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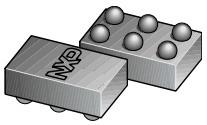


LD6938 series

Dual low-dropout regulators, low noise, 300 mA

Rev. 1 — 11 July 2013 Objective data sheet

1. Product profile

1.1 General description

The LD6938 series consists of small-size dual Low DropOut regulators (LDO). Each device delivers two times 300 mA with a typical voltage drop of 240 mV at full output load. The devices offer two separate fixed nominal output voltages ($V_{O(nom)}$) in the range of 1.2 V to 3.3 V.

The LDO has an integrated Soft start to control the inrush current during start-up. The output mode, when disabled, can be high-ohmic 3-state or auto discharge. Optionally a delayed start-up circuit is available for the second output. The devices are available in a 6-bump Wafer-Level Chip-Scale Package (WLCSP) with a height of 0.47 mm.

1.2 Features and benefits

- High Power Supply Rejection Ratio (PSRR)
- Low output noise
- Low quiescent current
- Extremely low standby current (≤ 0.1 μA)
- Soft start circuit to limit inrush current
- Output current limiter with foldback circuit
- Overtemperature protection
- Delayed output circuit for second LDO (optional)
- Auto discharge or high-ohmic mode for output when disabled
- WLCSP6 with 0.4 mm pitch and package size of 1.2 mm × 0.8 mm × 0.47 mm

1.3 Applications

- Smartphones
- Mobile handsets
- Digital still cameras
- Tablet PCs
- Mobile internet devices
- Portable media players

1.4 Quick reference data

- I_O = 300 mA for each LDO
- PSRR = 80 dB at 1 kHz
- RMS noise $V_{n(o)RMS}$ = 70 μV at 10 Hz to 100 kHz
- $t_{startup(reg)} \leq 200$ μs
- V_I = 1.7 V to 5.5 V
- V_O = 1.2 V to 3.3 V (fixed value)
- Drop voltage V_{do} = 240 mV at I_O = 300 mA
- Quiescent current I_q = 30 μA for each LDO at I_O = 0 mA

2. Pinning information

2.1 Pinning

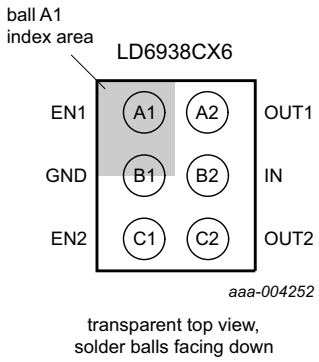


Fig 1. Pin configuration for WLCSP6

2.2 Pin description

Table 1. Pin description for WLCSP6

Symbol	Pin	Description
EN1	A1	regulator 1 enable input
OUT1	A2	regulator 1 output voltage
GND	B1	supply ground
IN	B2	supply voltage input
EN2	C1	regulator 2 enable input
OUT2	C2	regulator 2 output voltage

3. Ordering information

Table 2. Ordering information

Type number	Package		
	Name	Description	Version
LD6938CX6	WLCSP6	wafer level chip-size package; 6 bumps (2 × 3)	-

3.1 Ordering options

Further output voltage versions and optional delay circuit for the second LDO are available on request; see Section 15 “Contact information”.

Table 3. Type number extension of high ohmic output

Type number	Nominal output voltage $V_{O(nom)}$	
	OUT1	OUT2
LD6938CX6/1818H	1.8 V	1.8 V

Table 4. Type number extension for auto discharge

Type number	Nominal output voltage $V_{O(nom)}$	
	OUT1	OUT2
LD6938CX6/1215PL	1.2 V	1.5 V
LD6938CX6/1218PL	1.2 V	1.8 V
LD6938CX6/18125PL	1.8 V	1.25 V
LD6938CX6/1818PL	1.8 V	1.8 V
LD6938CX6/1833PL	1.8 V	3.3 V
LD6938CX6/285285PL	2.85 V	2.85 V
LD6938CX6/3018PL	3.0 V	1.8 V
LD6938CX6/3030PL	3.0 V	3.0 V
LD6938CX6/33285PL	3.3 V	2.85 V
LD6938CX6/3333PL	3.3 V	3.3 V

4. Block diagram

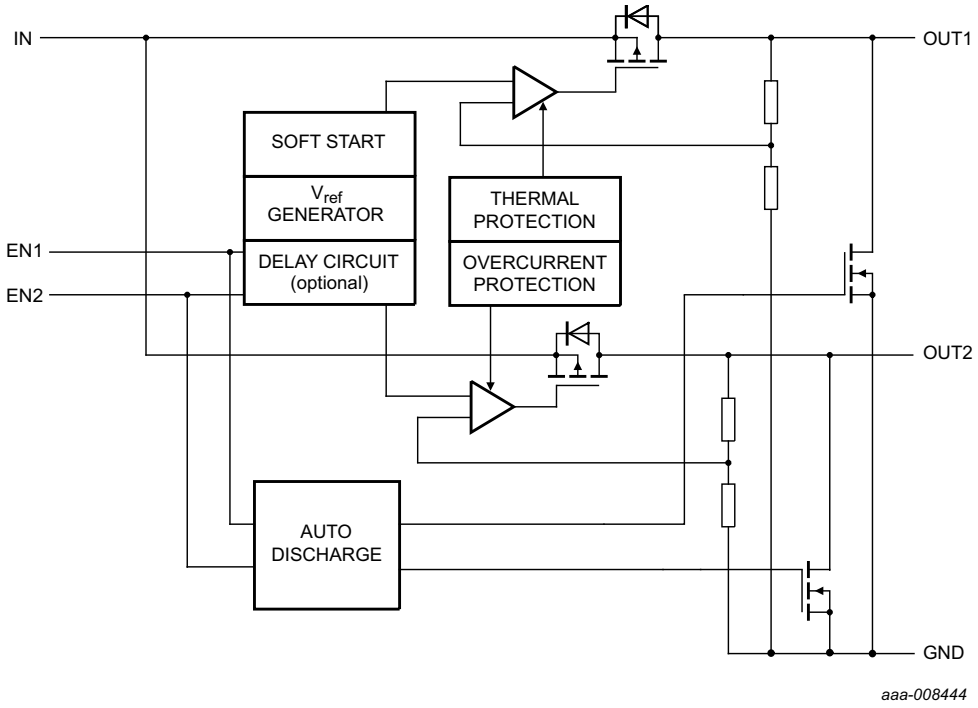


Fig 2. Block diagram dual LDO with auto discharge function (-PL version)

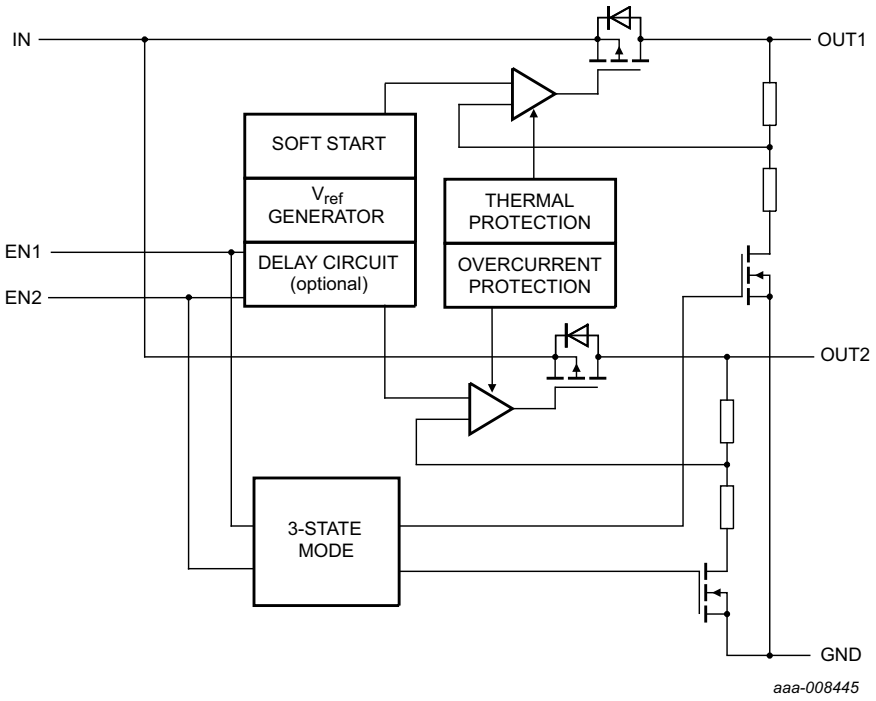


Fig 3. Block diagram dual LDO with high-ohmic output (-H version)

5. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions		Min	Max	Unit
T_{stg}	storage temperature			−55	+150	°C
T_j	junction temperature			−40	+125	°C
T_{amb}	ambient temperature			−40	+85	°C
P_{tot}	total power dissipation		[1]	-	1000	mW
V_{ESD}	electrostatic discharge voltage	human body model level 4	[2]	-	±2	kV
		machine model class 3	[3]	-	±200	V
Pin IN, EN1 and EN2						
V_I	input voltage	4 ms transient		−0.5	+6.0	V
V_{EN}	voltage on pin EN	4 ms transient		−0.5	+6.0	V
Pin OUT1 and OUT2						
V_O	output voltage	4 ms transient		−0.5	+6.0	V
I_O	output current			0	500	mA

[1] The (absolute) maximum power dissipation depends on the junction temperature T_j. Higher power dissipation is allowed with lower ambient temperatures. The conditions to determine the specified values are T_{amb} = 25 °C and the use of a two-layer Printed-Circuit Board (PCB).

[2] According to IEC 61340-3-1.

[3] According to JESD22-A115C.

6. Recommended operating conditions

Table 6. Operating conditions

Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions		Min	Max	Unit
T_{amb}	ambient temperature			−40	+85	°C
T_j	junction temperature			-	+125	°C
Pin IN						
V_I	input voltage			1.7	5.5	V
$C_{ext(IN)}$	external capacitance on pin IN		[1]	1.0	-	µF
Pin EN1 and EN2						
V_{EN}	voltage on pin EN			0	V_I	V
Pin OUT1 and OUT2						
V_O	output voltage			0	5.5	V
$C_{L(ext)}$	external load capacitance		[1]	1.0	-	µF

[1] See Section 9.1 “Input and output capacitor values”.

7. Thermal characteristics

Table 7. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient		[1][2]	100	K/W

[1] The overall $R_{th(j-a)}$ can vary depending on the board layout. To minimize the effective $R_{th(j-a)}$, all pins must have a solid connection to larger Cu layer areas for example to the power and ground layer. In multi-layer PCB applications, the second layer should be used to create a large heat spreader area directly below the LDO. If this layer is either ground or power, it should be connected with several vias to the top layer connecting to the device ground or supply. Avoid the use of solder-stop varnish under the chip.

[2] Use the measurement data given for a rough estimation of the $R_{th(j-a)}$ in your application. The actual $R_{th(j-a)}$ value can vary in applications using different layer stacks and layouts.

8. Characteristics

Table 8. Electrical characteristics

At recommended input voltages and T_{amb} = −40 °C to +85 °C; voltages are referenced to GND (ground = 0 V); unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Output voltage (pin OUT1 and OUT2)						
V_{do}	dropout voltage	I_O = 300 mA; $V_{IN} \leq V_{O(nom)}$	-	240	400	mV
ΔV_O	output voltage variation	$V_O \geq 1.5$ V; I_O = 1 mA				
		T_{amb} = +25 °C	−2	-	+2	%
		−30 °C ≤ T_{amb} ≤ +85 °C	−3	-	+3	%
		$V_O < 1.5$ V; I_O = 1 mA				
		T_{amb} = +25 °C	−3	-	+3	%
		−30 °C ≤ T_{amb} ≤ +85 °C	−4	-	+4	%
Line regulation error						
$\Delta V_O/(V_O x \Delta V_I)$	relative output voltage variation with input voltage	$V_I = (V_{O(nom)} + 1\ V)$ to 5.5 V; I_O = 1 mA	−0.1	-	+0.1	%/V
$\Delta V_O/V_O$	relative output voltage variation	$V_I = (V_{O(nom)} + 1\ V)$ to 5.5 V; I_O = 1 mA	−0.33	-	+0.33	%
Load regulation error						
$\Delta V_O/(V_O x \Delta I_O)$	relative output voltage variation with output current	$V_I = V_{O(nom)} + 1$ V; 1 mA ≤ I_O ≤ 300 mA	-	0.0025	0.0065	%/mA
$\Delta V_O/V_O$	relative output voltage variation	$V_I = V_{O(nom)} + 1$ V	-	-	2	%

Table 8. Electrical characteristics *...continued*

At recommended input voltages and T_{amb} = −40 °C to +85 °C; voltages are referenced to GND (ground = 0 V); unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Output current (pin OUT1 and OUT2)							
I_O	output current			300	-	-	mA
$I_{act(fold)}$	foldback activation current	$V_O = 0.9 \times V_{O(nom)}$		-	750	-	mA
I_{sc}	short-circuit current	V_O = 0 V		-	100	-	mA
I_q	quiescent current	(EN1 or EN2) = HIGH; I_O = 0 mA at OUT1 and OUT2; $V_I = V_{O(nom)}$ + 1 V		-	30	-	µA
		(EN1 and EN2) = HIGH; I_O = 0 mA at OUT1 and OUT2; $V_I = V_{O(nom)}$ + 1 V		-	58	75	µA
		(EN1 or EN2) = HIGH; 1 mA ≤ I_O ≤ 300 mA at OUT1 and OUT2; $V_I = V_{O(nom)}$ + 1 V		-	400	-	µA
		(EN1 and EN2) = LOW		-	-	1.0	µA
Ripple rejection and output noise							
PSRR	power supply rejection ratio	$V_I = V_{O(nom)}$ + 1 V; I_O = 50 mA; f_{ripple} = 1 kHz; $C_{L(ext)}$ = 1 µF		-	80	-	dB
$V_{n(o)(RMS)}$	RMS output noise voltage	bandwidth = 10 Hz to 100 kHz; $C_{L(ext)}$ = 1 µF; V_O = 1.8 V		-	70	-	µV
Enable input and timing (pin EN1 and EN2)							
V_{IL}	LOW-level input voltage			0	-	0.4	V
V_{IH}	HIGH-level input voltage			1.1	-	5.5	V
I_{en}	enable current	-H version		-	250	-	nA
		-PL version; V_{EN} = 1.8 V		-	12	-	µA
R_{pd}	pull-down resistance	-PL version		100	150	200	kΩ
$t_{startup(reg)}$	regulator start-up time	V_I = 5.5 V; $V_O = 0.95 \times V_{O(nom)}$; I_O = 300 mA; $C_{L(ext)}$ = 1 µF		-	110	200	µs
Automatic discharge function (-PL version)							
R_{pd}	pull-down resistance			-	100	-	Ω
$t_{sd(reg)}$	regulator shutdown time	V_I = 5.5 V; $C_{L(ext)}$ = 1 µF; I_O = 0 A; $V_O = 0.1 \times V_{O(nom)}$	[1]	-	300	-	µs
Thermal protection							
T_{sd}	shutdown temperature			-	160	-	°C
$T_{sd(hys)}$	shutdown temperature hysteresis		[1]	-	20	-	K

[1] After T_{sd} was reached and after the device was disabled, the junction temperature must decrease by $T_{sd(hys)}$ to enable the device.

9. Application information

9.1 Input and output capacitor values

The devices require external capacitors at the output to guarantee a stable regulator behavior. Also an input capacitor is recommended to keep the input voltage stable. These capacitors should not under-run the specified minimum Equivalent Series Resistance (ESR).

The absolute value of the total capacitance attached to the output pin OUT influences the shutdown time ($t_{sd(reg)}$) of the devices.

Table 9. External load capacitor

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$C_{ext(IN)}$	external capacitance on pin IN			0.7	1.0	-	µF
$C_{L(ext)}$	external load capacitance		[1]	0.7	1.0	-	µF
ESR	equivalent series resistance			5	-	500	mΩ

[1] The minimum value of capacitance for stability and correct operation is 0.7 µF. The capacitor tolerance should be ±30 % or better over the temperature range. The full range of operating conditions for the capacitor in the application should be considered during device selection to ensure that this minimum capacitance specification is met. The recommended capacitor type is X7R to meet the full device temperature specification of −40 °C to +125 °C.

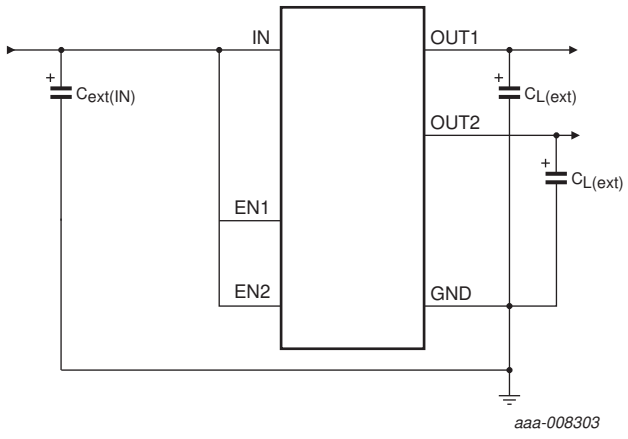


Fig 4. Application diagram

10. Test information

10.1 Quality information

This product has been qualified in accordance with *NX1-00023 NXP Semiconductors Quality and Reliability Specification* and is suitable for use in consumer applications

11. Package outline

WLCSP6: wafer level chip-size package; 6 bumps (2 x 3)

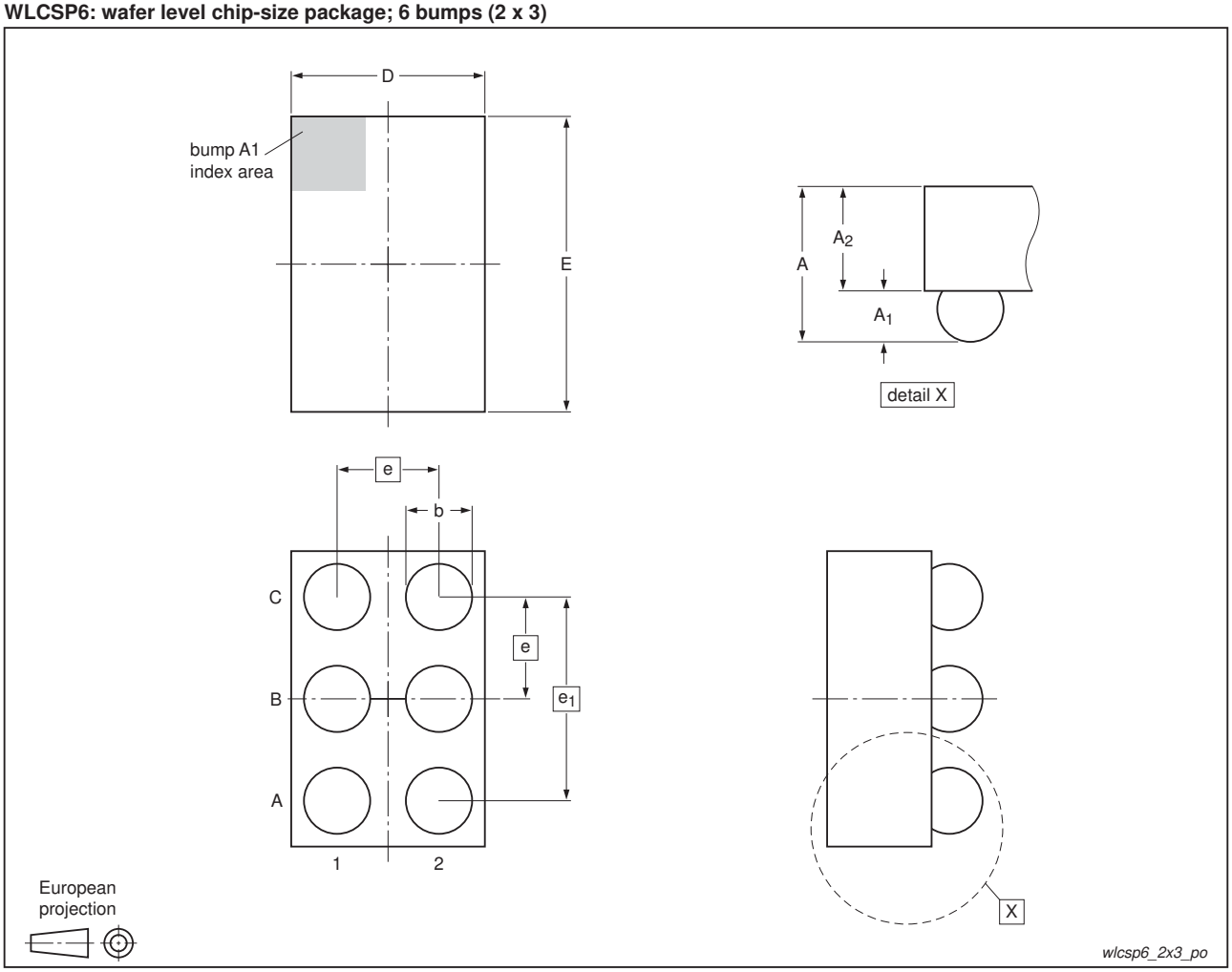


Fig 5. Package outline WLCSP6

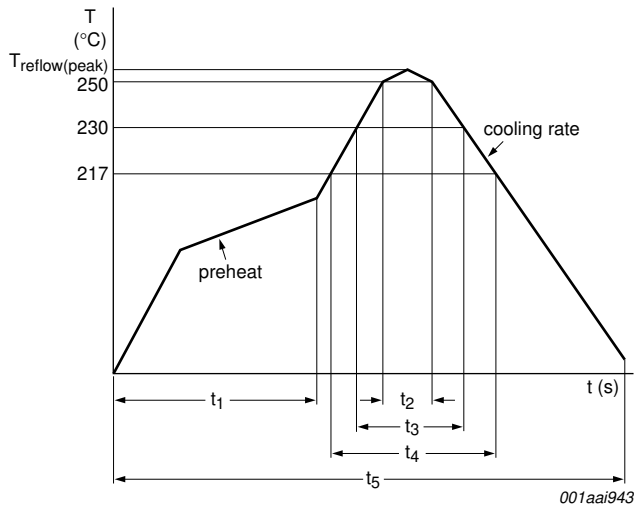
Table 10. Dimensions of LD6938 series in WLCSP6 (Figure 5)

Symbol	Min	Typ	Max	Unit
A	0.440	0.470	0.500	mm
A_1	0.180	0.200	0.220	mm
A_2	0.260	0.270	0.280	mm
b	0.210	0.260	0.310	mm
D	0.710	0.760	0.810	mm
E	1.110	1.160	1.210	mm
e	-	0.400	-	mm
e_1	-	0.800	-	mm

12. PCB assembly guidelines for Pb-free soldering

Table 11. Assembly recommendations

Parameter	Value or specification
Solder screen thickness	100 μm (0.004 inch)
Solder paste: Pb-free	SnAg (3 % to 4 %); Cu (0.5 % to 0.9 %)
Solder to flux ratio	50 : 50
Solder reflow profile	see Figure 6



The device can withstand at least three reflows at this profile.

Fig 6. Pb-free solder reflow profile

Table 12. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$T_{reflow(peak)}$	peak reflow temperature		230	-	260	°C
t_1	time 1	soak time	60	-	180	s
t_2	time 2	time during T ≥ 250 °C	-	-	30	s
t_3	time 3	time during T ≥ 230 °C	10	-	50	s
t_4	time 4	time during T > 217 °C	30	-	150	s
t_5	time 5		-	-	540	s
dT/dt	rate of change of temperature	cooling rate	-	-	−6	°C/s
		preheat	2.5	-	4.0	°C/s

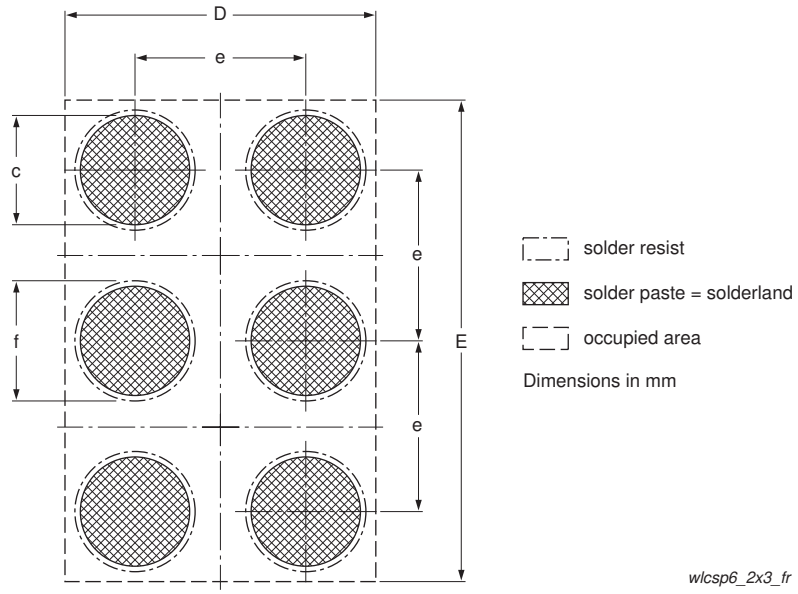


Fig 7. Soldering footprint WLCSP6

Table 13. Dimensions of soldering footprint WLCSP6 (Figure 7)

Symbol	Min	Typ	Max	Unit
c	-	0.25	-	mm
D	0.71	0.76	0.81	mm
E	1.11	1.16	1.21	mm
e	-	0.4	-	mm
f	-	0.325	-	mm

13. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
LD6938_SER v.1	20130711	Objective data sheet	-	-

14. Legal information

14.1 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.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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16. Contents

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Document identifier: LD6938_SER