circ}\text{C}$		-	-	60	V
$I_D$	drain current	$T_{mb} = 25^{\circ}\text{C}$ ; $V_{GS} = 10\text{ V}$ ; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>		-	-	51.5	A
$P_{tot}$	total power dissipation	$T_{mb} = 25^{\circ}\text{C}$ ; <a href="#">Fig. 1</a>		-	-	46	W
$T_j$	junction temperature			-55	-	175	°C
<b>Static characteristics</b>							
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $T_j = 25^{\circ}\text{C}$ ; <a href="#">Fig. 14</a> ; <a href="#">Fig. 10</a>		-	5.9	7.8	$\text{m}\Omega$
<b>Dynamic characteristics</b>							
$Q_{GD}$	gate-drain charge	$V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $V_{DS} = 30\text{ V}$ ; <a href="#">Fig. 16</a> ; <a href="#">Fig. 15</a>		-	10.6	-	nC
$Q_{G(tot)}$	total gate charge	$V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $V_{DS} = 30\text{ V}$ ; <a href="#">Fig. 15</a> ; <a href="#">Fig. 16</a>		-	38.7	-	nC



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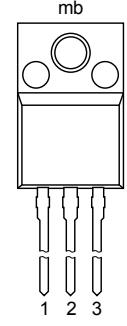
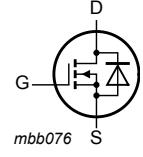


Symbol	Parameter	Conditions		Min	Typ	Max	Unit
<b>Avalanche ruggedness</b>							
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$V_{GS} = 10$ V; $T_{j(init)} = 25$ °C; $I_D = 51.5$ A; $V_{sup} \leq 60$ V; $R_{GS} = 50$ Ω; unclamped; <a href="#">Fig. 4</a>	[1]	-	-	191.5	mJ

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

## 5. Pinning information

**Table 2. Pinning information**

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		
2	D	drain		
3	S	source		
mb		mounting base; isolated	 <b>TO-220F (SOT186A)</b>	

## 6. Ordering information

**Table 3. Ordering information**

Type number	Package		
	Name	Description	Version
PSMN7R6-60XS	TO-220F	plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3-lead TO-220 "full pack"	SOT186A

## 7. Limiting values

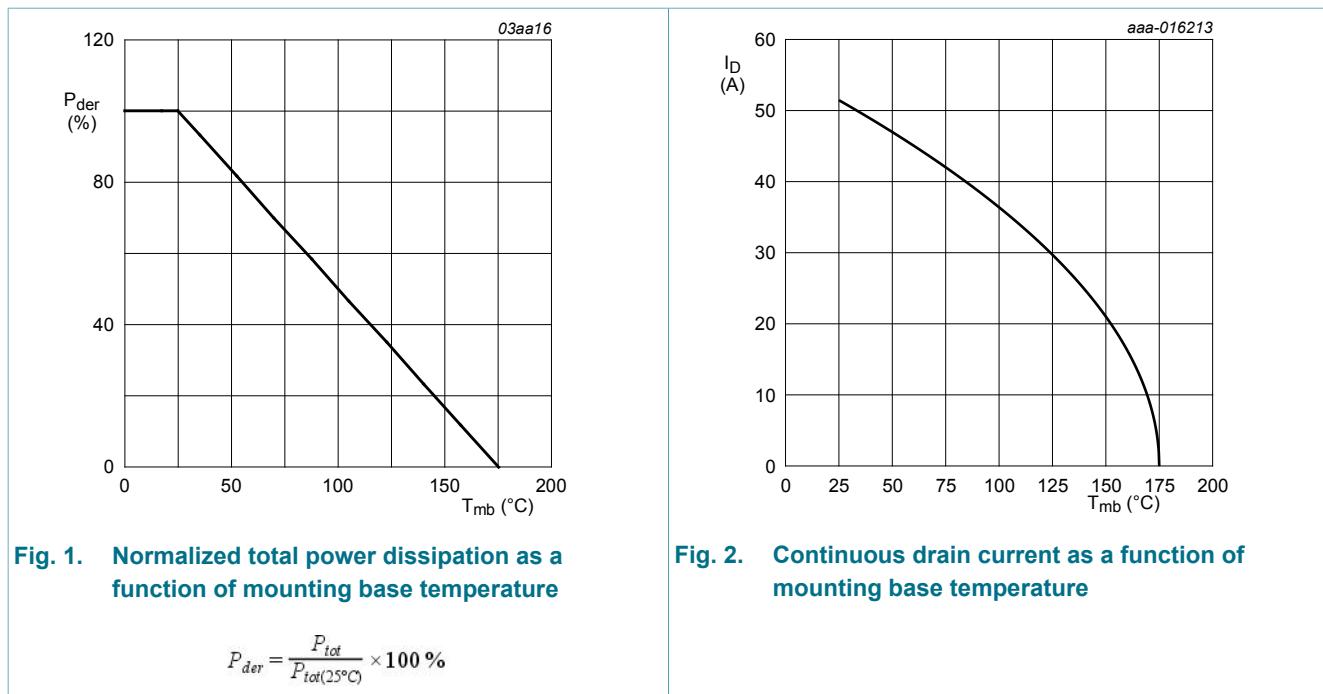
**Table 4. Limiting values**

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

Symbol	Parameter	Conditions		Min	Max	Unit
$V_{DS}$	drain-source voltage	$25$ °C $\leq T_j \leq 175$ °C		-	60	V
$V_{DGR}$	drain-gate voltage	$25$ °C $\leq T_j \leq 175$ °C; $R_{GS} = 20$ kΩ		-	60	V
$V_{GS}$	gate-source voltage			-20	20	V
$P_{tot}$	total power dissipation	$T_{mb} = 25$ °C; <a href="#">Fig. 1</a>		-	46	W
$I_D$	drain current	$V_{GS} = 10$ V; $T_{mb} = 100$ °C; <a href="#">Fig. 2</a>		-	36.4	A
		$V_{GS} = 10$ V; $T_{mb} = 25$ °C; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>		-	51.5	A

Symbol	Parameter	Conditions		Min	Max	Unit
$I_{DM}$	peak drain current	pulsed; $t_p \leq 10 \mu\text{s}$ ; $T_{mb} = 25^\circ\text{C}$ ; <a href="#">Fig. 3</a>		-	206	A
$T_{stg}$	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	$T_{mb} = 25^\circ\text{C}$		-	38.7	A
$I_{SM}$	peak source current	pulsed; $t_p \leq 10 \mu\text{s}$ ; $T_{mb} = 25^\circ\text{C}$		-	206	A
<b>Avalanche ruggedness</b>						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$V_{GS} = 10 \text{ V}$ ; $T_{j(\text{init})} = 25^\circ\text{C}$ ; $I_D = 51.5 \text{ A}$ ; $V_{\text{sup}} \leq 60 \text{ V}$ ; $R_{GS} = 50 \Omega$ ; unclamped; <a href="#">Fig. 4</a>	[1]	-	191.5	mJ

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



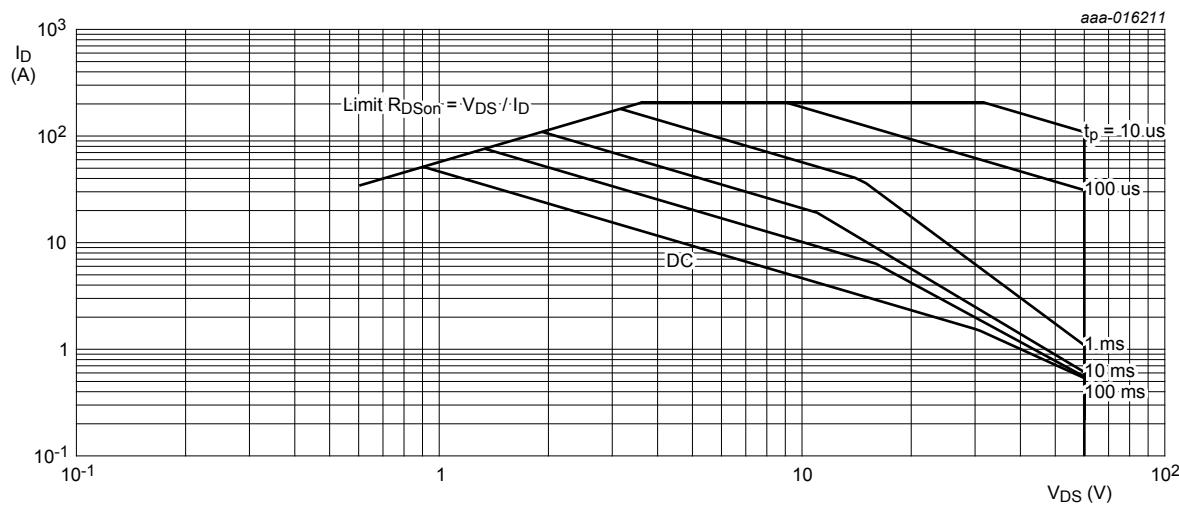


Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

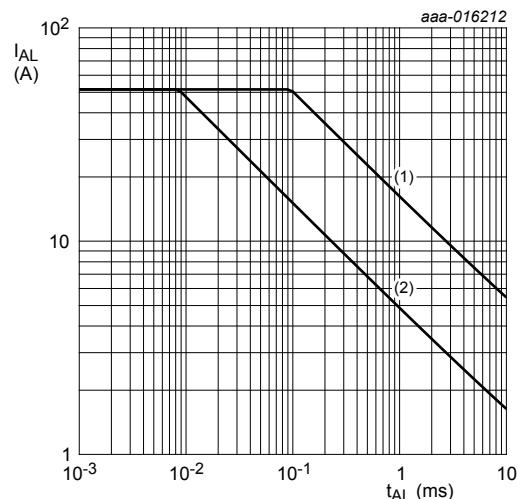
 $T_{mb} = 25^\circ C$ ;  $I_{DM}$  is a single pulse

Fig. 4. Avalanche rating; avalanche current as a function of avalanche time

(1)  $T_j (init) = 25^\circ C$ ; (2)  $T_j (init) = 130^\circ C$ 

## 8. Thermal characteristics

Table 5. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	<a href="#">Fig. 5</a>		-	3.01	3.23	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in free air		-	55	-	K/W

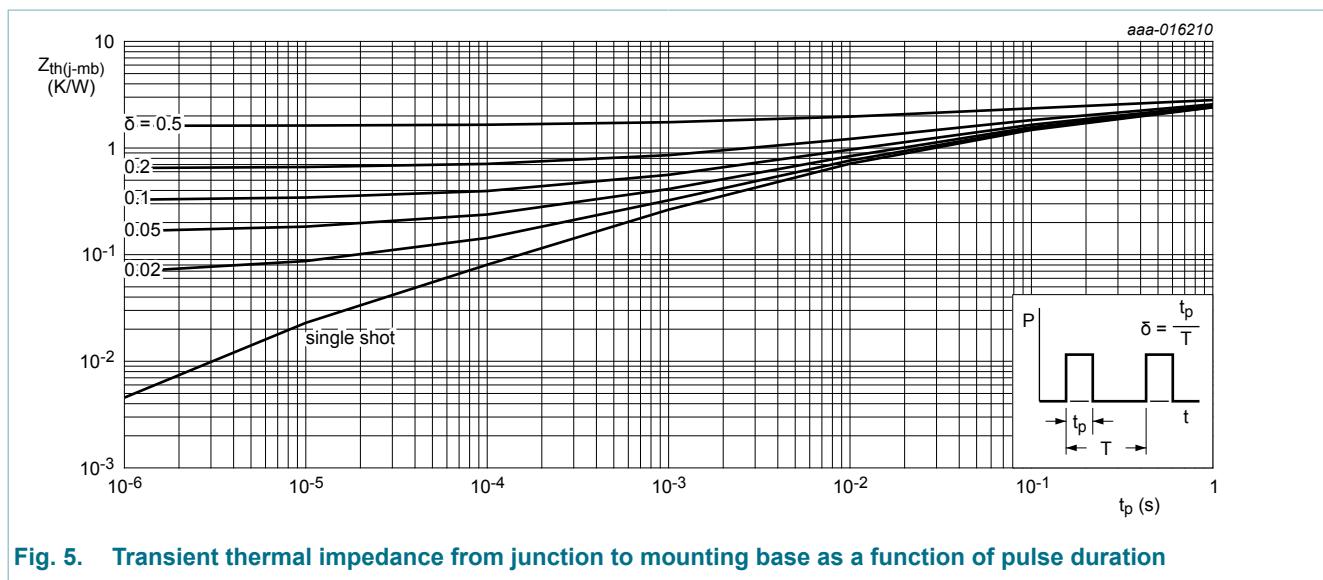


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 9. Isolation characteristics

Table 6. Isolation characteristics

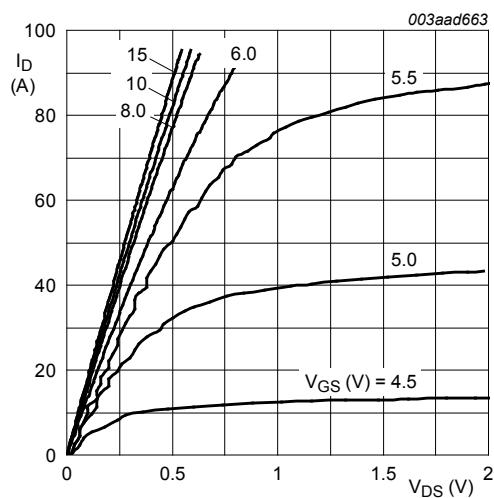
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$C_{isol}$	isolation capacitance	$f = 1$ MHz		-	10	-	pF
$V_{isol(RMS)}$	RMS isolation voltage	$50$ Hz $\leq f \leq 60$ Hz; RH $\leq 65$ %; sinusoidal waveform; clean and dust free		-	-	2500	V

## 10. Characteristics

Table 7. Characteristics

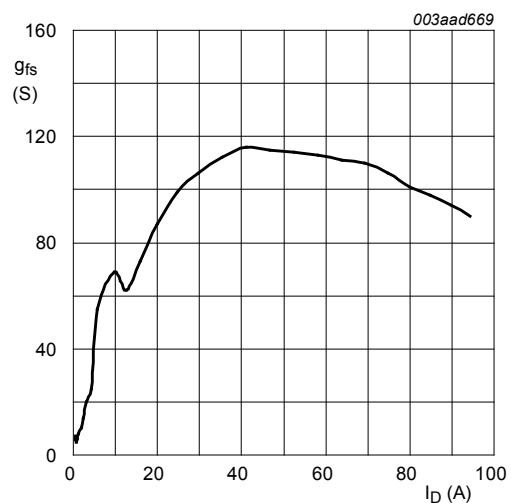
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
<b>Static characteristics</b>							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250$ $\mu$ A; $V_{GS} = 0$ V; $T_j = -55$ °C		54	-	-	V
		$I_D = 250$ $\mu$ A; $V_{GS} = 0$ V; $T_j = 25$ °C		60	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1$ mA; $V_{DS} = V_{GS}$ ; $T_j = 175$ °C; <a href="#">Fig. 11</a>		1	-	-	V
		$I_D = 1$ mA; $V_{DS} = V_{GS}$ ; $T_j = -55$ °C; <a href="#">Fig. 11</a>		-	-	4.6	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1$ mA; $V_{DS} = V_{GS}$ ; $T_j = 25$ °C; <a href="#">Fig. 12</a> ; <a href="#">Fig. 11</a>		2	3	4	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60$ V; $V_{GS} = 0$ V; $T_j = 25$ °C		-	0.05	10	$\mu$ A
		$V_{DS} = 60$ V; $V_{GS} = 0$ V; $T_j = 125$ °C		-	-	100	$\mu$ A
$I_{GSS}$	gate leakage current	$V_{GS} = 20$ V; $V_{DS} = 0$ V; $T_j = 25$ °C		-	2	100	nA

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
		$V_{GS} = -20 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$		-	2	100	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10 \text{ V}$ ; $I_D = 25 \text{ A}$ ; $T_j = 175 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 13</a>		-	13.3	18	mΩ
		$V_{GS} = 10 \text{ V}$ ; $I_D = 25 \text{ A}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 14</a> ; <a href="#">Fig. 10</a>		-	5.9	7.8	mΩ
$R_G$	gate resistance	$f = 1 \text{ MHz}$		-	0.98	-	Ω
<b>Dynamic characteristics</b>							
$Q_{G(tot)}$	total gate charge	$I_D = 25 \text{ A}$ ; $V_{DS} = 30 \text{ V}$ ; $V_{GS} = 10 \text{ V}$ ; <a href="#">Fig. 15</a> ; <a href="#">Fig. 16</a>		-	38.7	-	nC
$Q_{GS}$	gate-source charge			-	12.9	-	nC
$Q_{GS(th)}$	pre-threshold gate-source charge			-	6.9	-	nC
$Q_{GS(th-pl)}$	post-threshold gate-source charge			-	6	-	nC
$Q_{GD}$	gate-drain charge	$I_D = 25 \text{ A}$ ; $V_{DS} = 30 \text{ V}$ ; $V_{GS} = 10 \text{ V}$ ; <a href="#">Fig. 16</a> ; <a href="#">Fig. 15</a>		-	10.6	-	nC
$V_{GS(pl)}$	gate-source plateau voltage	$I_D = 25 \text{ A}$ ; $V_{DS} = 30 \text{ V}$ ; <a href="#">Fig. 15</a> ; <a href="#">Fig. 16</a>		-	5.6	-	V
$C_{iss}$	input capacitance	$V_{DS} = 30 \text{ V}$ ; $V_{GS} = 0 \text{ V}$ ; $f = 1 \text{ MHz}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 17</a> ; <a href="#">Fig. 9</a>		-	2651	-	pF
$C_{oss}$	output capacitance	$V_{DS} = 30 \text{ V}$ ; $V_{GS} = 0 \text{ V}$ ; $f = 1 \text{ MHz}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 17</a>		-	342	-	pF
$C_{rss}$	reverse transfer capacitance	$V_{DS} = 30 \text{ V}$ ; $V_{GS} = 0 \text{ V}$ ; $f = 1 \text{ MHz}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 17</a> ; <a href="#">Fig. 9</a>		-	183	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = 30 \text{ V}$ ; $R_L = 1.2 \Omega$ ; $V_{GS} = 10 \text{ V}$ ; $R_{G(ext)} = 4.7 \Omega$		-	19	-	ns
$t_r$	rise time			-	21	-	ns
$t_{d(off)}$	turn-off delay time			-	37	-	ns
$t_f$	fall time			-	13	-	ns
<b>Source-drain diode</b>							
$V_{SD}$	source-drain voltage	$I_S = 25 \text{ A}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 18</a>		-	0.86	1.2	V
$t_{rr}$	reverse recovery time	$I_S = 25 \text{ A}$ ; $dI_S/dt = 100 \text{ A}/\mu\text{s}$ ; $V_{GS} = 0 \text{ V}$ ; $V_{DS} = 30 \text{ V}$		-	40.4	-	ns
$Q_r$	recovered charge			-	56	-	nC

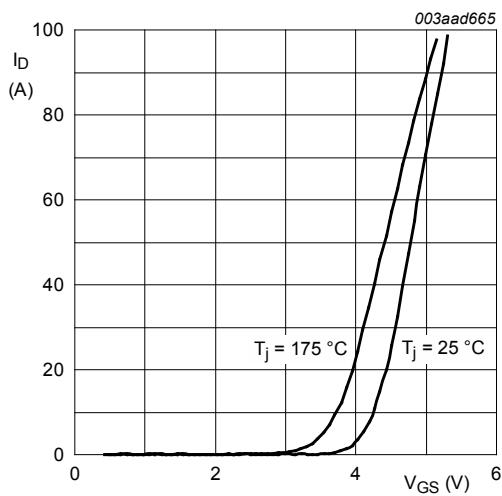


**Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values**

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

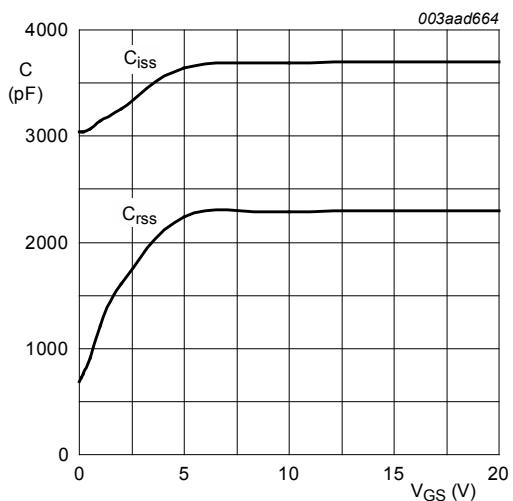


**Fig. 7. Forward transconductance as a function of drain current; typical values**



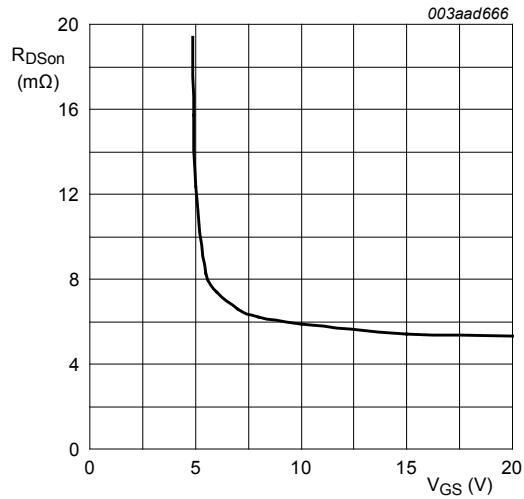
**Fig. 8. Transfer characteristics: drain current as a function of gate-source voltage; typical values**

$V_{DS} = 25 \text{ V}$



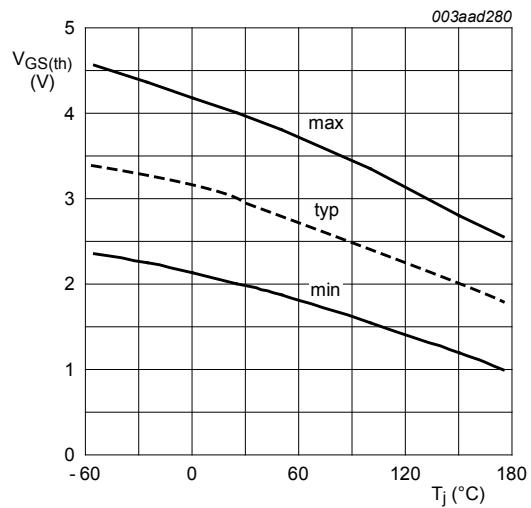
**Fig. 9. Input and reverse transfer capacitances as a function of gate-source voltage; typical values**

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



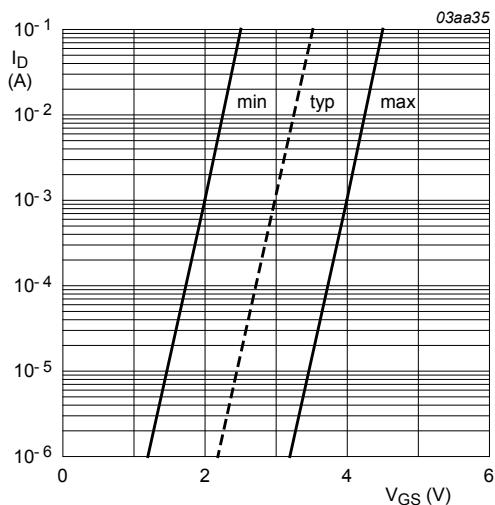
**Fig. 10. Drain-source on-state resistance as a function of gate-source voltage; typical values**

$T_j = 25^\circ C$



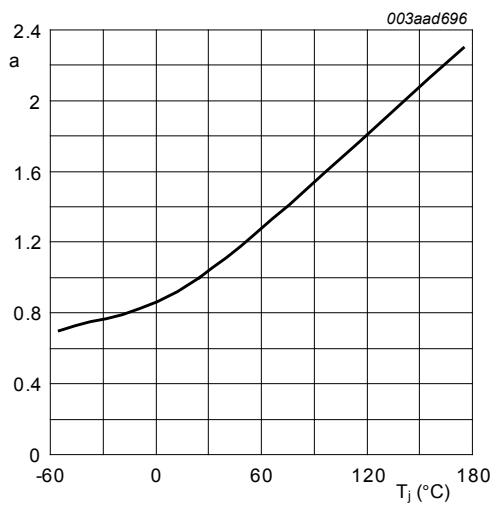
**Fig. 11. Gate-source threshold voltage as a function of junction temperature**

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



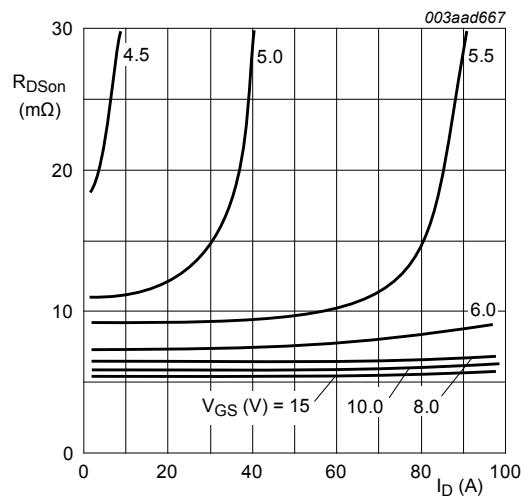
**Fig. 12. Sub-threshold drain current as a function of gate-source voltage**

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



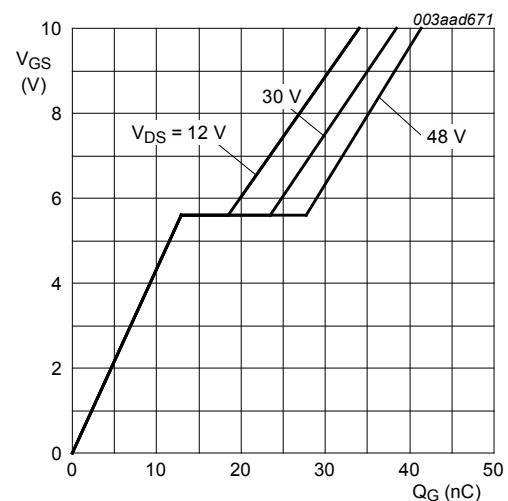
**Fig. 13. Normalized drain-source on-state resistance factor as a function of junction temperature.**

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



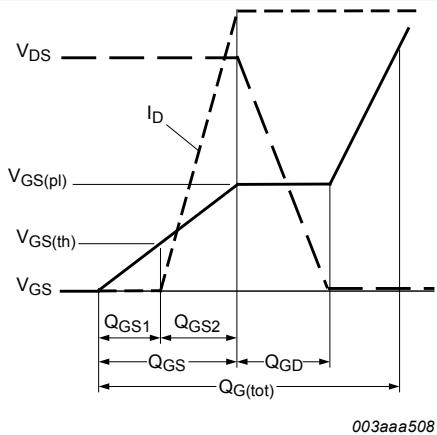
**Fig. 14. Drain-source on-state resistance as a function of drain current; typical values**

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

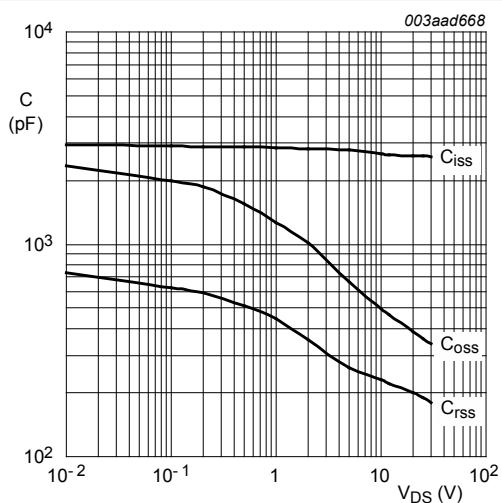


**Fig. 15. Gate-source voltage as a function of gate charge; typical values**

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



**Fig. 16. Gate charge waveform definitions**



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

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

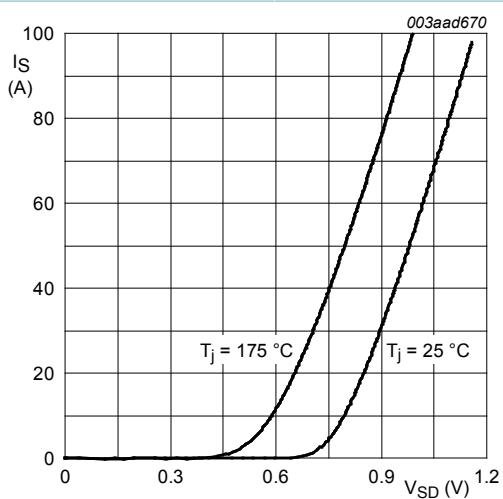


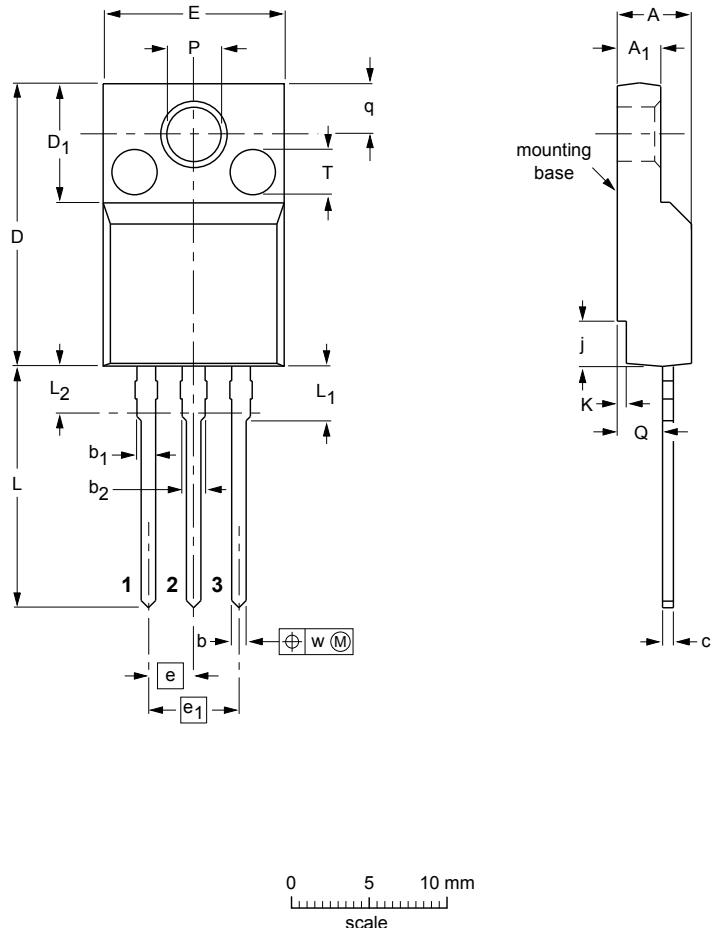
Fig. 18. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values

$V_{GS} = 0V$

## 11. Package outline

Plastic single-ended package; isolated heatsink mounted;  
1 mounting hole; 3-lead TO-220 'full pack'

SOT186A



### DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub>	b	b <sub>1</sub>	b <sub>2</sub>	c	D	D <sub>1</sub>	E	e	e <sub>1</sub>	j	K	L	L <sub>1</sub>	L <sub>2</sub> <sup>(1)</sup> max.	P	Q	q	T <sup>(2)</sup>	w
mm	4.6	2.9	0.9	1.1	1.4	0.7	15.8	6.5	10.3	2.54	5.08	2.7	0.6	14.4	3.30	3	3.2	2.6	3.0	2.5	0.4
	4.0	2.5	0.7	0.9	1.0	0.4	15.2	6.3	9.7	2.54	5.08	1.7	0.4	13.5	2.79	3.0	3.0	2.3	2.6	2.5	0.4

### Notes

1. Terminal dimensions within this zone are uncontrolled.
2. Both recesses are # 2.5 × 0.8 max. depth

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT186A		3-lead TO-220F				-02-04-09- 06-02-14

Fig. 19. Package outline TO-220F (SOT186A)

## 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.

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- [2] The term 'short data sheet' is explained in section "Definitions".
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