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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
Static characteristics							
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 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

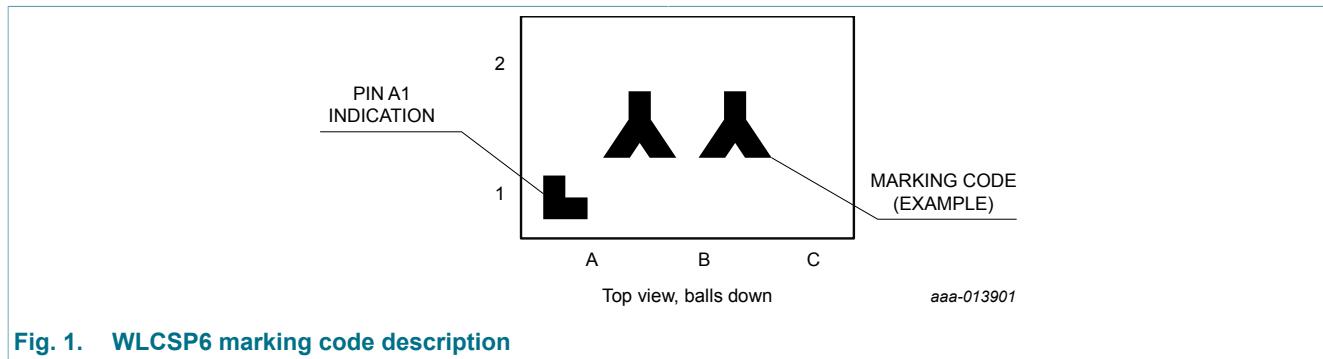


Fig. 1. WLCSP6 marking code description

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	$T_{amb} = 25^\circ\text{C}$; 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
Source-drain diode						
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 cm^2 .

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

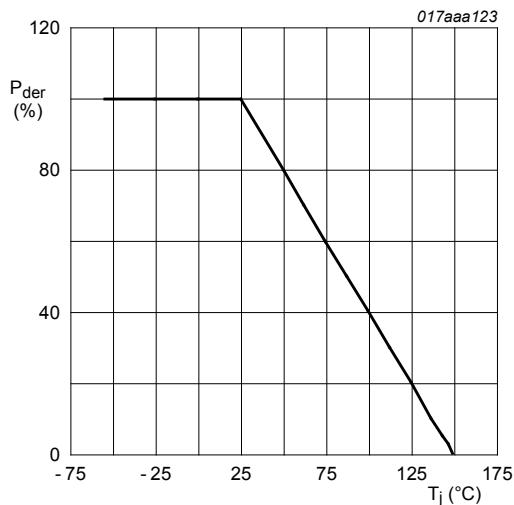


Fig. 2. MOSFET transistor: Normalized total power dissipation as a function of junction temperature

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

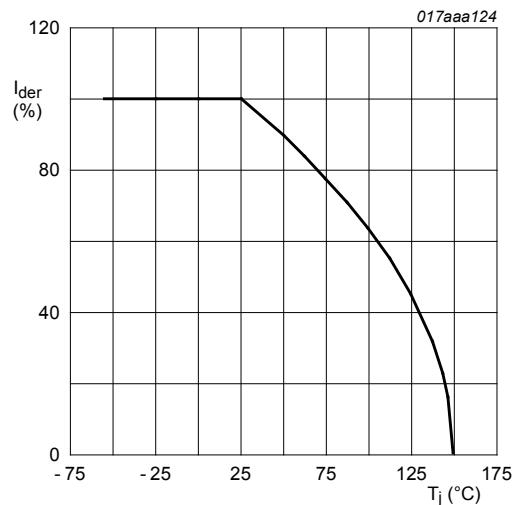


Fig. 3. MOSFET transistor: Normalized continuous drain current as a function of junction temperature

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

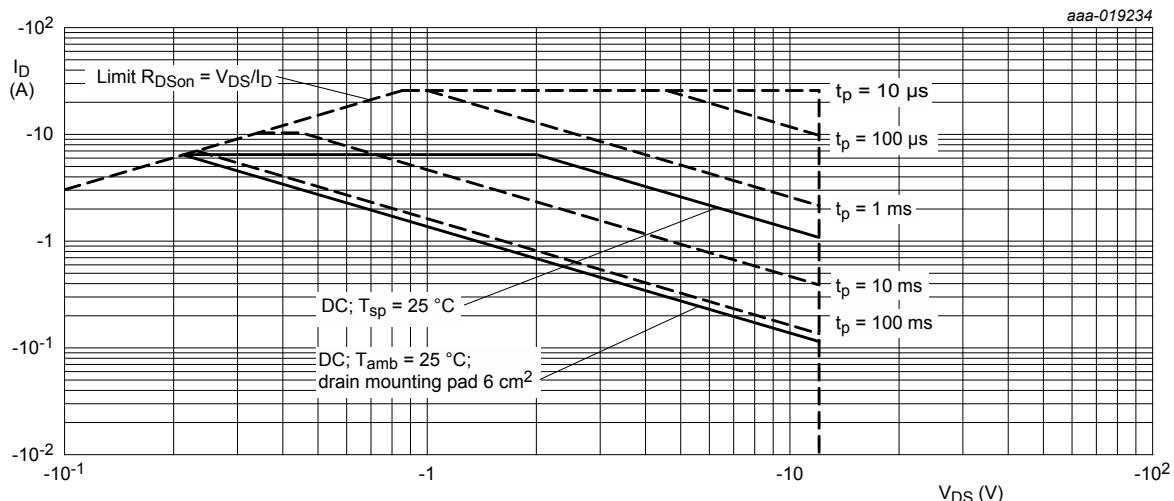


Fig. 4. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

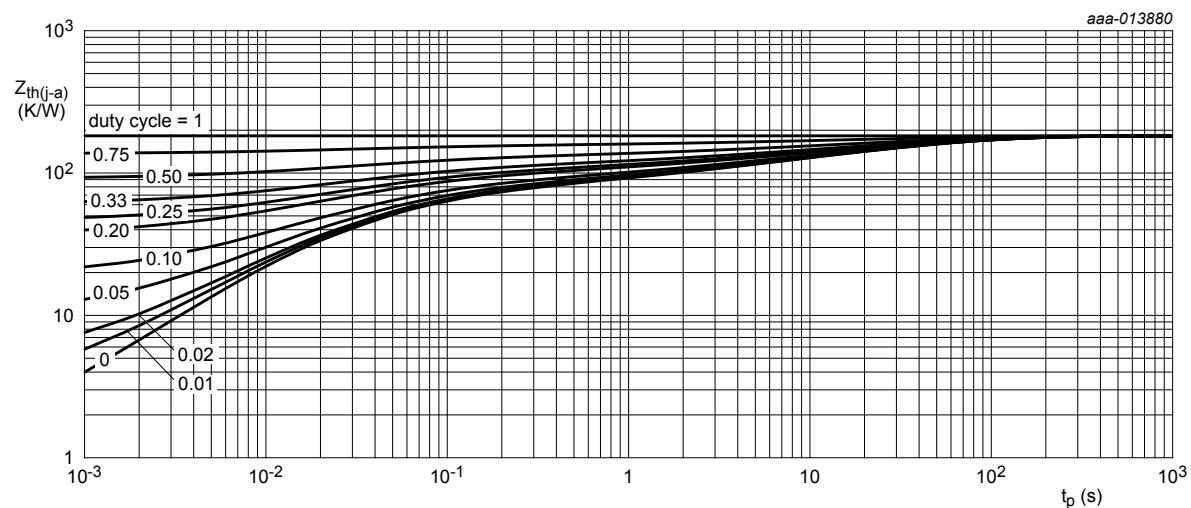
9. Thermal characteristics

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

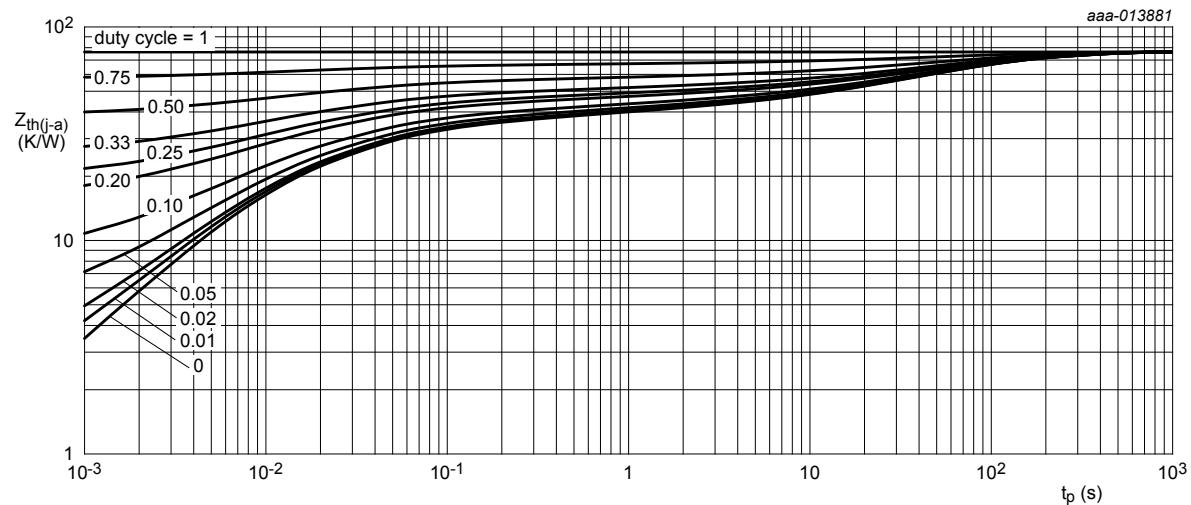
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
		in free air; $t \leq 5$ s	[3]	-	45	55	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	5	10	K/W

[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 cm^2 .
 [3] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm^2 .



FR4 PCB, standard footprint

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



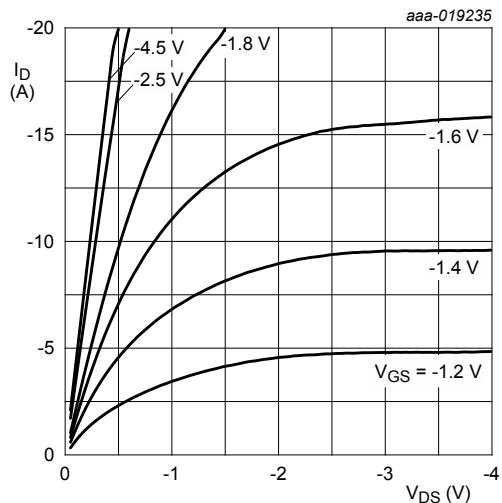
FR4 PCB, mounting pad for drain 6 cm^2

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

10. Characteristics

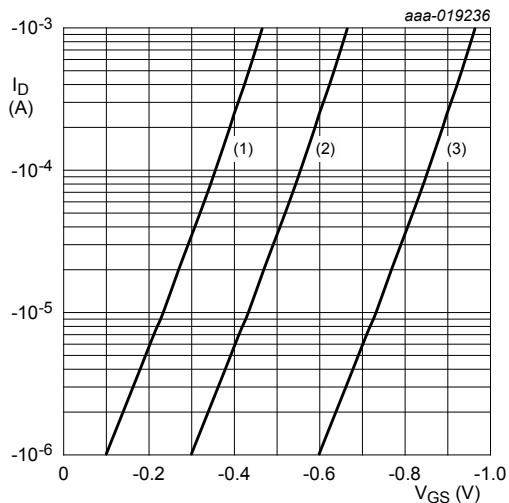
Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Static characteristics							
$V_{(BR)DSS}$	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	μA
I_{GSS}	gate leakage current	$V_{GS} = -8 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	-10	μA
		$V_{GS} = 8 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	10	μA
		$V_{GS} = -4.5 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	-1	μA
		$V_{GS} = 4.5 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	1	μA
		$V_{GS} = -2.5 V; V_{DS} = 0 V; T_j = 25^\circ C$		-	-	-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	-	Ω
Dynamic characteristics							
$Q_{G(tot)}$	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
Source-drain diode							
V_{SD}	source-drain voltage	$I_S = -1.2 A; V_{GS} = 0 V; T_j = 25^\circ C$		-	-0.9	-1.2	V



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

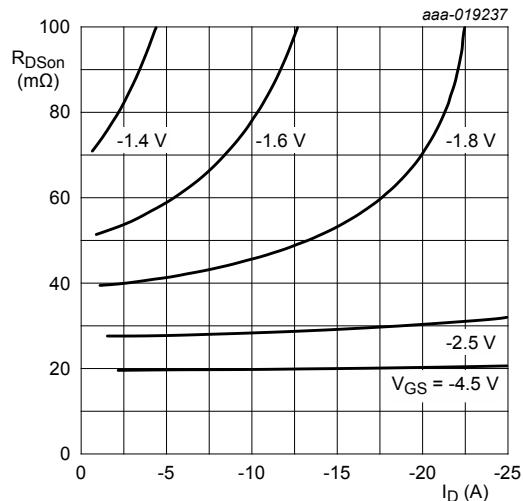
Fig. 7. Output characteristics: drain current as a function of drain-source voltage; typical values



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

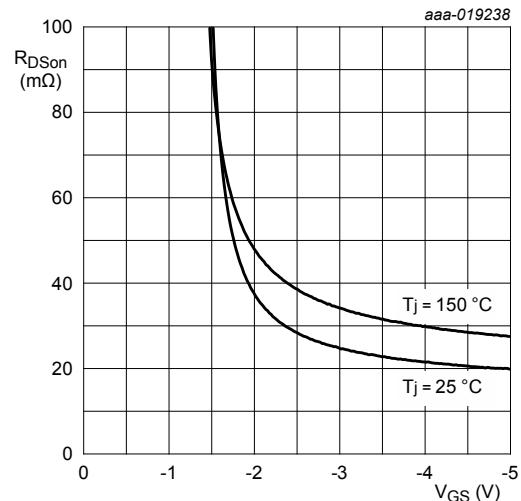
- (1) minimum values
- (2) typical values
- (3) maximum values

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



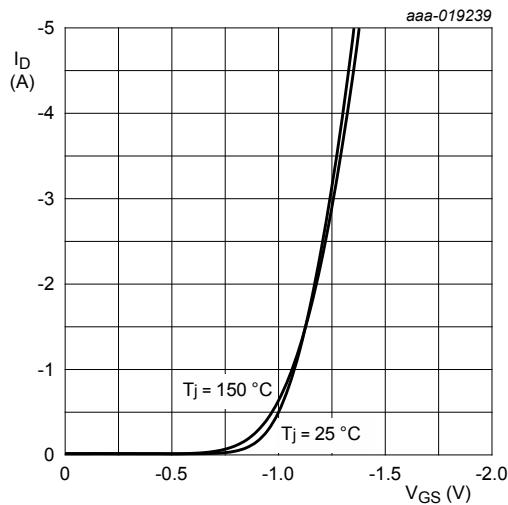
$T_j = 25^\circ\text{C}$

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

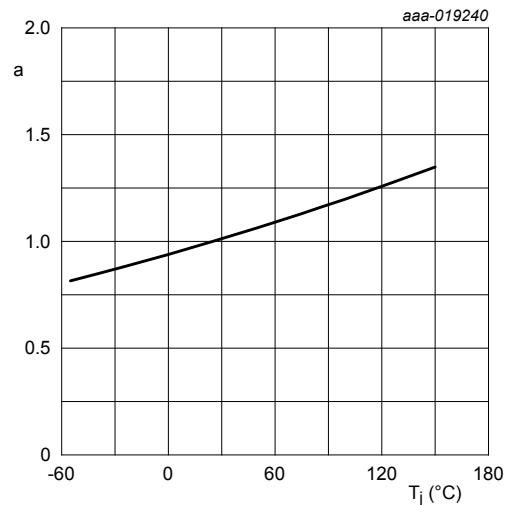
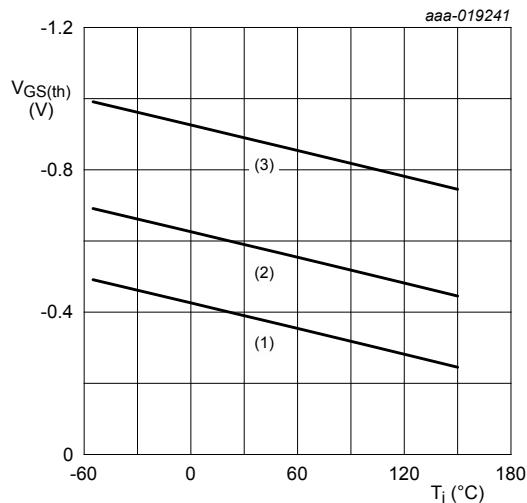


Fig. 12. Normalized drain-source on-state resistance as a function of junction temperature; typical values

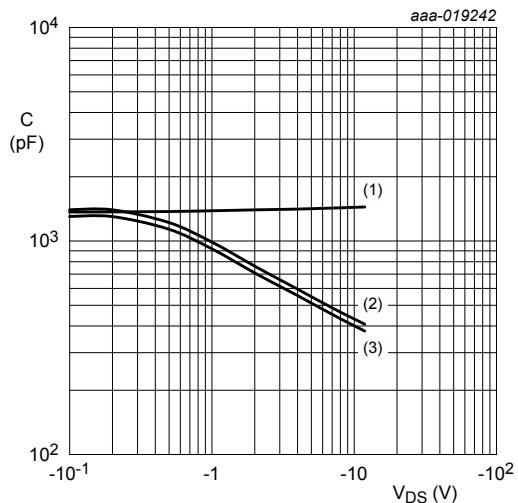
$$a = \frac{R_{DSon}}{R_{DSon}(25\text{ }^\circ\text{C})}$$



$$I_D = -0.25\text{ mA}; V_{DS} = V_{GS}$$

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

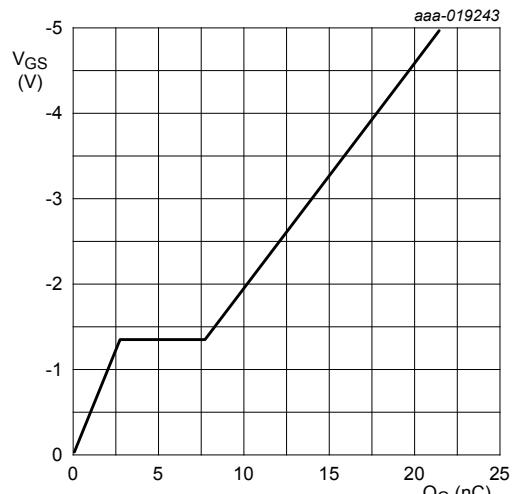
Fig. 13. Gate-source threshold voltage as a function of junction temperature



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

(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

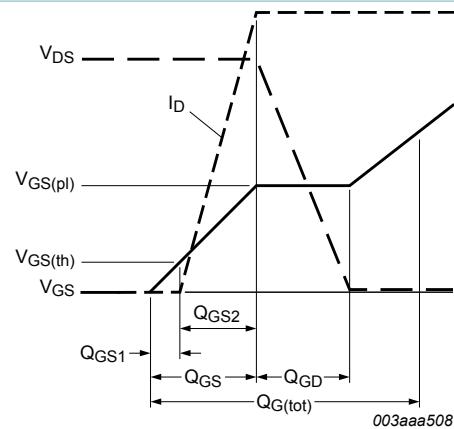
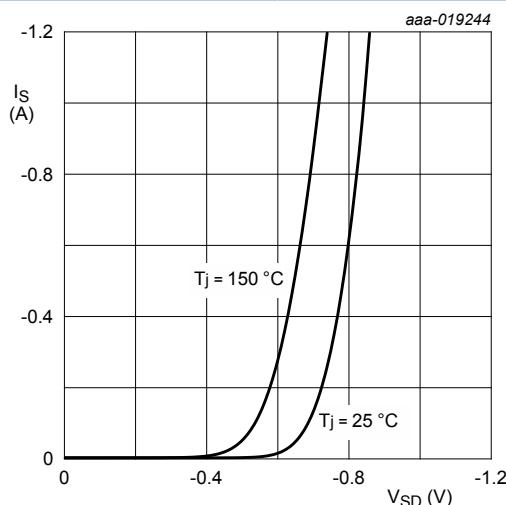


Fig. 16. MOSFET transistor: Gate charge waveform definitions



$V_{GS} = 0$ V

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

11. Test information

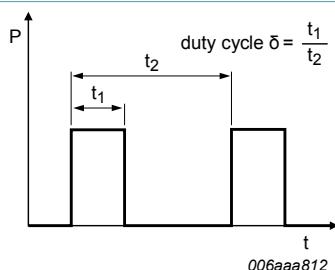


Fig. 18. Duty cycle definition

12. Package outline

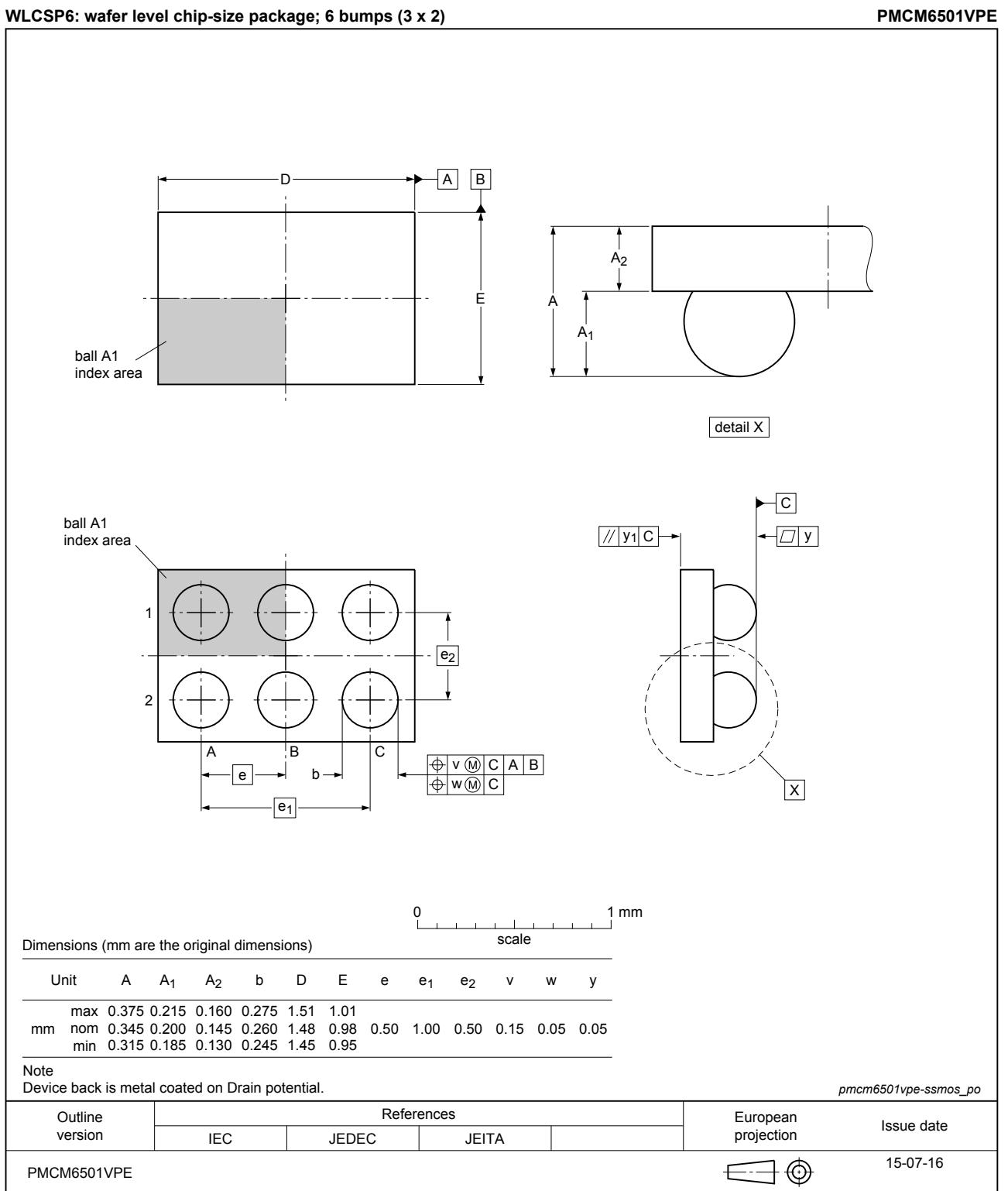
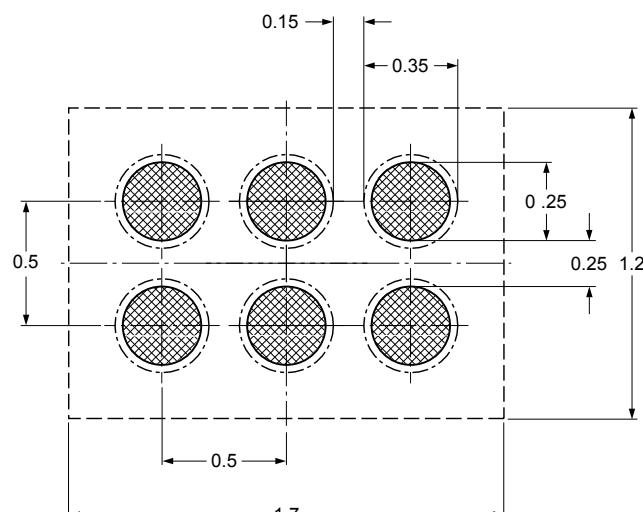


Fig. 19. Package outline WLCSP6 (OL-PMCM6501VPE)

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
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16. Contents

1	General description	1
2	Features and benefits	1
3	Applications	1
4	Quick reference data	1
5	Pinning information	2
6	Ordering information	2
7	Marking	2
8	Limiting values	3
9	Thermal characteristics	4
10	Characteristics	6
11	Test information	9
12	Package outline	10
13	Soldering	11
14	Revision history	12
15	Legal information	13
15.1	Data sheet status	13
15.2	Definitions	13
15.3	Disclaimers	13
15.4	Trademarks	14

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