



# PMCM4401VPE

12 V, P-channel Trench MOSFET

29 July 2015

Product data sheet

## 1. General description

P-channel enhancement mode Field-Effect Transistor (FET) in a 4 bumps Wafer Level Chip-Size Package (WLCSP) using Trench MOSFET technology.

## 2. Features and benefits

- Low threshold voltage
- Ultra small package: 0.78 × 0.78 × 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

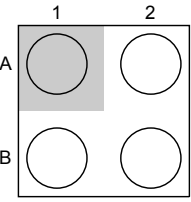
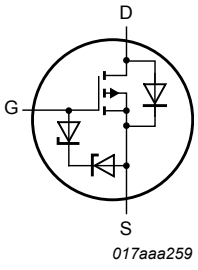
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j = 25\text{ °C}$	-	-	-12	V
$V_{GS}$	gate-source voltage		-8	-	8	V
$I_D$	drain current	$V_{GS} = -4.5\text{ V}; T_{amb} = 25\text{ °C}; t \leq 5\text{ s}$	[1]	-	-4.9	A
<b>Static characteristics</b>						
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = -4.5\text{ V}; I_D = -3\text{ A}; T_j = 25\text{ °C}$	-	55	65	mΩ

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 6 cm<sup>2</sup>.

### 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
A1	G	gate	 <p>Transparent top view <b>WLCSP4 (OL-PMCM4401VPE)</b></p>	
A2	S	source		
B1	D	drain		
B2	S	source		

### 6. Ordering information

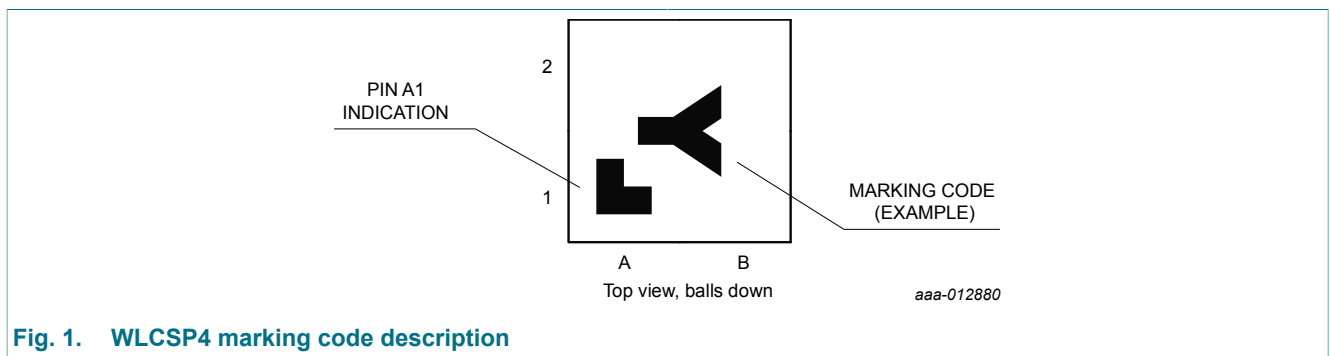
Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PMCM4401VPE	WLCSP4	WLCSP4: wafer level chip-size package; 4 bumps (2 x 2)	OL-PMCM4401VPE

### 7. Marking

Table 4. Marking codes

Type number	Marking code
PMCM4401VPE	Q



## 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	$T_j = 25\text{ °C}$		-	-12	V
$V_{GS}$	gate-source voltage			-8	8	V
$I_D$	drain current	$V_{GS} = -4.5\text{ V}; T_{amb} = 25\text{ °C}; t \leq 5\text{ s}$	[1]	-	-4.9	A
		$V_{GS} = -4.5\text{ V}; T_{amb} = 25\text{ °C}$	[1]	-	-3.9	A
		$V_{GS} = -4.5\text{ V}; T_{amb} = 100\text{ °C}$	[1]	-	-2.5	A
$I_{DM}$	peak drain current	$T_{amb} = 25\text{ °C};$ single pulse; $t_p \leq 10\text{ }\mu\text{s}$		-	-16	A
$P_{tot}$	total power dissipation	$T_{amb} = 25\text{ °C}$	[2]	-	400	mW
			[1]	-	1300	mW
		$T_{sp} = 25\text{ °C}$		-	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	$T_{amb} = 25\text{ °C}$	[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.

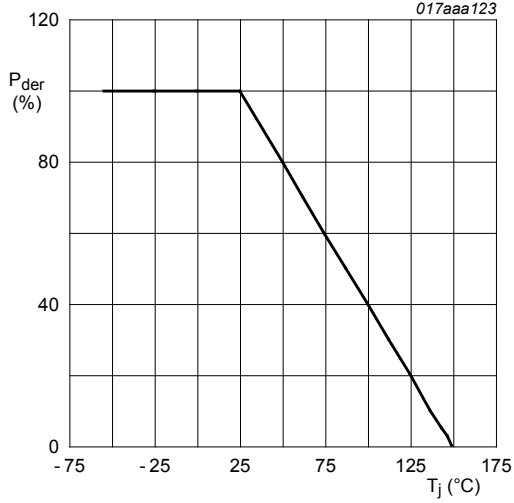


Fig. 2. MOSFET transistor: Normalized total power dissipation as a function of junction temperature

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

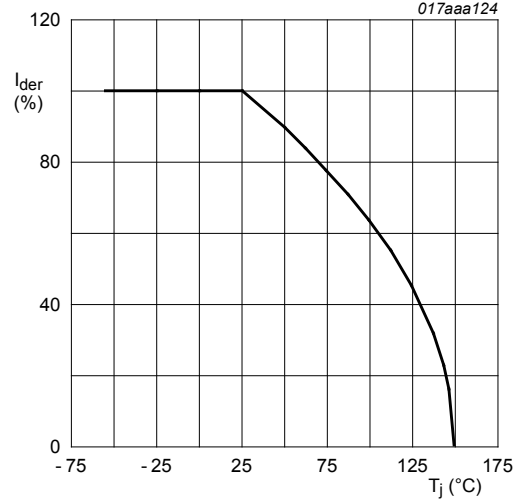
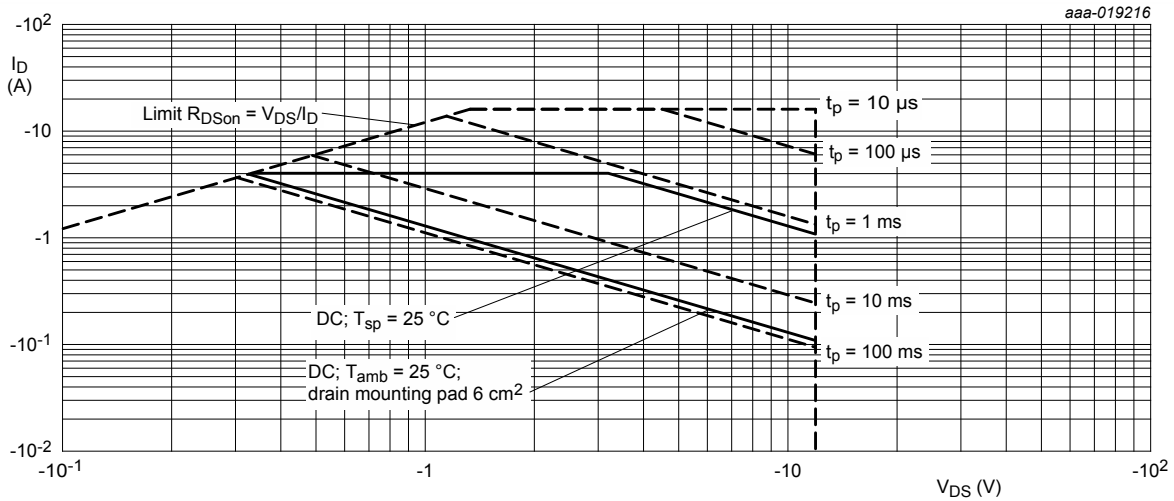


Fig. 3. MOSFET transistor: Normalized continuous drain current as a function of junction temperature

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



I<sub>DM</sub> = 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 <sub>th(j-a)</sub>	thermal resistance from junction to ambient	in free air	[1]	-	250	300	K/W
			[2]	-	70	85	K/W
			[3]	-	85	100	K/W

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
		in free air; $t \leq 5$ s	[3]	-	50	60	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<sup>2</sup>.
- [3] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm<sup>2</sup>.

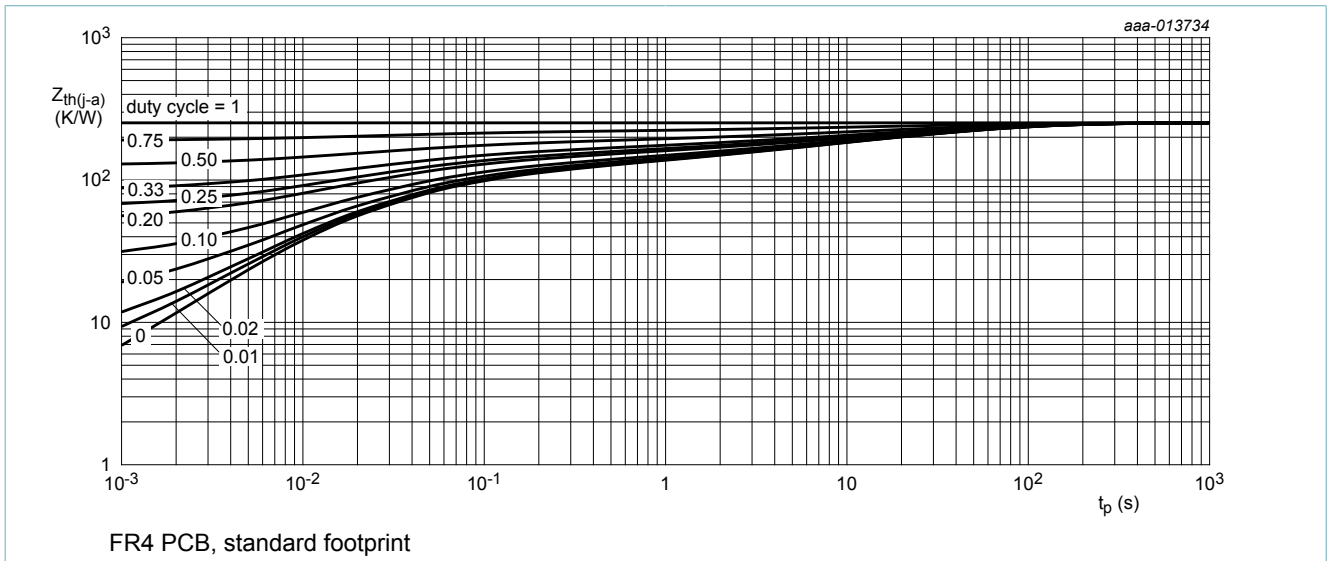


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

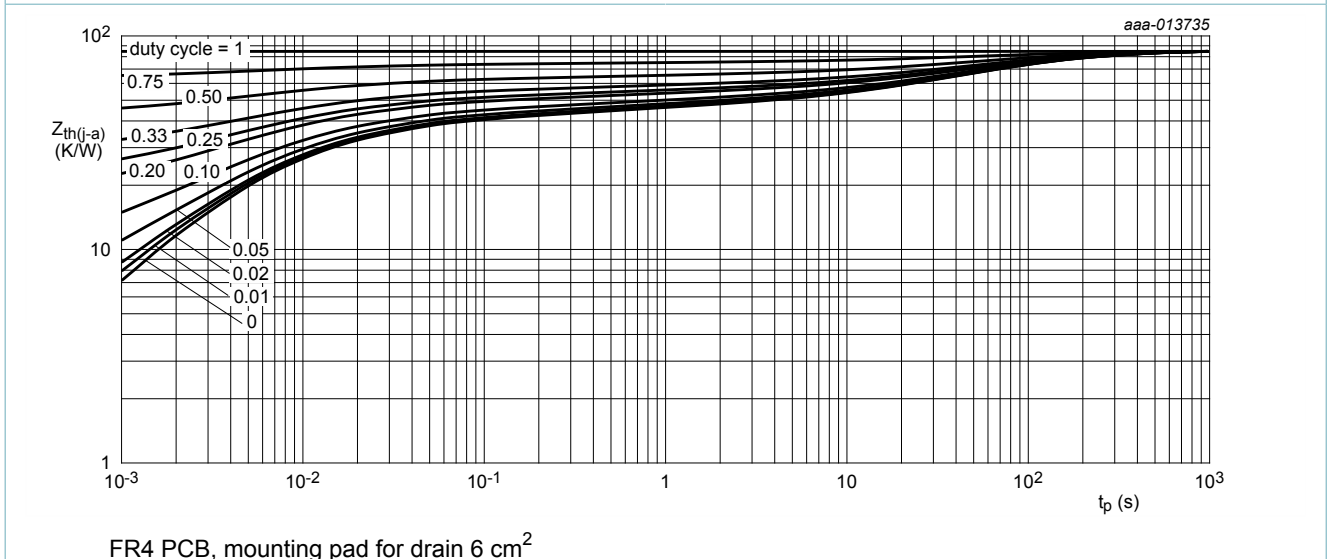


Fig. 6. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = -250 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-12	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = -250 \mu A$ ; $V_{DS} = V_{GS}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-0.4	-0.6	-0.9	V
$I_{DSS}$	drain leakage current	$V_{DS} = -12 V$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	-1	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = -8 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	-10	$\mu A$
		$V_{GS} = 8 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	10	$\mu A$
		$V_{GS} = -4.5 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	-1	$\mu A$
		$V_{GS} = 4.5 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	1	$\mu A$
		$V_{GS} = -2.5 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	-200	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = -4.5 V$ ; $I_D = -3 A$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	55	65	m $\Omega$
		$V_{GS} = -4.5 V$ ; $I_D = -3 A$ ; $T_j = 150 \text{ }^\circ\text{C}$	-	73	86	m $\Omega$
		$V_{GS} = -2.5 V$ ; $I_D = -2 A$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	77	96	m $\Omega$
		$V_{GS} = -1.8 V$ ; $I_D = -0.1 A$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	110	160	m $\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = -6 V$ ; $I_D = -3 A$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	13.6	-	S
$R_G$	gate resistance	$f = 1 \text{ MHz}$	-	5.5	-	$\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$V_{DS} = -6 V$ ; $I_D = -3 A$ ; $V_{GS} = -4.5 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	6.8	10	nC
$Q_{GS}$	gate-source charge		-	0.8	-	nC
$Q_{GD}$	gate-drain charge		-	2.2	-	nC
$C_{iss}$	input capacitance	$V_{DS} = -6 V$ ; $f = 1 \text{ MHz}$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	415	-	pF
$C_{oss}$	output capacitance		-	195	-	pF
$C_{rss}$	reverse transfer capacitance		-	165	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = -6 V$ ; $I_D = -3.5 A$ ; $V_{GS} = -4.5 V$ ; $R_{G(ext)} = 6 \Omega$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	4.8	-	ns
$t_r$	rise time		-	24.7	-	ns
$t_{d(off)}$	turn-off delay time		-	25.1	-	ns
$t_f$	fall time		-	16.5	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = -1.2 A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-0.8	-1.2	V

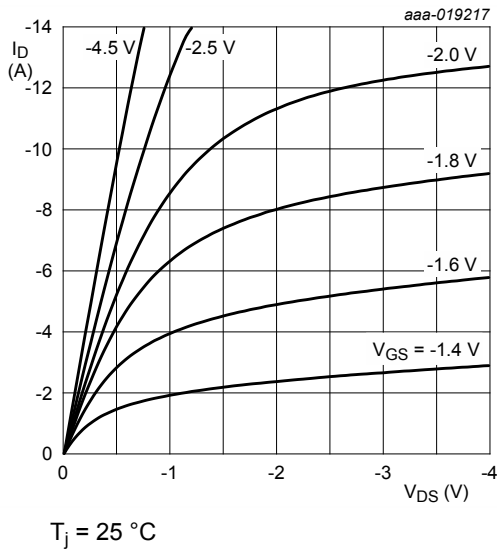


Fig. 7. Output characteristics: drain current as a function of drain-source voltage; typical values

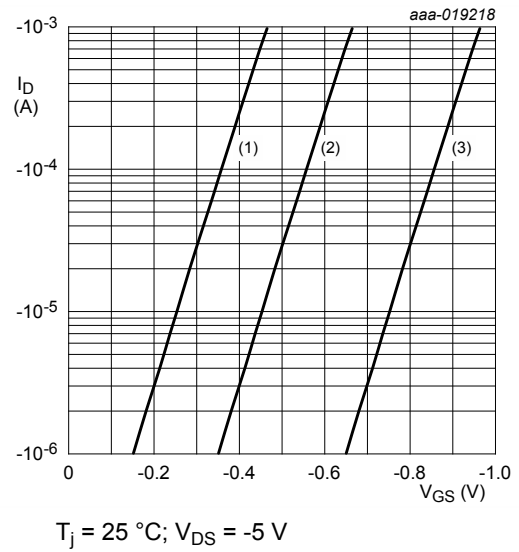


Fig. 8. Sub-threshold drain current as a function of gate-source voltage

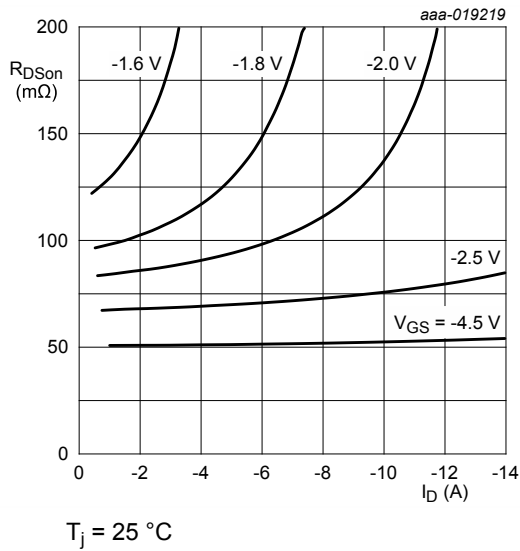


Fig. 9. Drain-source on-state resistance as a function of drain current; typical values

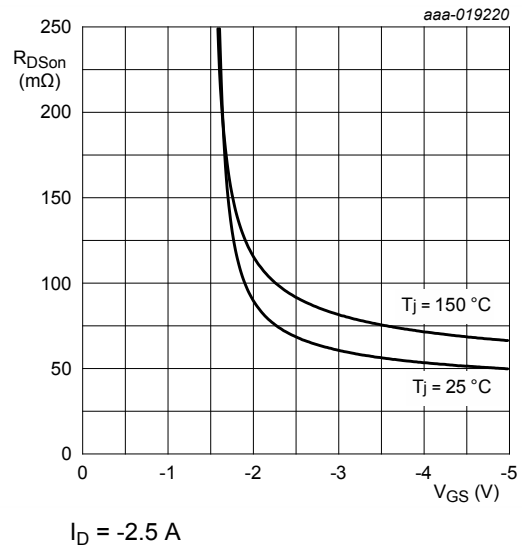
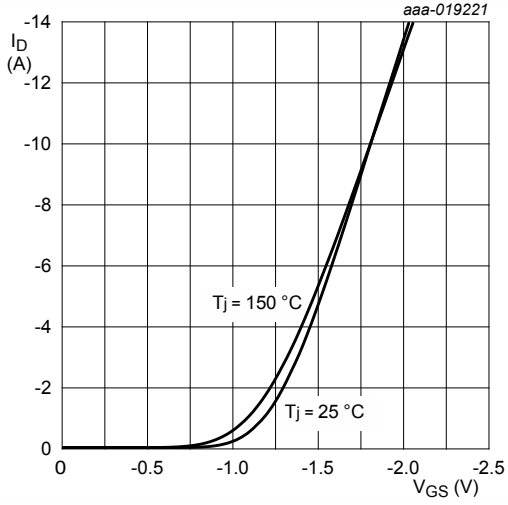
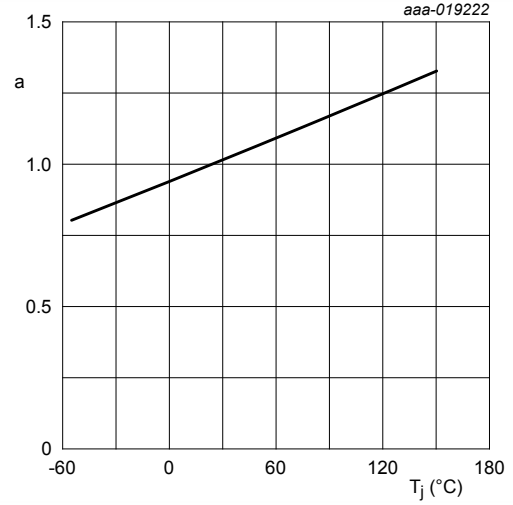


Fig. 10. Drain-source on-state resistance as a function of gate-source voltage; typical values



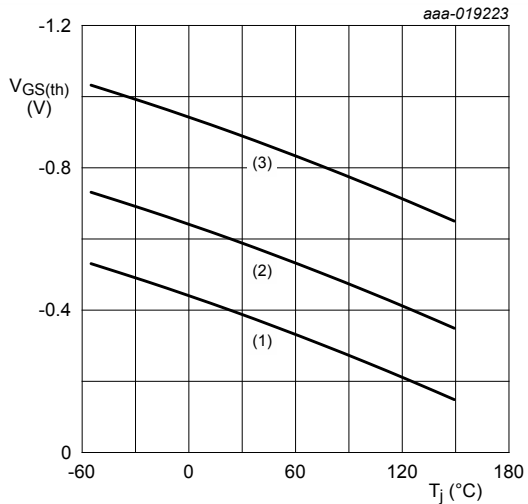
$$V_{DS} > I_D \times R_{DSon}$$

**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**

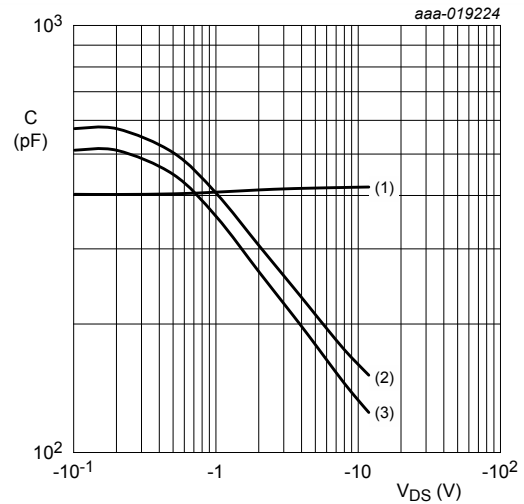
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ C)}}$$



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

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

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

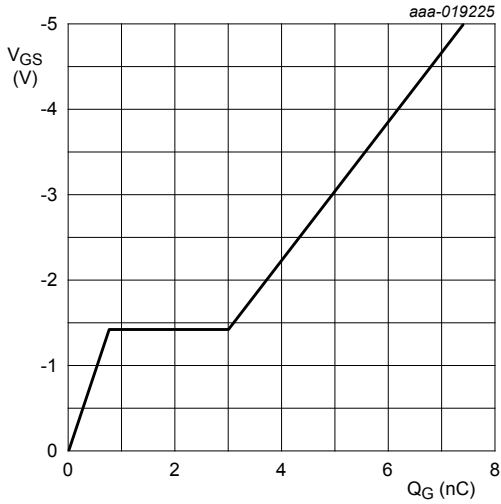


$$f = 1 \text{ MHz}; V_{GS} = 0 \text{ V}$$

- (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**





$I_D = -3 \text{ A}; V_{DS} = -6 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$

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

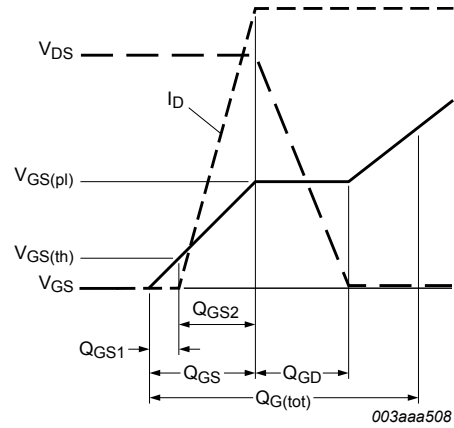
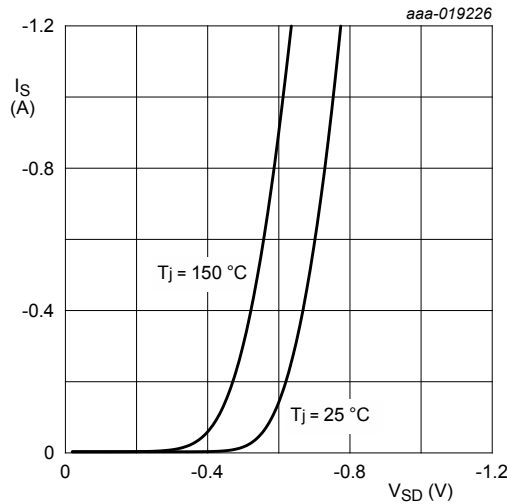


Fig. 16. MOSFET transistor: Gate charge waveform definitions



$V_{GS} = 0 \text{ V}$

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

## 11. Test information

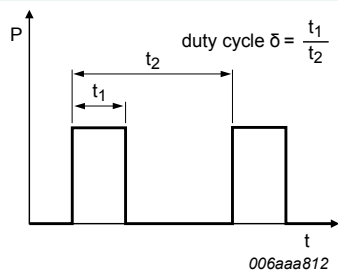


Fig. 18. Duty cycle definition

## 12. Package outline

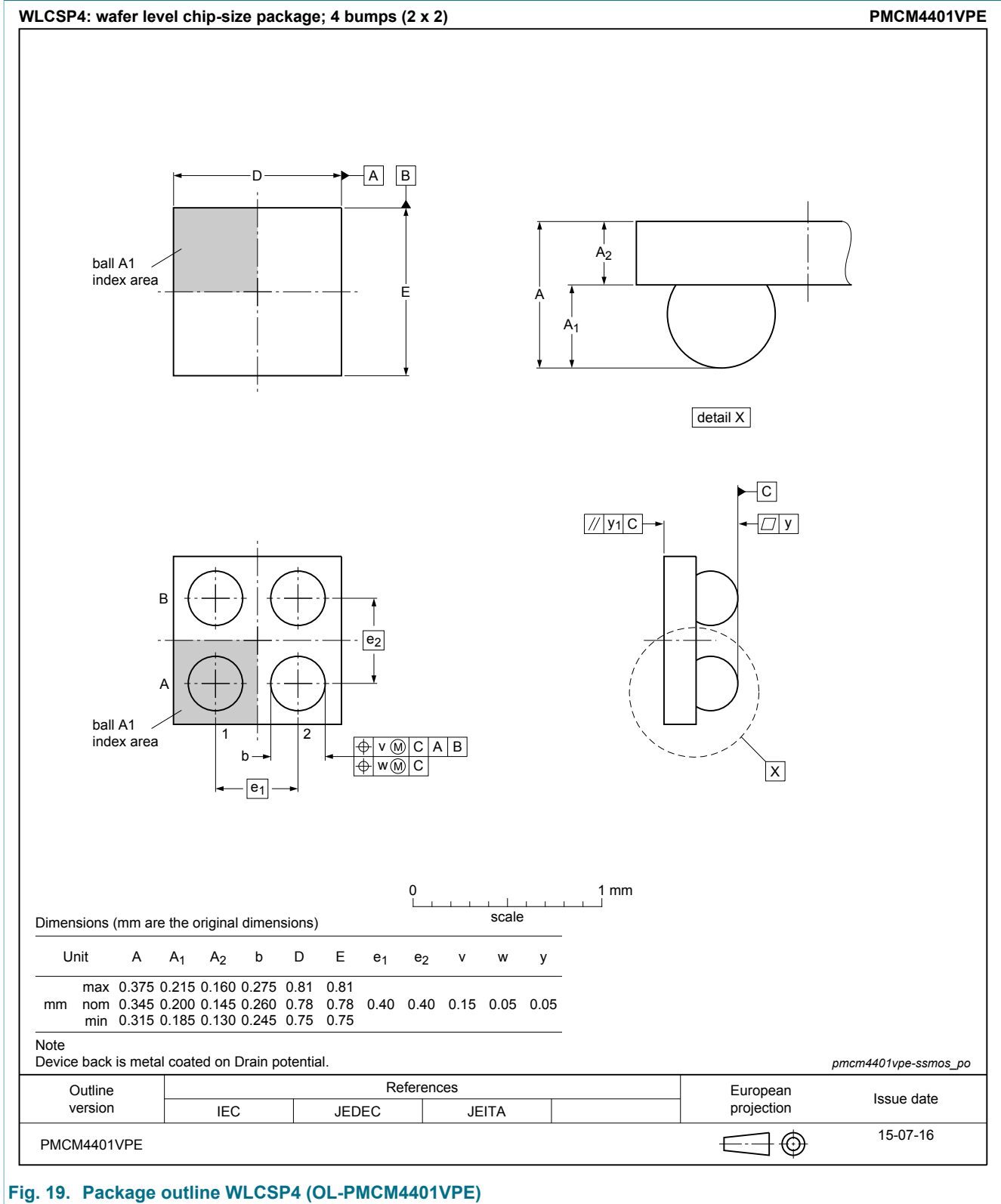


Fig. 19. Package outline WLCSP4 (OL-PMCM4401VPE)

### 13. Soldering

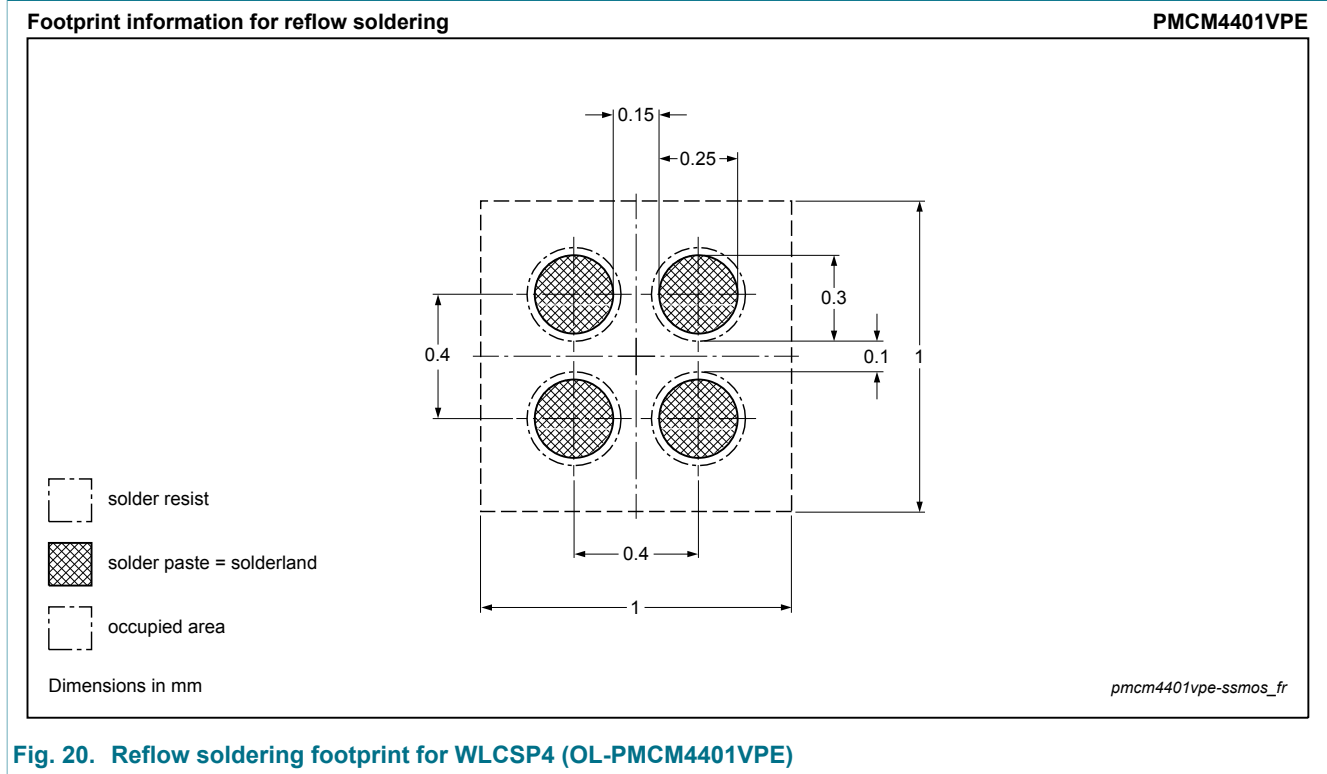


Fig. 20. Reflow soldering footprint for WLCSP4 (OL-PMCM4401VPE)

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PMCM4401VPE v.1	20150729	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.
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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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