

# PMCM4401UPE

20 V, P-channel Trench MOSFET

7 October 2016

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

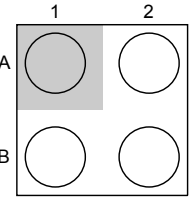
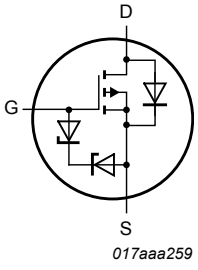
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>DS</sub>	drain-source voltage	T <sub>j</sub> = 25 °C	-	-	-20	V
V <sub>GS</sub>	gate-source voltage		-8	-	8	V
I <sub>D</sub>	drain current	V <sub>GS</sub> = -4.5 V; T <sub>amb</sub> = 25 °C; t ≤ 5 s	[1]	-	-4	A
<b>Static characteristics</b>						
R <sub>DSon</sub>	drain-source on-state resistance	V <sub>GS</sub> = -4.5 V; I <sub>D</sub> = -3 A; T <sub>j</sub> = 25 °C	-	75	95	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-PMCM4401UPE)</b></p>	 <p>017aaa259</p>
A2	S	source		
B1	D	drain		
B2	S	source		

### 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PMCM4401UPE	WLCSP4	WLCSP4: wafer level chip-size package; 4 bumps (2 x 2)	OL-PMCM4401UPE

### 7. Marking

Table 4. Marking codes

Type number	Marking code
PMCM4401UPE	S

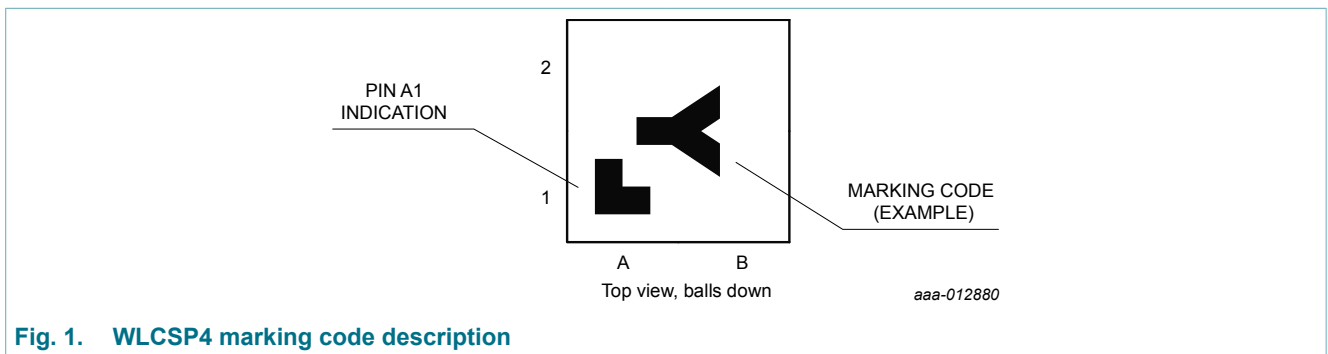


Fig. 1. WLCSP4 marking code description

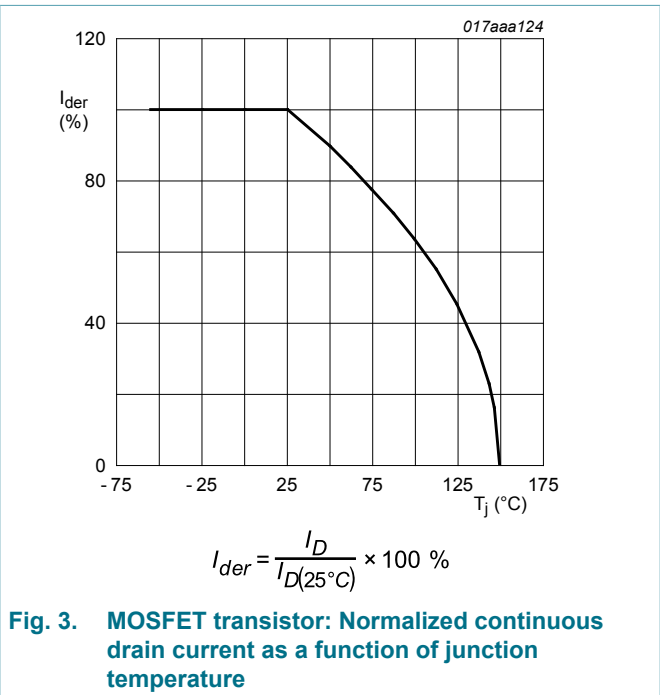
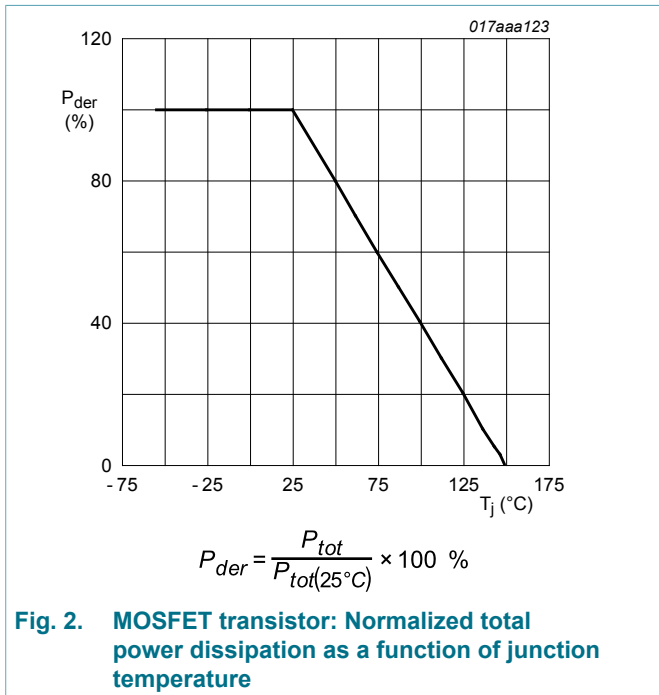
## 8. Limiting values

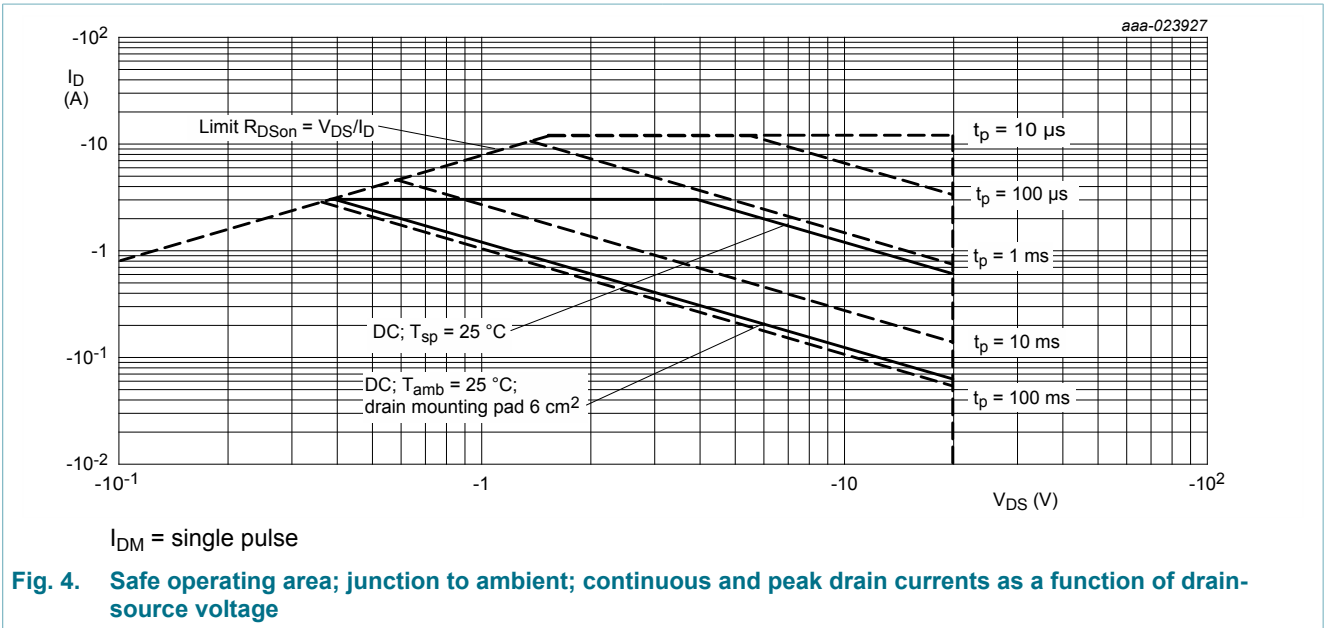
**Table 5. Limiting values**

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

Symbol	Parameter	Conditions		Min	Max	Unit
V <sub>DS</sub>	drain-source voltage	T <sub>j</sub> = 25 °C		-	-20	V
V <sub>GS</sub>	gate-source voltage			-8	8	V
I <sub>D</sub>	drain current	V <sub>GS</sub> = -4.5 V; T <sub>amb</sub> = 25 °C; t ≤ 5 s	[1]	-	-4	A
		V <sub>GS</sub> = -4.5 V; T <sub>amb</sub> = 25 °C	[1]	-	-3.2	A
		V <sub>GS</sub> = -4.5 V; T <sub>amb</sub> = 100 °C	[1]	-	-2	A
I <sub>DM</sub>	peak drain current	T <sub>amb</sub> = 25 °C; single pulse; t <sub>p</sub> ≤ 10 μs		-	-13	A
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2]	-	400	mW
			[1]	-	1300	mW
		T <sub>sp</sub> = 25 °C		-	12500	mW
T <sub>j</sub>	junction temperature			-55	150	°C
T <sub>amb</sub>	ambient temperature			-55	150	°C
T <sub>stg</sub>	storage temperature			-65	150	°C
<b>Source-drain diode</b>						
I <sub>S</sub>	source current	T <sub>amb</sub> = 25 °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<sup>2</sup>.
- [2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.



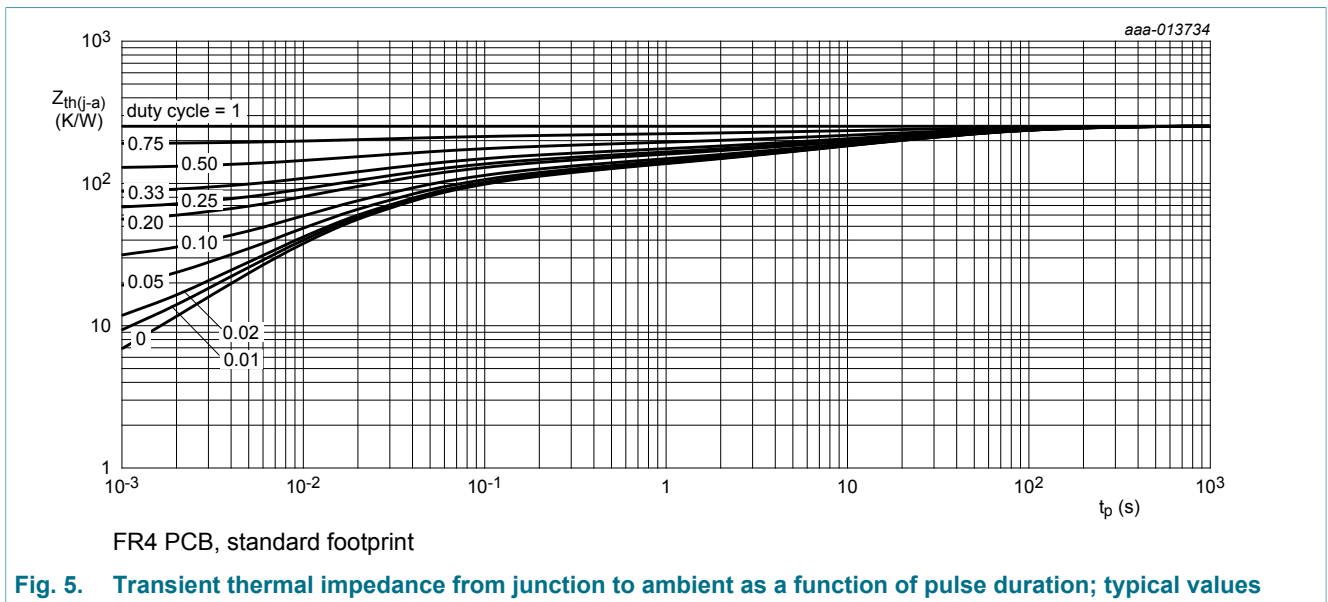


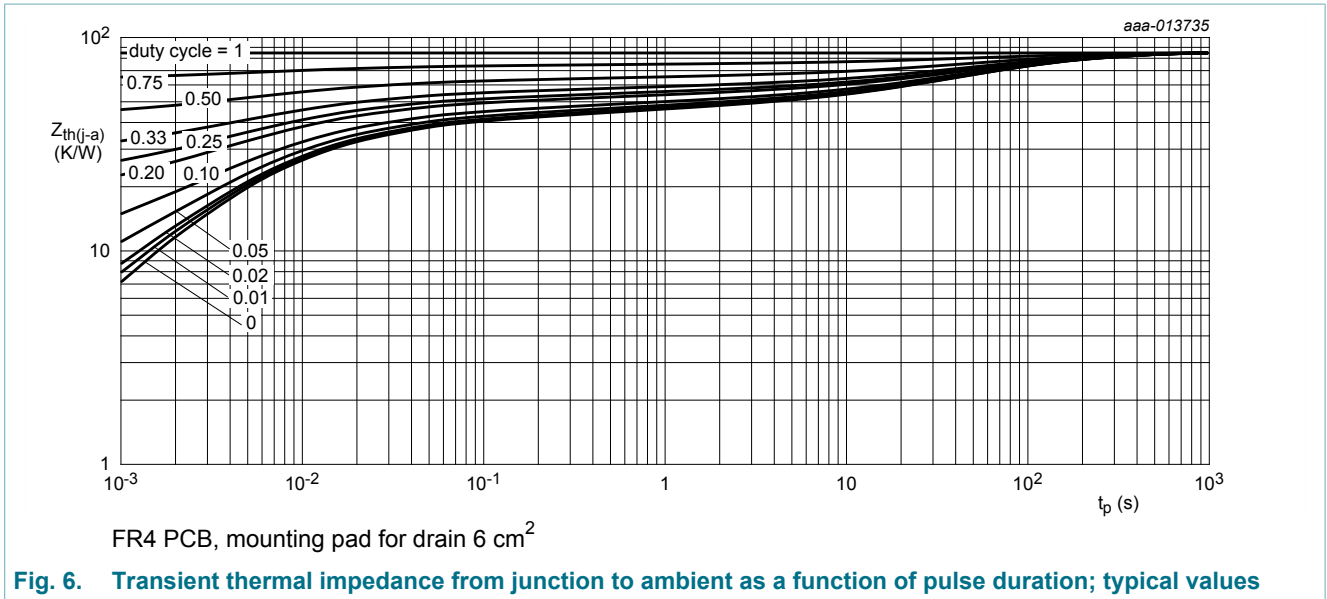
### 9. Thermal characteristics

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
		in free air; t ≤ 5 s	[3]	-	50	60	K/W
R <sub>th(j-sp)</sub>	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>.





## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = -250 \mu\text{A}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-20	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = -250 \mu\text{A}$ ; $V_{DS} = V_{GS}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-0.4	-0.6	-0.9	V
$I_{DSS}$	drain leakage current	$V_{DS} = -20 \text{ V}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	-1	$\mu\text{A}$
$I_{GSS}$	gate leakage current	$V_{GS} = -8 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	-10	$\mu\text{A}$
		$V_{GS} = 8 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	10	$\mu\text{A}$
		$V_{GS} = -4.5 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	-1	$\mu\text{A}$
		$V_{GS} = 4.5 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	1	$\mu\text{A}$
		$V_{GS} = -2.5 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	-200	nA
		$V_{GS} = 2.5 \text{ V}$ ; $V_{DS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-	200	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = -4.5 \text{ V}$ ; $I_D = -3 \text{ A}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	75	95	m $\Omega$
		$V_{GS} = -4.5 \text{ V}$ ; $I_D = -3 \text{ A}$ ; $T_j = 150 \text{ }^\circ\text{C}$	-	100	120	m $\Omega$
		$V_{GS} = -2.5 \text{ V}$ ; $I_D = -2 \text{ A}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	95	130	m $\Omega$
		$V_{GS} = -1.8 \text{ V}$ ; $I_D = -0.1 \text{ A}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	130	190	m $\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = -6 \text{ V}$ ; $I_D = -3 \text{ A}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	10.8	-	S
$R_G$	gate resistance	$f = 1 \text{ MHz}$	-	7	-	$\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$V_{DS} = -10 \text{ V}$ ; $I_D = -3 \text{ A}$ ; $V_{GS} = -4.5 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	5.9	10	nC
$Q_{GS}$	gate-source charge		-	0.6	-	nC
$Q_{GD}$	gate-drain charge		-	1.7	-	nC
$C_{iss}$	input capacitance	$V_{DS} = -10 \text{ V}$ ; $f = 1 \text{ MHz}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	420	-	pF
$C_{oss}$	output capacitance		-	64	-	pF
$C_{rss}$	reverse transfer capacitance		-	58	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DS} = -10 \text{ V}$ ; $I_D = -3.3 \text{ A}$ ; $V_{GS} = -4.5 \text{ V}$ ; $R_{G(ext)} = 6 \text{ } \Omega$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	4	-	ns
$t_r$	rise time		-	18	-	ns
$t_{d(off)}$	turn-off delay time		-	31	-	ns
$t_f$	fall time		-	13	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = -1.2 \text{ A}$ ; $V_{GS} = 0 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$	-	-0.8	-1.2	V

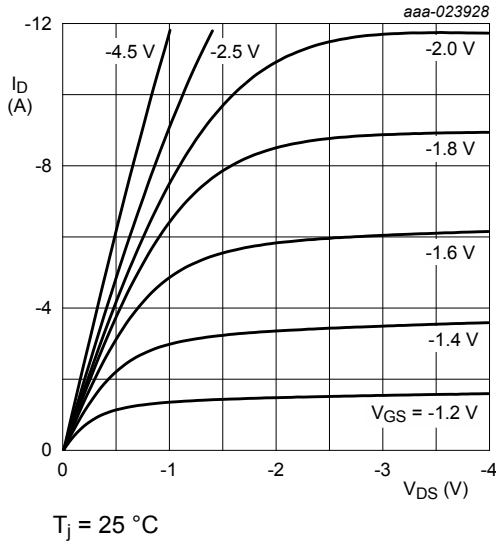


Fig. 7. Output characteristics: drain current as a function of drain-source voltage; typical values

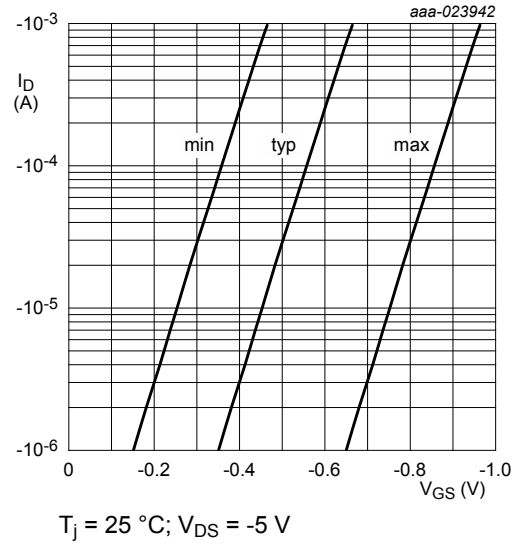


Fig. 8. Sub-threshold drain current as a function of gate-source voltage

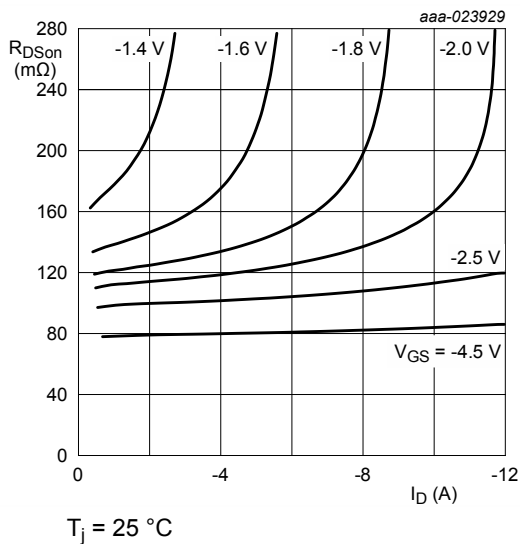


Fig. 9. Drain-source on-state resistance as a function of drain current; typical values

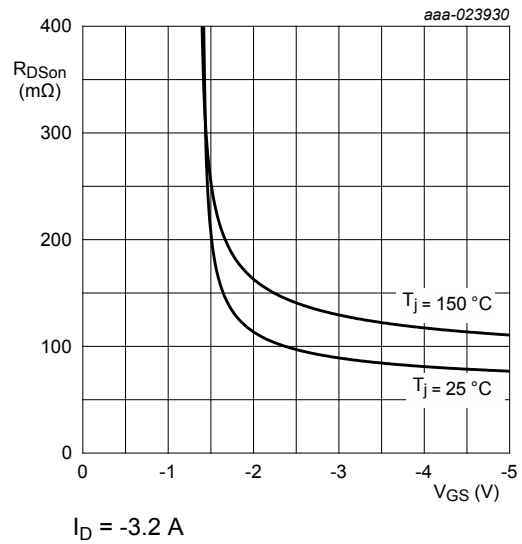
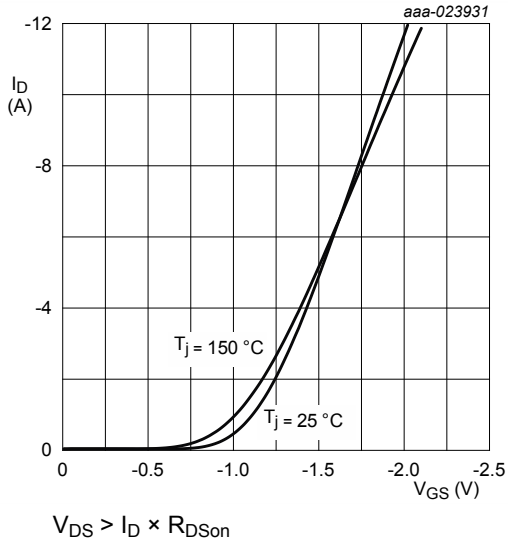
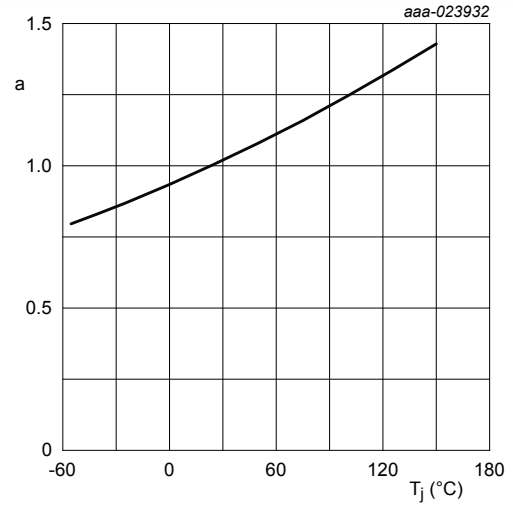


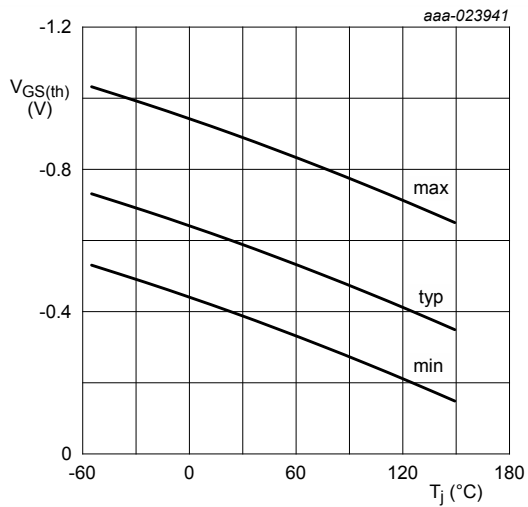
Fig. 10. Drain-source on-state resistance as a function of gate-source voltage; typical values



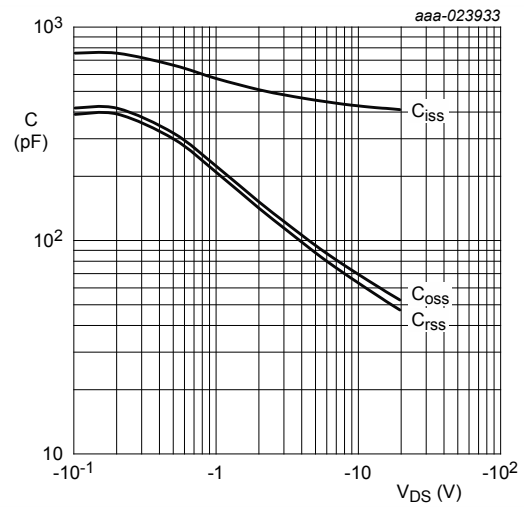
**Fig. 11. Transfer characteristics: drain current as a function of gate-source voltage; typical values**



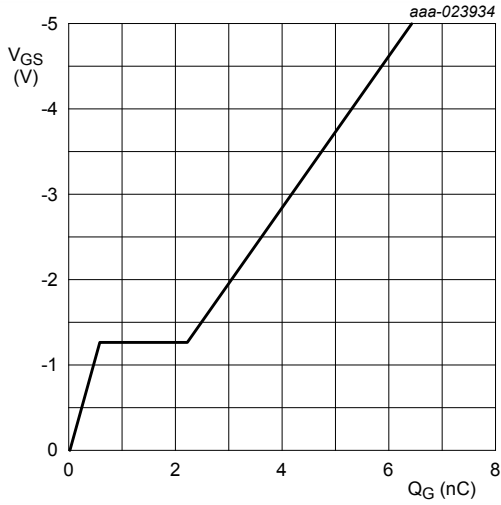
**Fig. 12. Normalized drain-source on-state resistance as a function of junction temperature; typical values**



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



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



$I_D = -3$  A;  $V_{DS} = -10$  V;  $T_{amb} = 25$  °C

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

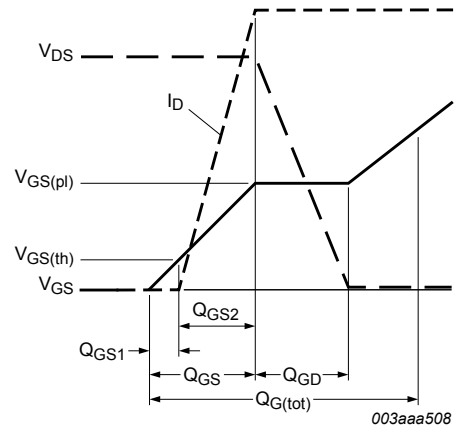
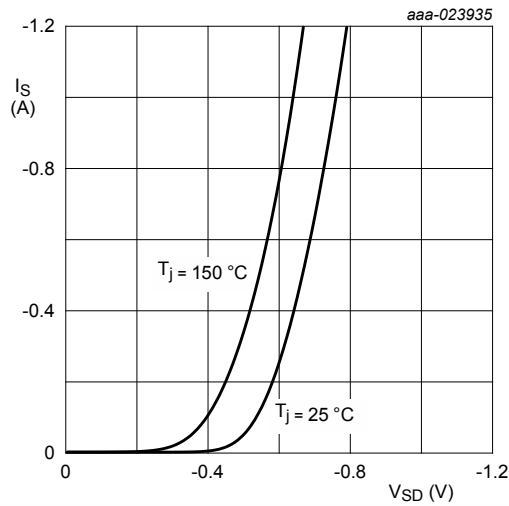


Fig. 16. MOSFET transistor: Gate charge waveform definitions



$V_{GS} = 0$  V

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

## 11. Test information

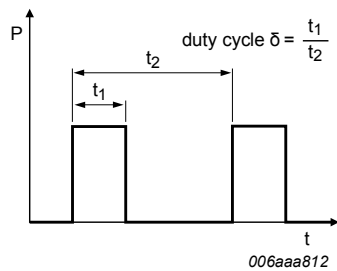


Fig. 18. Duty cycle definition

## 12. Package outline

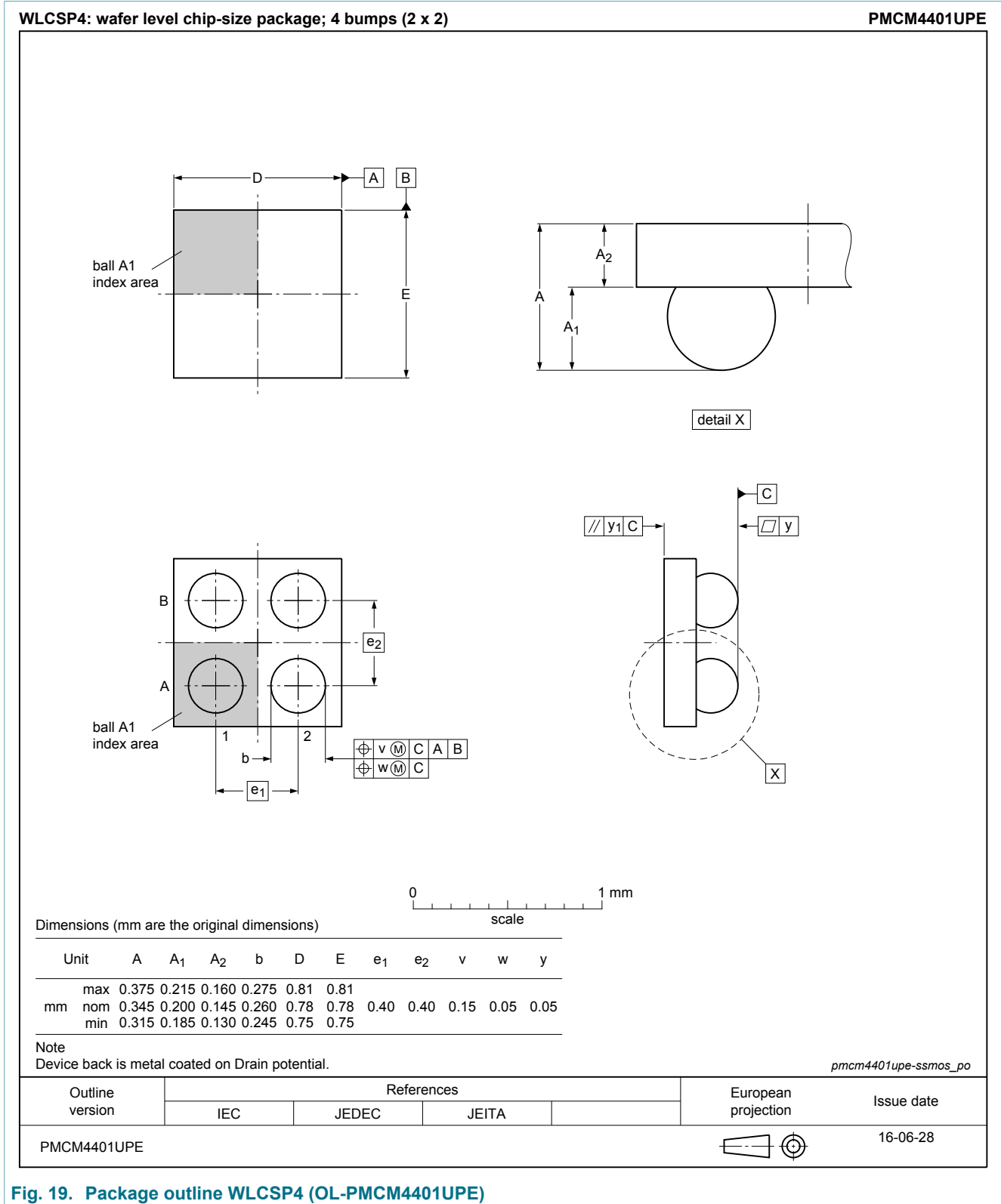


Fig. 19. Package outline WLCSP4 (OL-PMCM4401UPE)

### 13. Soldering

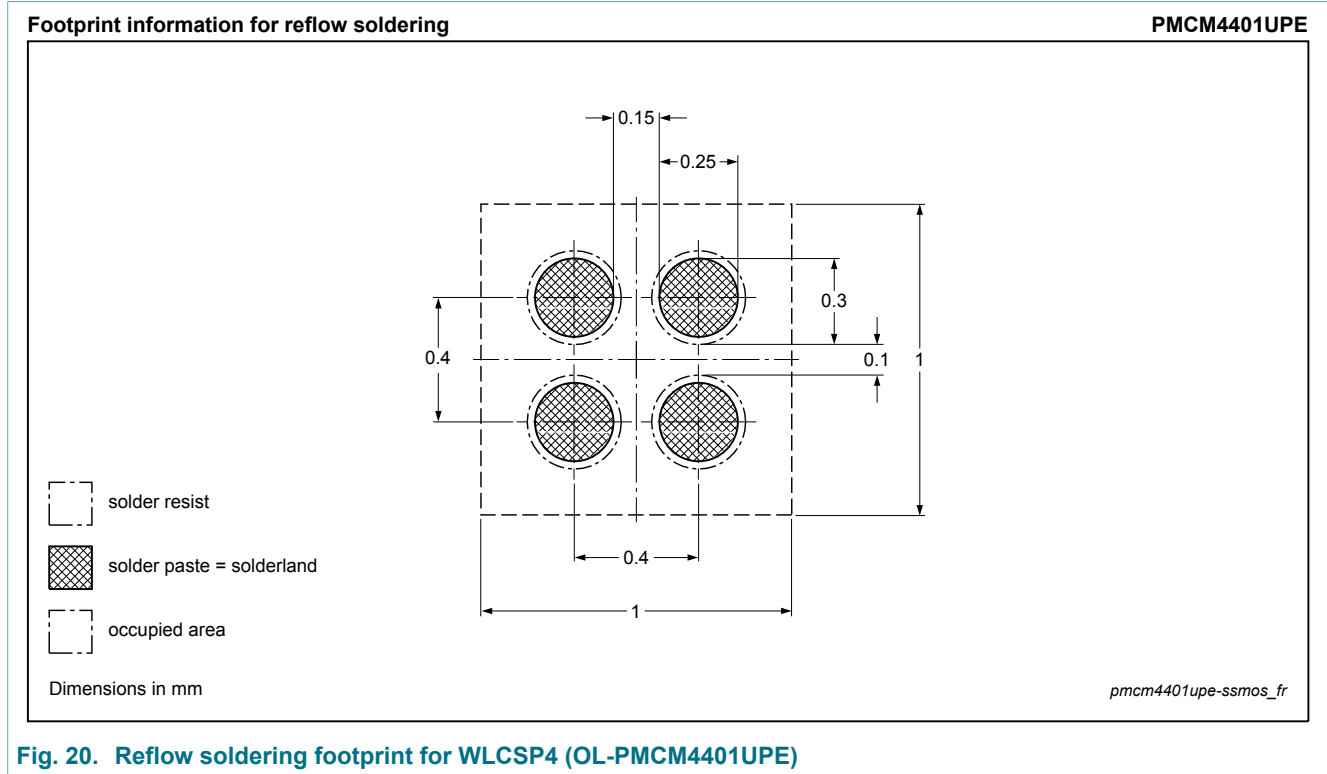


Fig. 20. Reflow soldering footprint for WLCSP4 (OL-PMCM4401UPE)

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PMCM4401UPE v.2	20161007	Product data sheet	-	PMCM4401UPE v.1
Modification:	<ul style="list-style-type: none"><li><math>R_{dson}</math> at <math>V_{GS} = -4.5\text{ V}</math>; <math>I_D = -3\text{ A}</math>; <math>T_j = 25\text{ °C}</math> corrected to <math>95\text{ m}\Omega</math>.</li></ul>			
PMCM4401UPE v.1	20160704	Product data sheet	-	-

## 15. Legal information

### 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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