



# PMCM950ENE

60 V, N-channel Trench MOSFET

13 May 2019

Product data sheet

## 1. General description

N-channel enhancement mode Field-Effect Transistor (FET) in a 9 bumps Wafer Level Chip-Size Package (WLCSP) using Trench MOSFET technology.

## 2. Features and benefits

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

## 3. Applications

- High-speed line driver
- Low-side load switch
- Switching circuits

## 4. Quick reference data

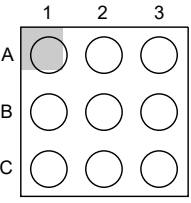
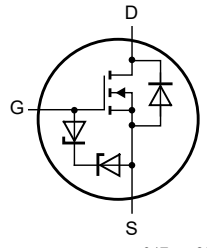
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DS}$	drain-source voltage	$T_j = 25\text{ °C}$	-	-	60	V
$V_{GS}$	gate-source voltage		-20	-	20	V
$I_D$	drain current	$V_{GS} = 10\text{ V}; T_{amb} = 25\text{ °C}; t \leq 5\text{ s}$	[1]	-	6.1	A
<b>Static characteristics</b>						
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\text{ V}; I_D = 3\text{ A}; T_j = 25\text{ °C}$	-	28	41	mΩ

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and 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>WLCSP9 (WLCSP9_3x3)</b></p>	 <p>017aaa255</p>
A2	S	source		
A3	S	source		
B1	S	source		
B2	S	source		
B3	S	source		
C1	D	drain		
C2	D	drain		
C3	D	drain		

### 6. Ordering information

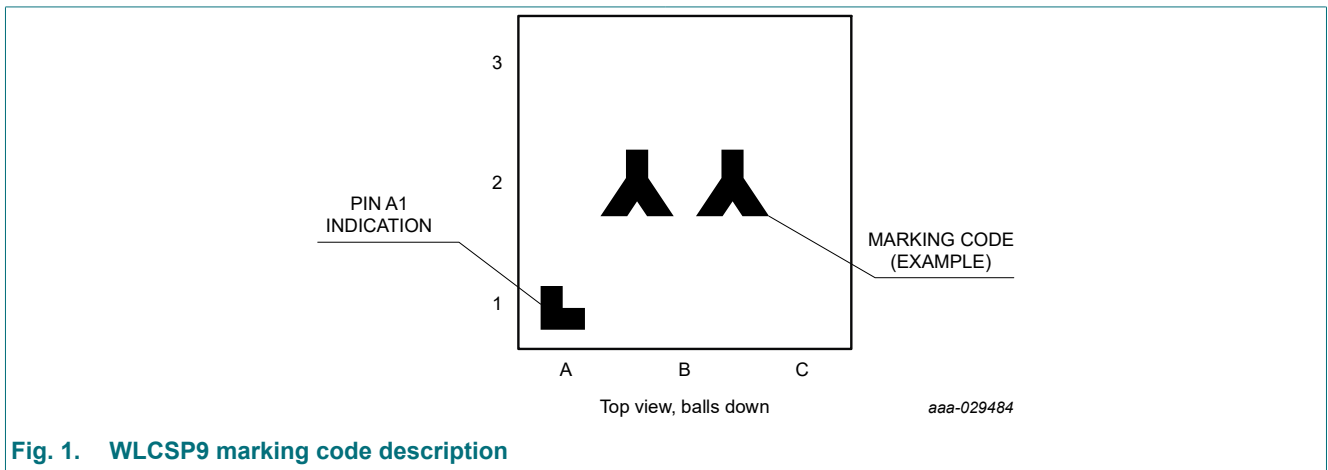
Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PMCM950ENE	WLCSP9	WLCSP9: wafer level chip-size package; 9 bumps (3 x 3)	WLCSP9_3x3

### 7. Marking

Table 4. Marking codes

Type number	Marking code
PMCM950ENE	A1



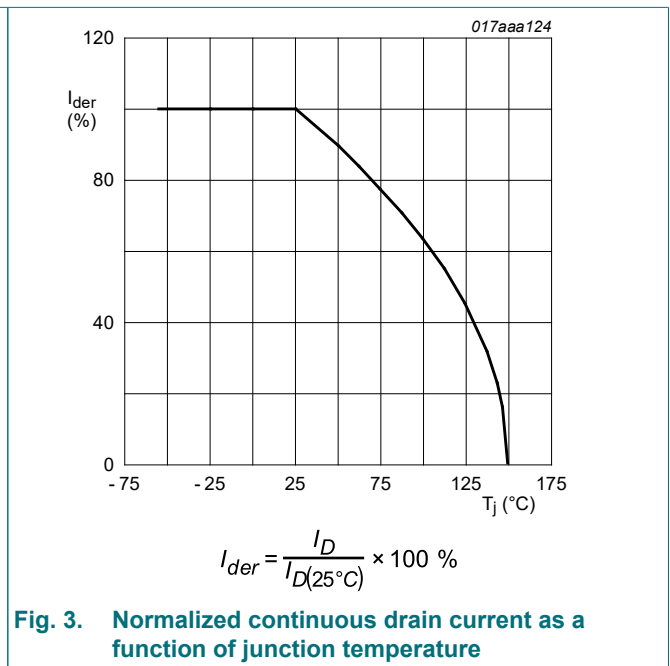
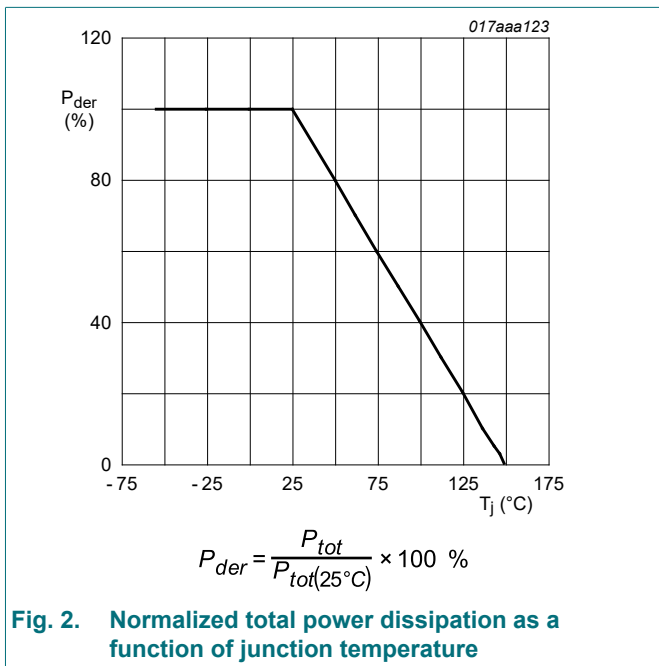
## 8. Limiting values

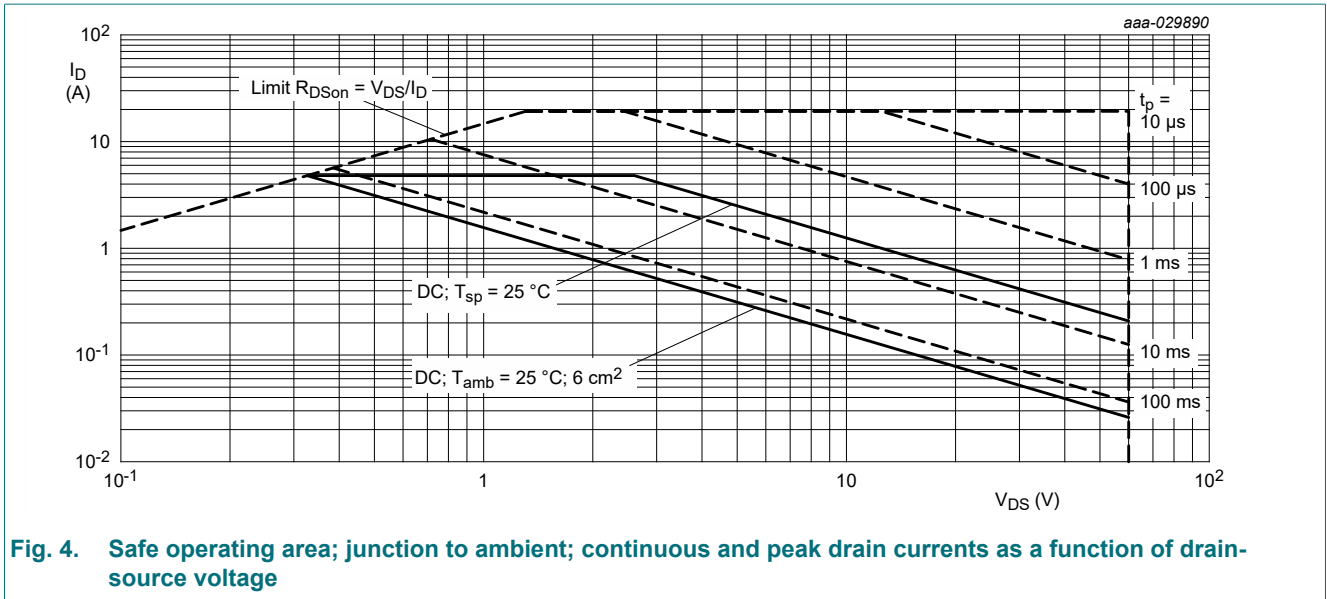
**Table 5. Limiting values**

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		-	60	V
V <sub>GS</sub>	gate-source voltage			-20	20	V
I <sub>D</sub>	drain current	V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C; t ≤ 5 s	[1]	-	6.1	A
		V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C	[1]	-	4.8	A
		V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 100 °C	[1]	-	3	A
I <sub>DM</sub>	peak drain current	T <sub>amb</sub> = 25 °C; single pulse; t <sub>p</sub> ≤ 10 μs		-	19	A
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = 25 °C	[2]	-	780	mW
			[1]	-	1.4	W
		T <sub>sp</sub> = 25 °C		-	12.5	W
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]	-	1.4	A

- [1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and 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
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	130	160	K/W
			[2]	-	50	60	K/W
			[3]	-	65	80	K/W
		$t \leq 5$ s	[3]	-	42	50	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 and mounting pad for drain, 4 layer, 1 cm<sup>2</sup>.
- [3] Device mounted on an FR4 PCB, single-sided copper, tin-plated and mounting pad for drain 6 cm<sup>2</sup>.

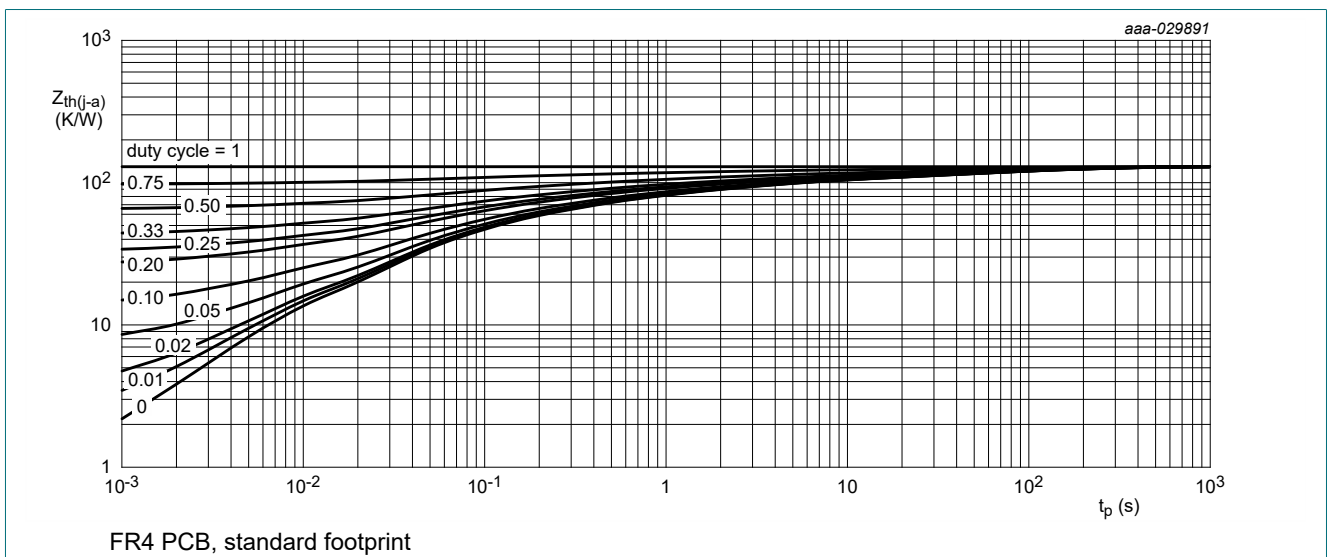


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

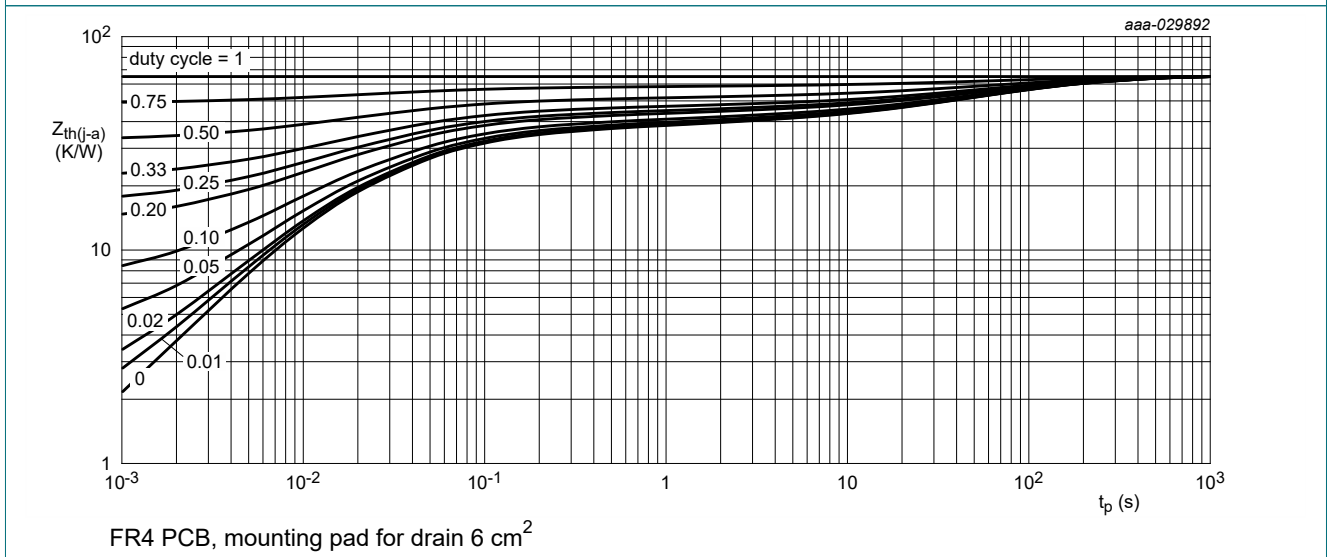


Fig. 6. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Static characteristics</b>						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 250 \mu A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	60	-	-	V
$V_{GSth}$	gate-source threshold voltage	$I_D = 250 \mu A$ ; $V_{DS} = V_{GS}$ ; $T_j = 25 \text{ }^\circ C$	0.9	1.2	1.5	V
$I_{DSS}$	drain leakage current	$V_{DS} = 60 V$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	1	$\mu A$
$I_{GSS}$	gate leakage current	$V_{GS} = 20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	10	$\mu A$
		$V_{GS} = -20 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	-10	$\mu A$
		$V_{GS} = 8 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	1	$\mu A$
		$V_{GS} = -8 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	-1	$\mu A$
		$V_{GS} = 4.5 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	200	nA
		$V_{GS} = -4.5 V$ ; $V_{DS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	-	-200	nA
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 10 V$ ; $I_D = 3 A$ ; $T_j = 25 \text{ }^\circ C$	-	28	41	m $\Omega$
		$V_{GS} = 10 V$ ; $I_D = 3 A$ ; $T_j = 150 \text{ }^\circ C$	-	46	68	m $\Omega$
		$V_{GS} = 4.5 V$ ; $I_D = 3 A$ ; $T_j = 25 \text{ }^\circ C$	-	31	47	m $\Omega$
$g_{fs}$	forward transconductance	$V_{DS} = 5 V$ ; $I_D = 3 A$ ; $T_j = 25 \text{ }^\circ C$	-	20	-	S
$R_G$	gate resistance	$f = 1 \text{ MHz}$	-	5.7	-	$\Omega$
<b>Dynamic characteristics</b>						
$Q_{G(tot)}$	total gate charge	$V_{DS} = 30 V$ ; $I_D = 3 A$ ; $V_{GS} = 10 V$ ; $T_j = 25 \text{ }^\circ C$	-	30	45	nC
$Q_{GS}$	gate-source charge		-	2.3	-	nC
$Q_{GD}$	gate-drain charge		-	5.9	-	nC
$C_{iss}$	input capacitance	$V_{DS} = 30 V$ ; $f = 1 \text{ MHz}$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	1160	-	pF
$C_{oss}$	output capacitance		-	71	-	pF
$C_{rss}$	reverse transfer capacitance		-	62	-	pF
$t_{d(on)}$	turn-on delay time		$V_{DS} = 30 V$ ; $I_D = 3 A$ ; $V_{GS} = 10 V$ ; $R_{G(ext)} = 6 \Omega$ ; $T_j = 25 \text{ }^\circ C$	-	2	-
$t_r$	rise time	-		4	-	ns
$t_{d(off)}$	turn-off delay time	-		70	-	ns
$t_f$	fall time	-		17	-	ns
<b>Source-drain diode</b>						
$V_{SD}$	source-drain voltage	$I_S = 1.4 A$ ; $V_{GS} = 0 V$ ; $T_j = 25 \text{ }^\circ C$	-	0.7	1.2	V

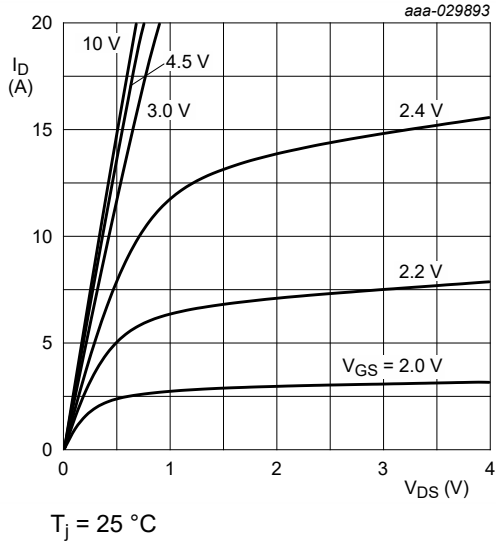


Fig. 7. Output characteristics: drain current as a function of drain-source voltage; typical values

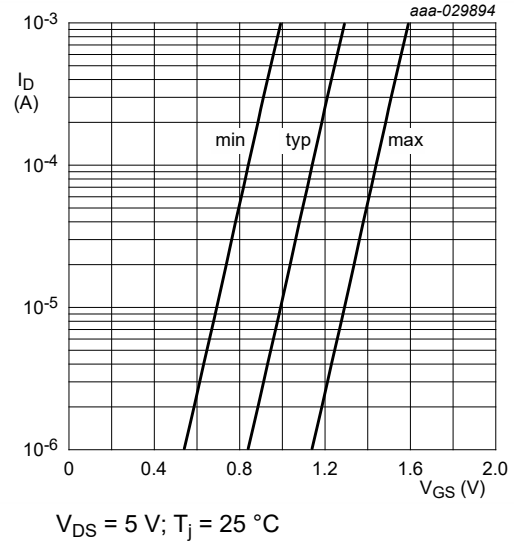


Fig. 8. Sub-threshold drain current as a function of gate-source voltage

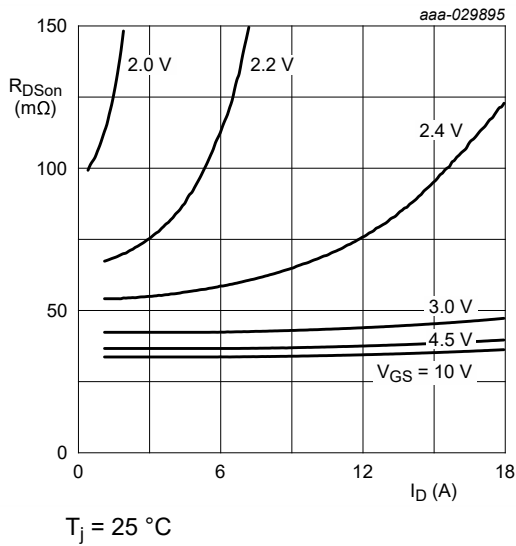


Fig. 9. Drain-source on-state resistance as a function of drain current; typical values

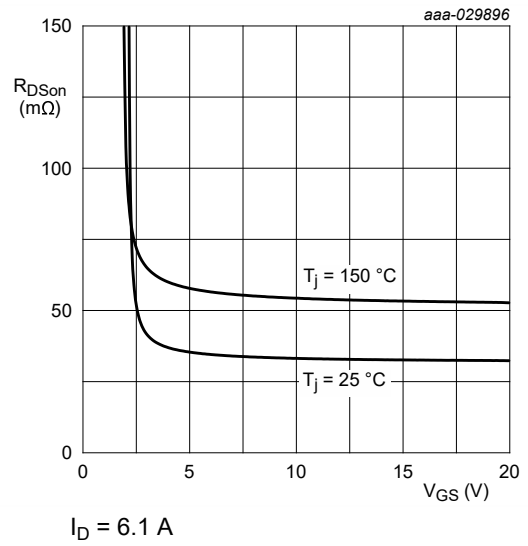
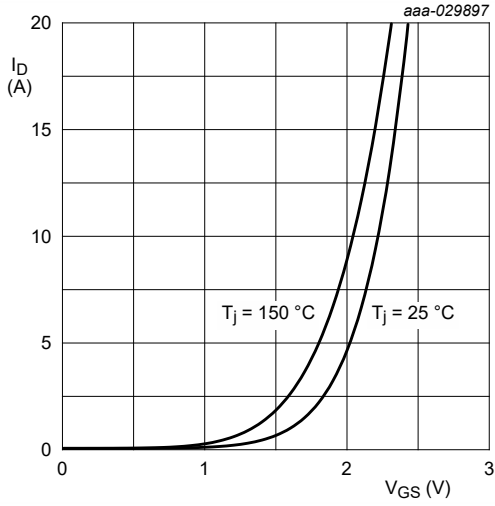
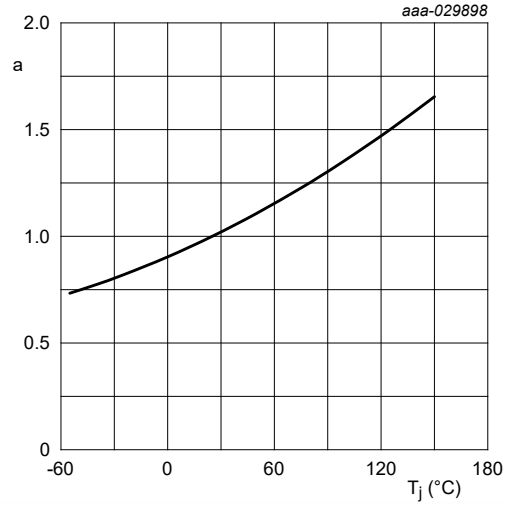


Fig. 10. Drain-source on-state resistance as a function of gate-source voltage; typical values



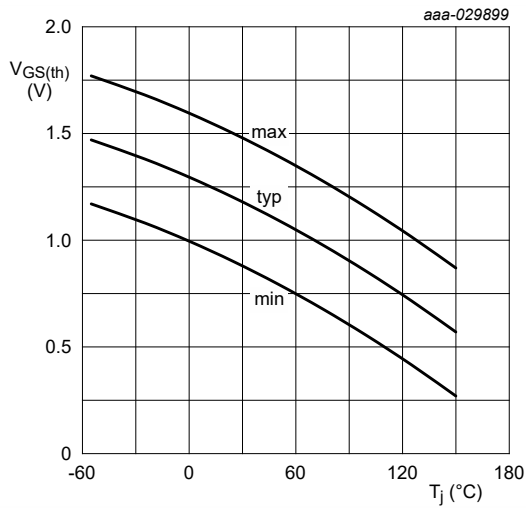
$$V_{DS} > I_D \times R_{DSon}$$

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



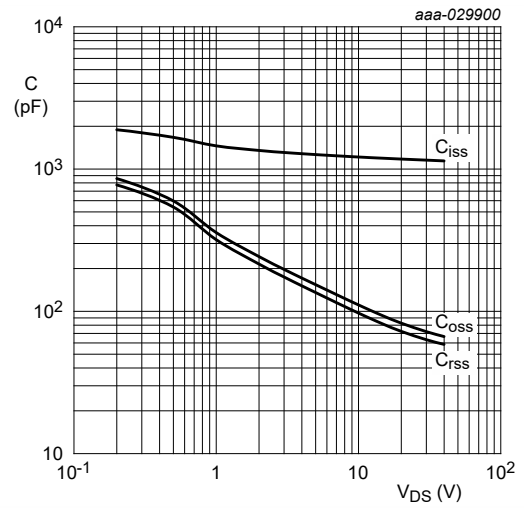
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ C)}}$$

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



$$I_D = 250 \mu A; V_{DS} = V_{GS}$$

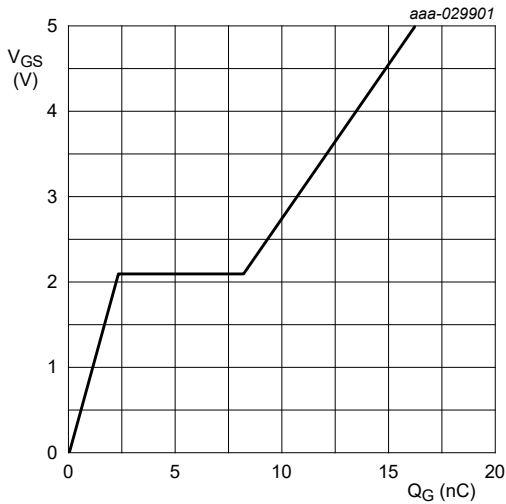
Fig. 13. Gate-source threshold voltage as a function of junction temperature



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

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





$V_{DS} = 30 \text{ V}; I_D = 3 \text{ A}; T_{amb} = 25 \text{ }^\circ\text{C}$

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

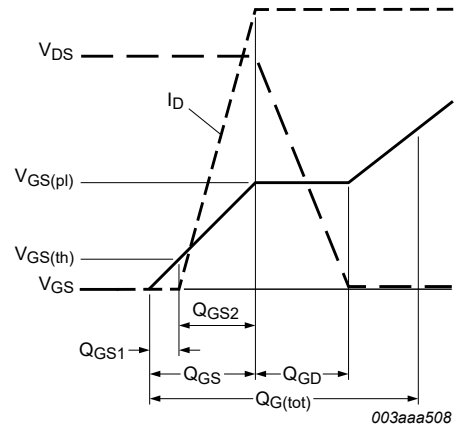
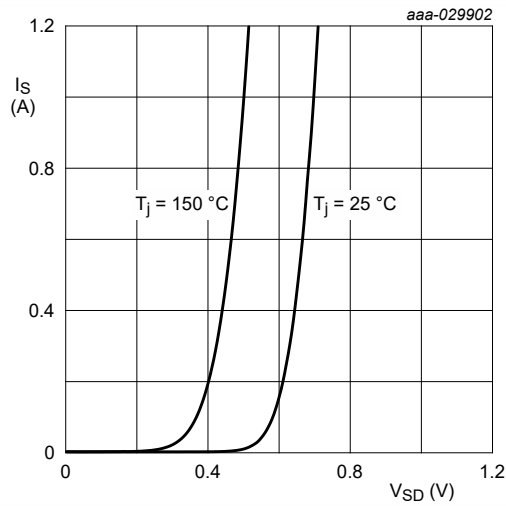


Fig. 16. Gate charge waveform definitions



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

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

## 11. Test information

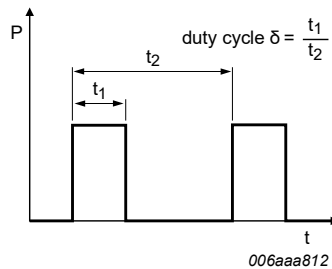


Fig. 18. Duty cycle definition

12. Package outline

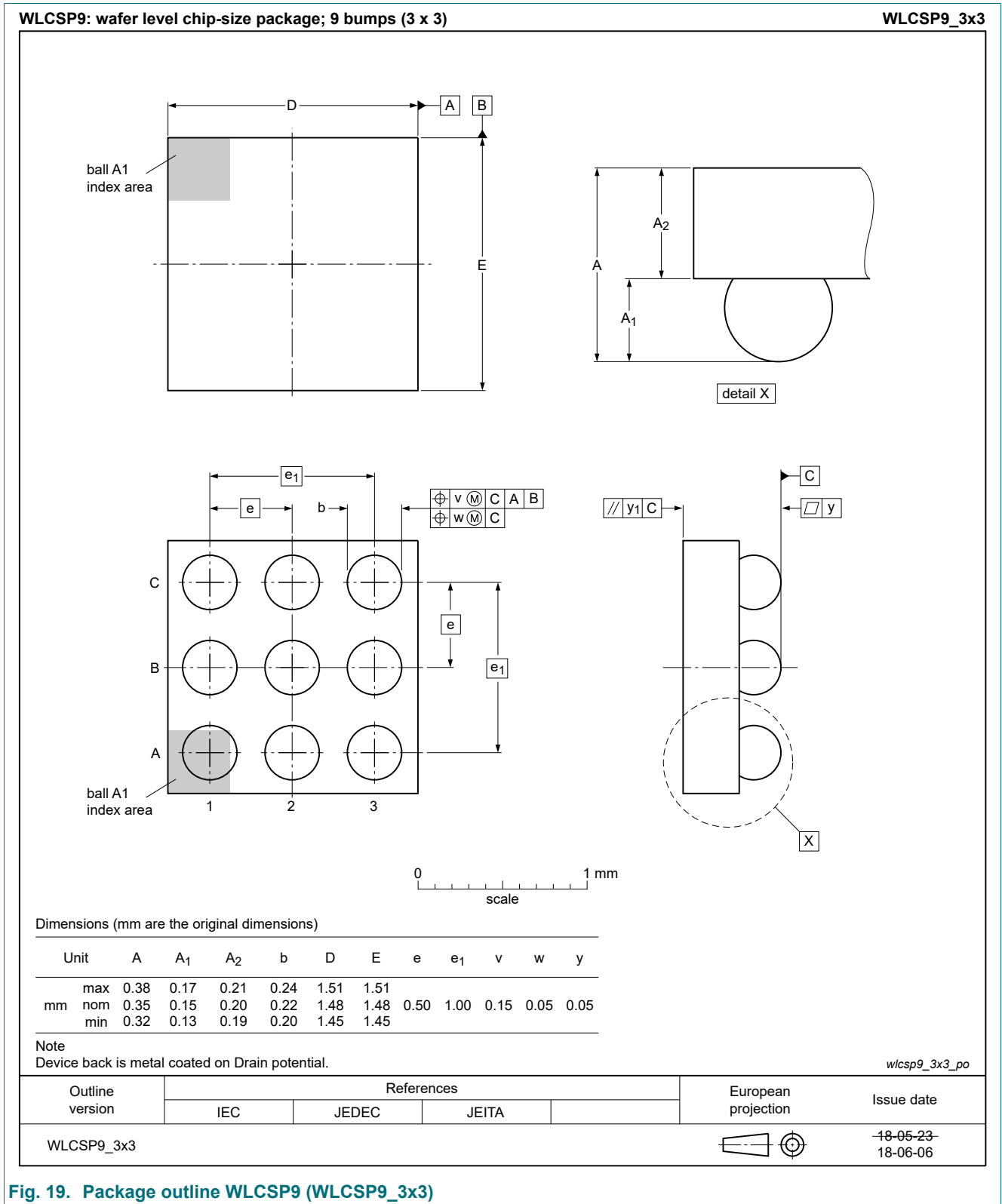
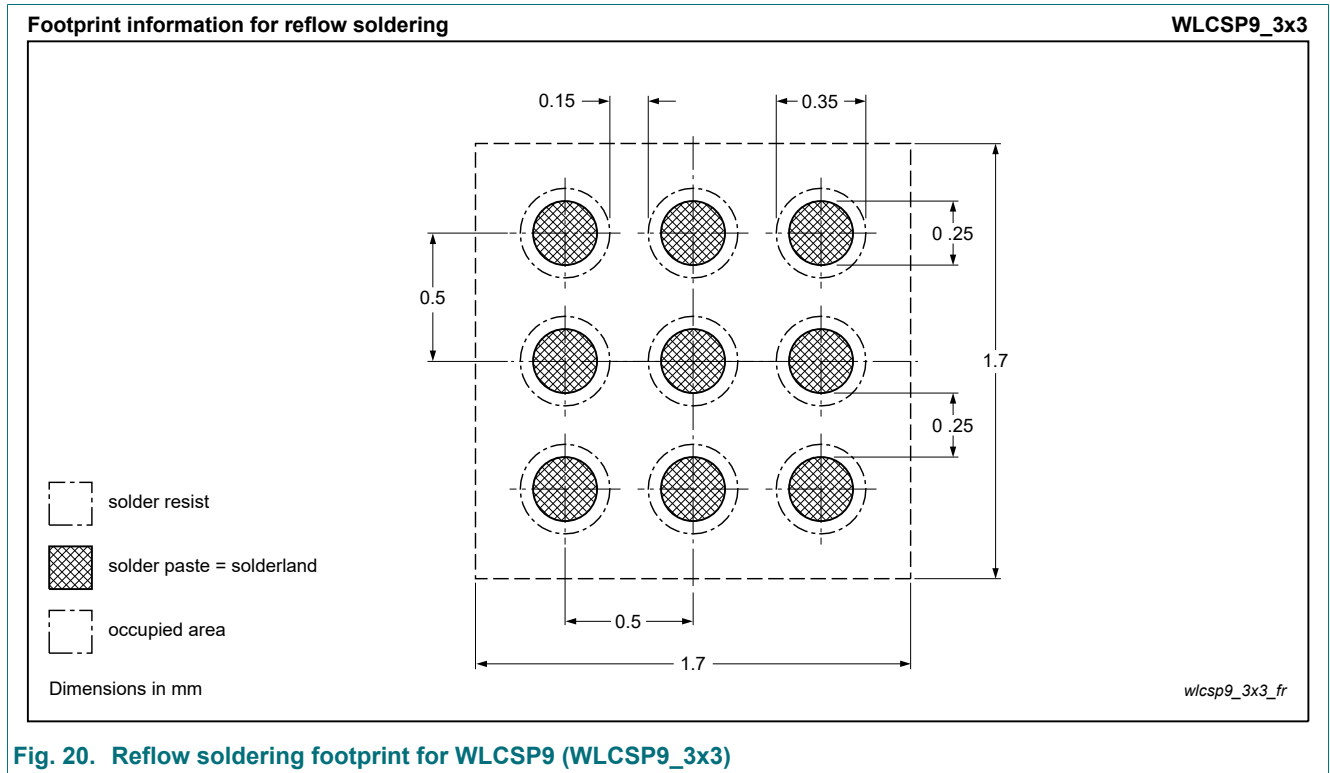


Fig. 19. Package outline WLCSP9 (WLCSP9\_3x3)

### 13. Soldering



**Fig. 20. Reflow soldering footprint for WLCSP9 (WLCSP9\_3x3)**

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PMCM950ENE v.1	20190513	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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