



# PMCM6501VPE

12 V, P-channel Trench MOSFET

10 August 2015

Product data sheet

## 1. General description

P-channel enhancement mode Field-Effect Transistor (FET) in a 6 bumps Wafer Level Chip-Size Package (WLCSP) using Trench MOSFET technology.

## 2. Features and benefits

- Low threshold voltage
- Ultra small package:  $0.98 \times 1.48 \times 0.35$  mm
- Trench MOSFET technology
- ElectroStatic Discharge (ESD) protection > 2 kV HBM

## 3. Applications

- Battery switch
- High-speed line driver
- Low-side loadswitch
- Switching circuits

## 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j = 25^\circ\text{C}$		-	-	-12	V
$V_{GS}$	gate-source voltage			-8	-	8	V
$I_D$	drain current	$V_{GS} = -4.5$ V; $T_{amb} = 25^\circ\text{C}$ ; $t \leq 5$ s	[1]	-	-	-8.2	A
<b>Static characteristics</b>							
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = -4.5$ V; $I_D = -3.0$ A; $T_j = 25^\circ\text{C}$		-	19	25	$\text{m}\Omega$

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain  $6 \text{ cm}^2$ .

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## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
A1	G	gate		
A2	S	source		
B1	S	source		
B2	S	source		
C1	D	drain		
C2	D	drain		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PMCM6501VPE	WLCSP6	WLCSP6: wafer level chip-size package; 6 bumps (3 x 2)	OL-PMCM6501VPE

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PMCM6501VPE	AD

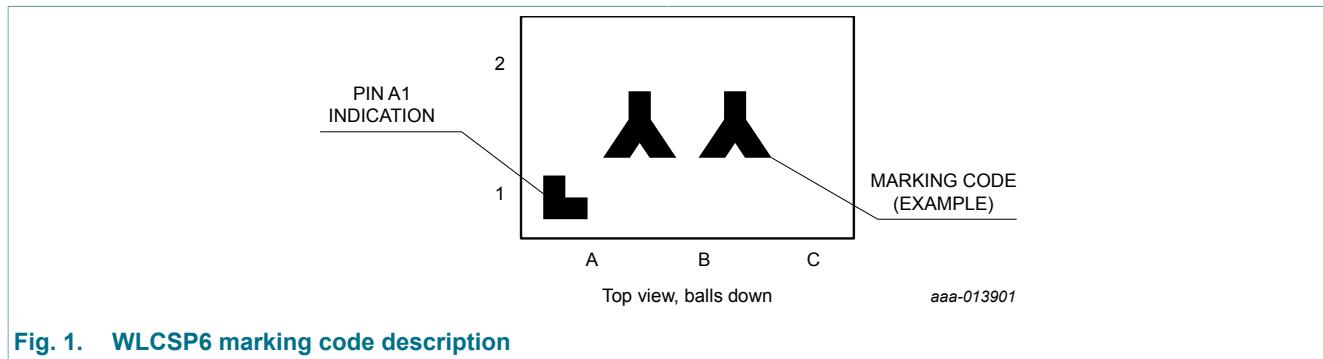


Fig. 1. WLCSP6 marking code description

## 8. Limiting values

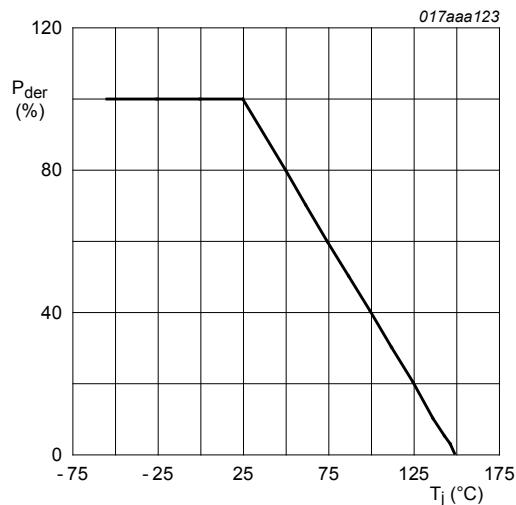
**Table 5. Limiting values**

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

Symbol	Parameter	Conditions		Min	Max	Unit
$V_{DS}$	drain-source voltage	$T_j = 25^\circ\text{C}$		-	-12	V
$V_{GS}$	gate-source voltage			-8	8	V
$I_D$	drain current	$V_{GS} = -4.5\text{ V}; T_{amb} = 25^\circ\text{C}; t \leq 5\text{ s}$	[1]	-	-8.2	A
		$V_{GS} = -4.5\text{ V}; T_{amb} = 25^\circ\text{C}$	[1]	-	-6.2	A
		$V_{GS} = -4.5\text{ V}; T_{amb} = 100^\circ\text{C}$	[1]	-	-4	A
$I_{DM}$	peak drain current	$T_{amb} = 25^\circ\text{C}; \text{single pulse}; t_p \leq 10\text{ }\mu\text{s}$		-	-25	A
$P_{tot}$	total power dissipation	$T_{amb} = 25^\circ\text{C}$	[2]	-	556	mW
			[1]	-	1300	mW
		$T_{sp} = 25^\circ\text{C}$		-	12500	mW
$T_j$	junction temperature			-55	150	°C
$T_{amb}$	ambient temperature			-55	150	°C
$T_{stg}$	storage temperature			-65	150	°C
<b>Source-drain diode</b>						
$I_S$	source current	$T_{amb} = 25^\circ\text{C}$	[1]	-	-1.2	A

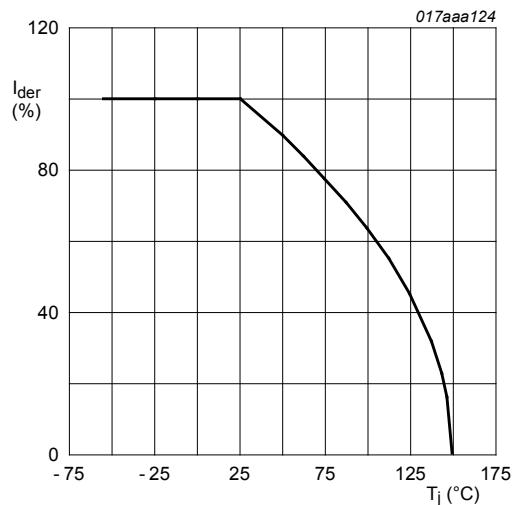
[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain  $6\text{ cm}^2$ .

[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.



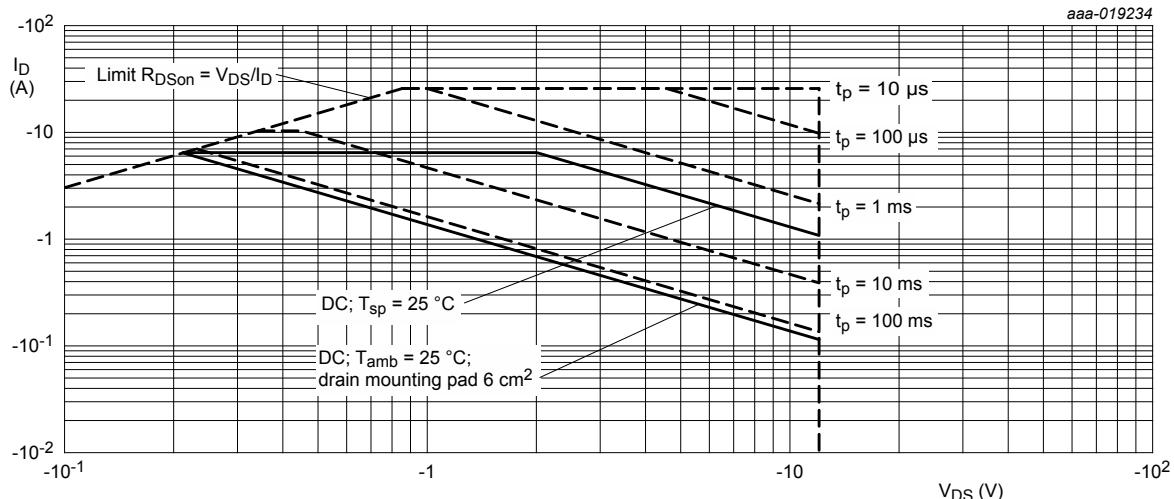
**Fig. 2. MOSFET transistor: Normalized total power dissipation as a function of junction temperature**

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



**Fig. 3. MOSFET transistor: Normalized continuous drain current as a function of junction temperature**

$$I_{der} = \frac{I_D}{I_D(25^{\circ}\text{C})} \times 100 \text{ \%}$$



$I_{DM}$  = single pulse

**Fig. 4. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage**

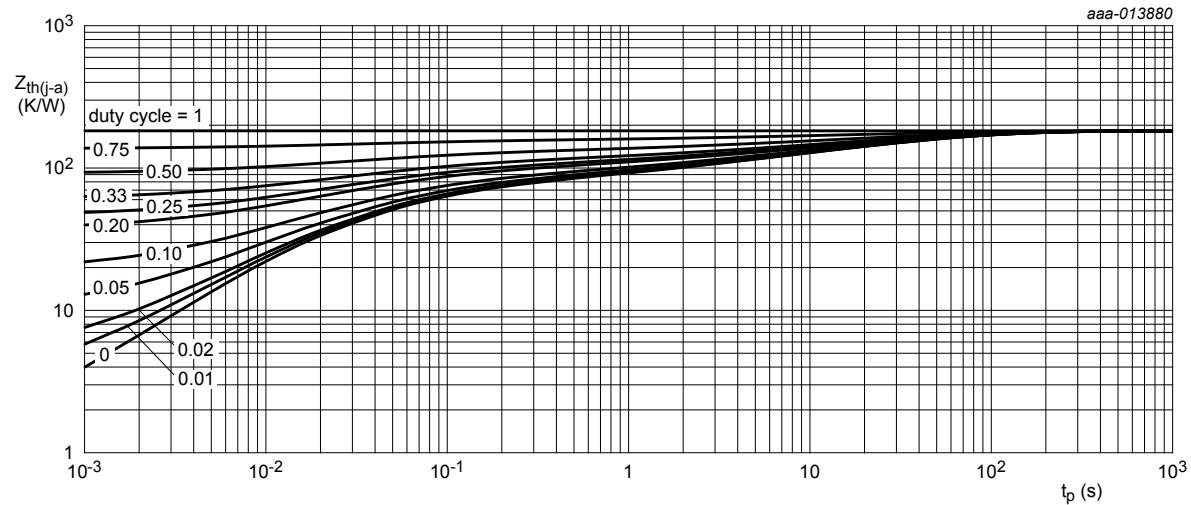
## 9. Thermal characteristics

**Table 6. Thermal characteristics**

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	180	225	K/W
			[2]	-	65	85	K/W
			[3]	-	75	95	K/W

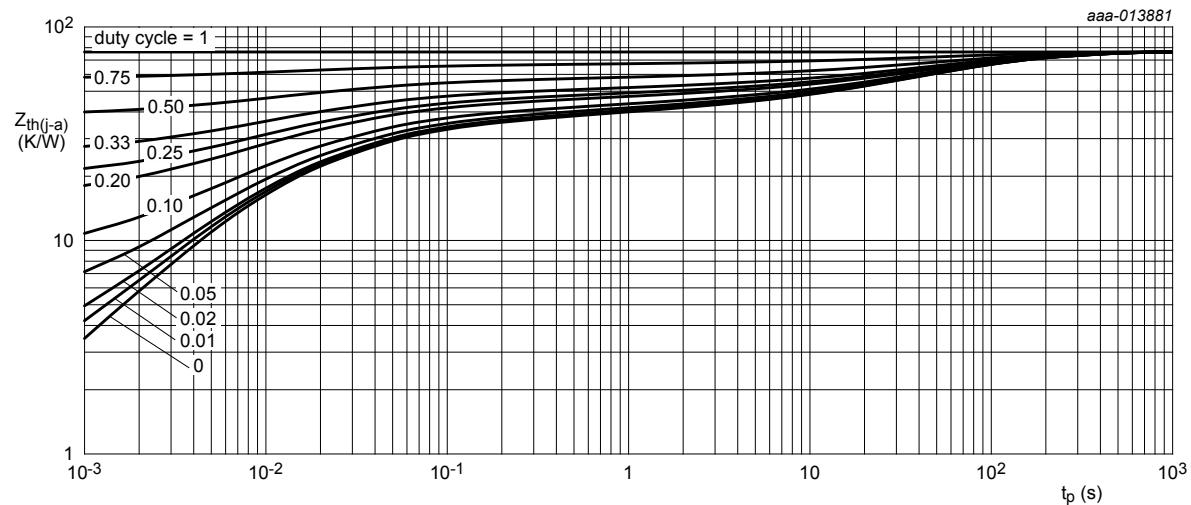
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
		in free air; $t \leq 5$ s	[3]	-	45	55	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	5	10	K/W

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.  
 [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 4-layer  $1\text{ cm}^2$ .  
 [3] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6  $\text{cm}^2$ .



FR4 PCB, standard footprint

**Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**



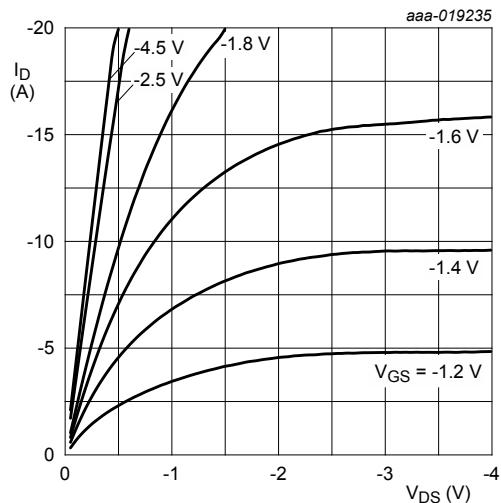
FR4 PCB, mounting pad for drain 6  $\text{cm}^2$

**Fig. 6. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

## 10. Characteristics

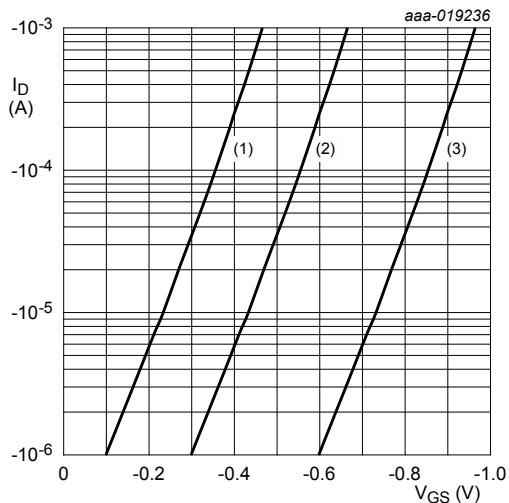
Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
<b>Static characteristics</b>							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = -250 \mu A; V_{GS} = 0 V; T_j = 25^\circ C$		-12	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = -250 \mu A; V_{DS} = V_{GS}; T_j = 25^\circ C$		-0.4	-0.6	-0.9	V
$I_{DSS}$	drain leakage current	$V_{DS} = -12 V; V_{GS} = 0 V; T_j = 25^\circ C$		-	-	-1	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = -8 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	-10	$\mu A$
		$V_{GS} = 8 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	10	$\mu A$
		$V_{GS} = -4.5 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	-1	$\mu A$
		$V_{GS} = 4.5 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	1	$\mu A$
		$V_{GS} = -2.5 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	-200	nA
		$V_{GS} = 2.5 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	200	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = -4.5 V; I_D = -3.0 A; T_j = 25^\circ C$		-	19	25	$m\Omega$
		$V_{GS} = -4.5 V; I_D = -3.0 A; T_j = 150^\circ C$		-	26	34	$m\Omega$
		$V_{GS} = -2.5 V; I_D = -3.0 A; T_j = 25^\circ C$		-	25	33	$m\Omega$
		$V_{GS} = -1.8 V; I_D = -1.0 A; T_j = 25^\circ C$		-	37	60	$m\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = -6.0 V; I_D = -3.0 A; T_j = 25^\circ C$		-	13	-	S
$R_G$	gate resistance	$f = 1 \text{ MHz}$		-	12.6	-	$\Omega$
<b>Dynamic characteristics</b>							
$Q_{G(tot)}$	total gate charge	$V_{DS} = -6 V; I_D = -3 A; V_{GS} = -4.5 V; T_j = 25^\circ C$		-	19.6	29.4	nC
$Q_{GS}$	gate-source charge			-	2.7	-	nC
$Q_{GD}$	gate-drain charge			-	5	-	nC
$C_{iss}$	input capacitance	$V_{DS} = -6 V; f = 1 \text{ MHz}; V_{GS} = 0 V; T_j = 25^\circ C$		-	1400	-	pF
$C_{oss}$	output capacitance			-	430	-	pF
$C_{rss}$	reverse transfer capacitance			-	400	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = -6 V; I_D = -6 A; V_{GS} = -4.5 V; R_{G(ext)} = 6 \Omega; T_j = 25^\circ C$		-	8	-	ns
$t_r$	rise time			-	51	-	ns
$t_{d(off)}$	turn-off delay time			-	72	-	ns
$t_f$	fall time			-	62	-	ns
<b>Source-drain diode</b>							
$V_{SD}$	source-drain voltage	$I_S = -1.2 A; V_{GS} = 0 V; T_j = 25^\circ C$		-	-0.9	-1.2	V



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

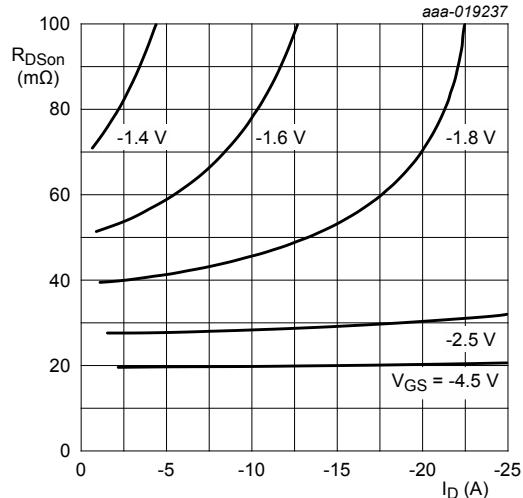
**Fig. 7. Output characteristics: drain current as a function of drain-source voltage; typical values**



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

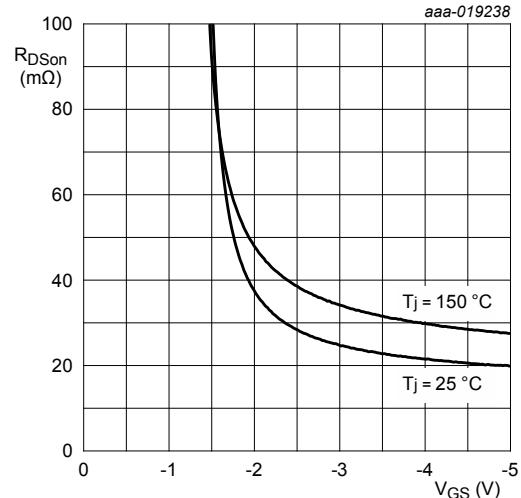
- (1) minimum values
- (2) typical values
- (3) maximum values

**Fig. 8. Sub-threshold drain current as a function of gate-source voltage**



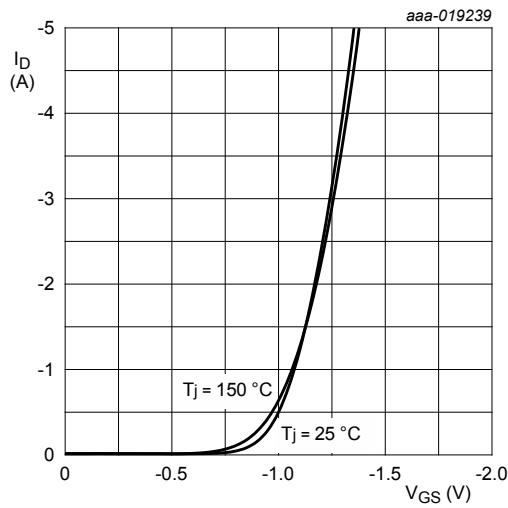
$T_j = 25^\circ\text{C}$

**Fig. 9. Drain-source on-state resistance as a function of drain current; typical values**



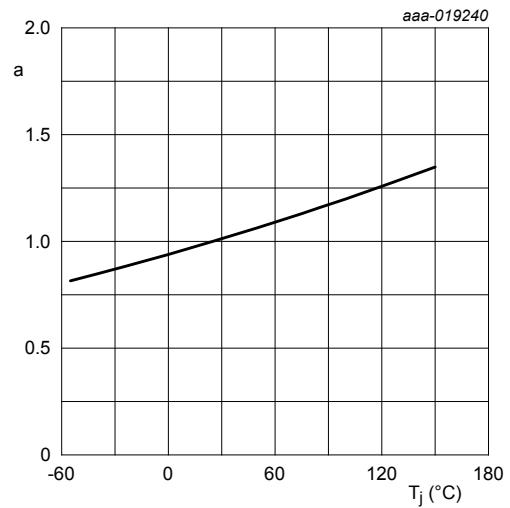
$I_D = -3\text{ A}$

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



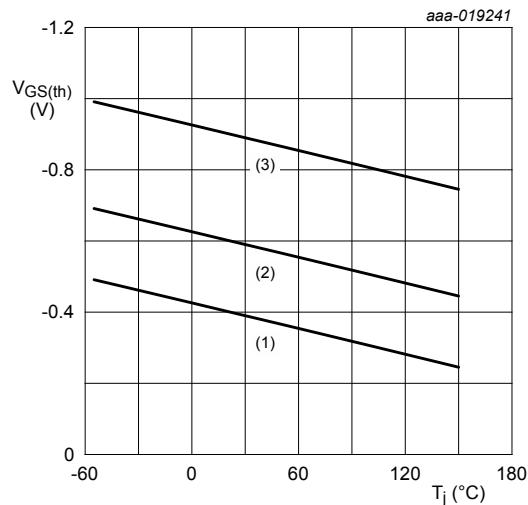
$$V_{DS} > I_D \times R_{DSon}$$

**Fig. 11. Transfer characteristics: drain current as a function of gate-source voltage; typical values**



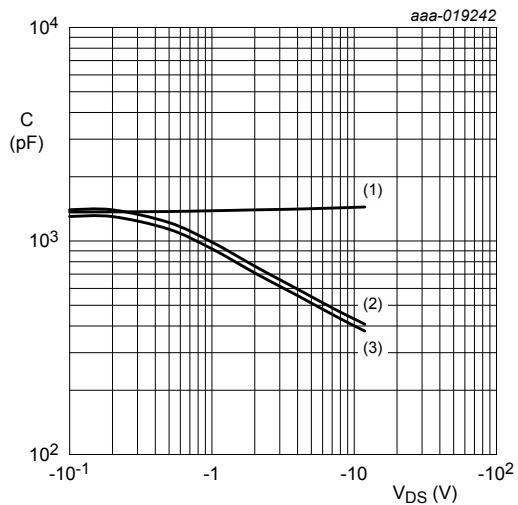
**Fig. 12. Normalized drain-source on-state resistance as a function of junction temperature; typical values**

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



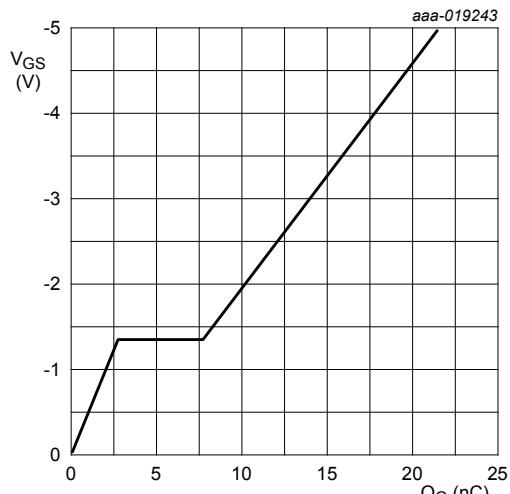
$I_D = -0.25 \text{ mA}; V_{DS} = V_{GS}$   
 (1) minimum values  
 (2) typical values  
 (3) maximum values

**Fig. 13. Gate-source threshold voltage as a function of junction temperature**



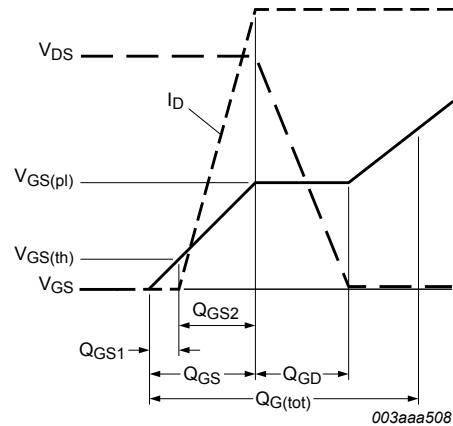
$f = 1 \text{ MHz}; V_{GS} = 0 \text{ V}$   
 (1)  $C_{iss}$   
 (2)  $C_{oss}$   
 (3)  $C_{rss}$

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

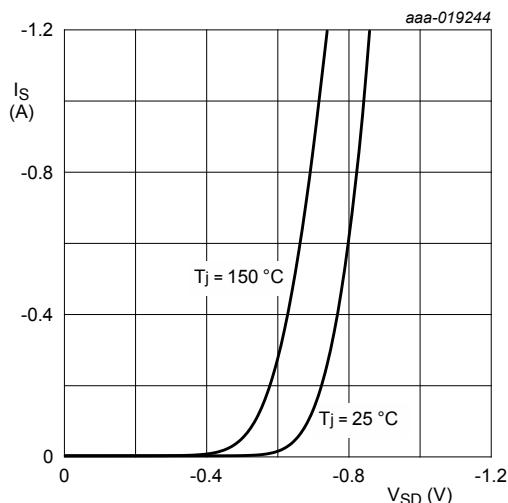


$I_D = -3$  A;  $V_{DS} = -6$  V;  $T_{amb} = 25$  °C

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



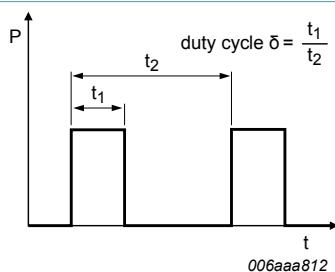
**Fig. 16. MOSFET transistor: Gate charge waveform definitions**



$V_{GS} = 0$  V

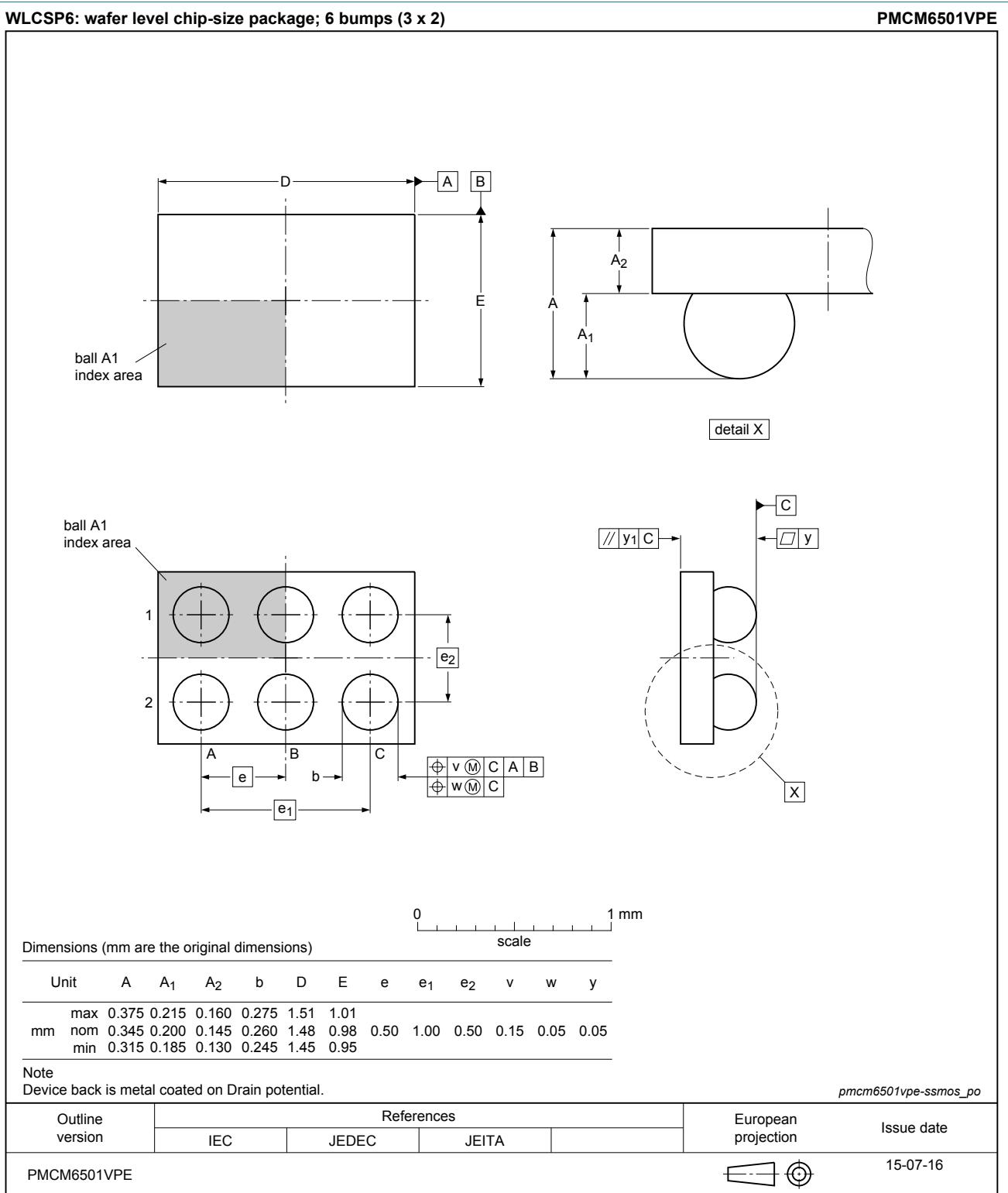
**Fig. 17. Source current as a function of source-drain voltage; typical values**

## 11. Test information



**Fig. 18. Duty cycle definition**

## 12. Package outline

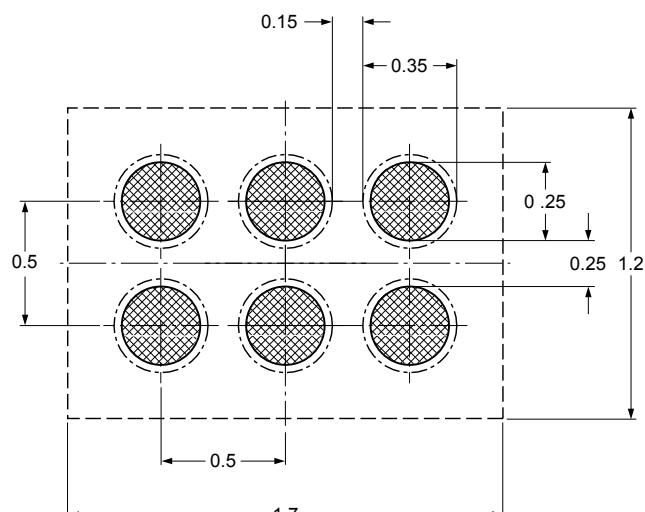


**Fig. 19. Package outline WLCSP6 (OL-PMCM6501VPE)**

## 13. Soldering

### Footprint information for reflow soldering

PMCM6501VPE



Dimensions in mm

pmcm6501vpe-ssmos\_fr

Fig. 20. Reflow soldering footprint for WLCSP6 (OL-PMCM6501VPE)

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PMCM6501VPE v.1	20150810	Product data sheet	-	-

## 15. Legal information

### 15.1 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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