36V Over-Voltage, Over-Current Protection Load Switch with Adjustable Current-Limit Control

■ General Description

The OCP9227 advanced load-management switch targets application requiring a highly integrated solution. It disconnects loads powered from the DC power rail (<6V) with stringent off-state current targets and high load capacitances (<100 µF). The OCP9227 consists of a slew-rate controlled low-impedance MOSFET switch (35mΩ typical) and integrated analog features. The slew-rate controlled turn-on characteristic prevents inrush current and the resulting excessive voltage drop on power rails. OCP9227 has over-voltage protection and over- temperature protection.

The OCP9227 has a True Reverse-Current Blocking(TRCB) function that obstructs unwanted reverse current from VOUT to VIN during ON and OFF states. The exceptionally low off-state current drain (<2 µA maximum) facilitate compliance with standby power requirements. The input voltage range operates from 2.5V to 5.5V DC to support a wide range of applications in consumer power management.

Switch control is managed by a logic input (active HIGH) capable of interfacing directly with low-voltage control signal /General-Purpose Input/ Output (GPIO) without an external pull-down resistor.

The OCP9227 is available in a fully “green” compliant 1.28mm * 1.85mm WLCSP-12B Package.

■ Features

- V_{IN}: 2.5 V~5.5V
- 36V Absolute Ratings at V_{OUT}
- Current Capability 4A
  Typ 0.10A~3.5A with 10% Accuracy
- Ron: 35mΩ (Typ.), 50mΩ(Max) at $5V_{IN}$ and 1A I_{OUT}
- Output Over-Voltage Protection 5.8V(Typ)
- Open-Drain OCP on FLAGB
- Thermal Shutdown
- Ture Reverse-Current Blocking
- ESD Protect
  - HBM: >8KV
  - CDM: >2KV
  - IEC61000-4-2 Air Discharge: >15KV
  - IEC61000-4-2 Contact Discharge: > 8KV

■ Applications

- Type C Power Source Switch
- Mobile Handsets
- Tablet PCs and Laptops/Net books

■ Pin Configuration

WLCSP-12B(Top View):

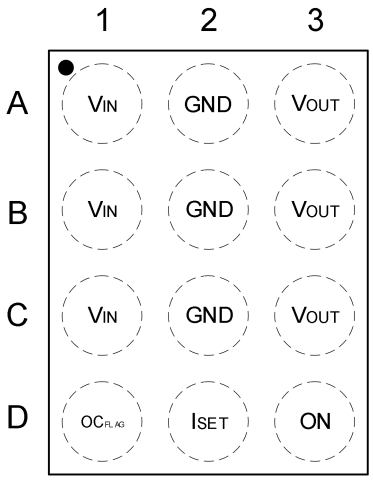


Figure 1, Pin Assignments of OCP9227

Pin Name	Pin No.	Pin Function
V_{OUT}	A3 B3 C3	Switch output to Load
V_{IN}	A1 B1 C1	Switch input and Device supply
GND	A2 B2 C2	Ground
ON	D3	Enable pin, active high
OC_{FLAG}	D1	Fault Output: Active LOW, open-drain output that indicates an input over current. External pull-up resistor is required.
I_{SET}	D2	Current Limit Set Input: A resistor from ISET to ground sets the current limit for the switch.

■ Typical Application Circuit[1]

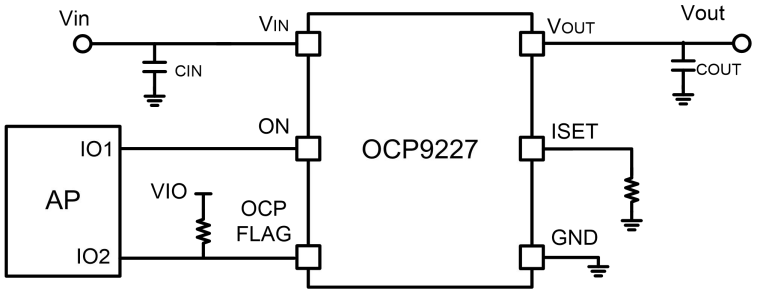


Figure 2, Typical Application

Note 1: CIN and COUT capacitors recommended for improvement of device power rail stability.

■ Block Diagram

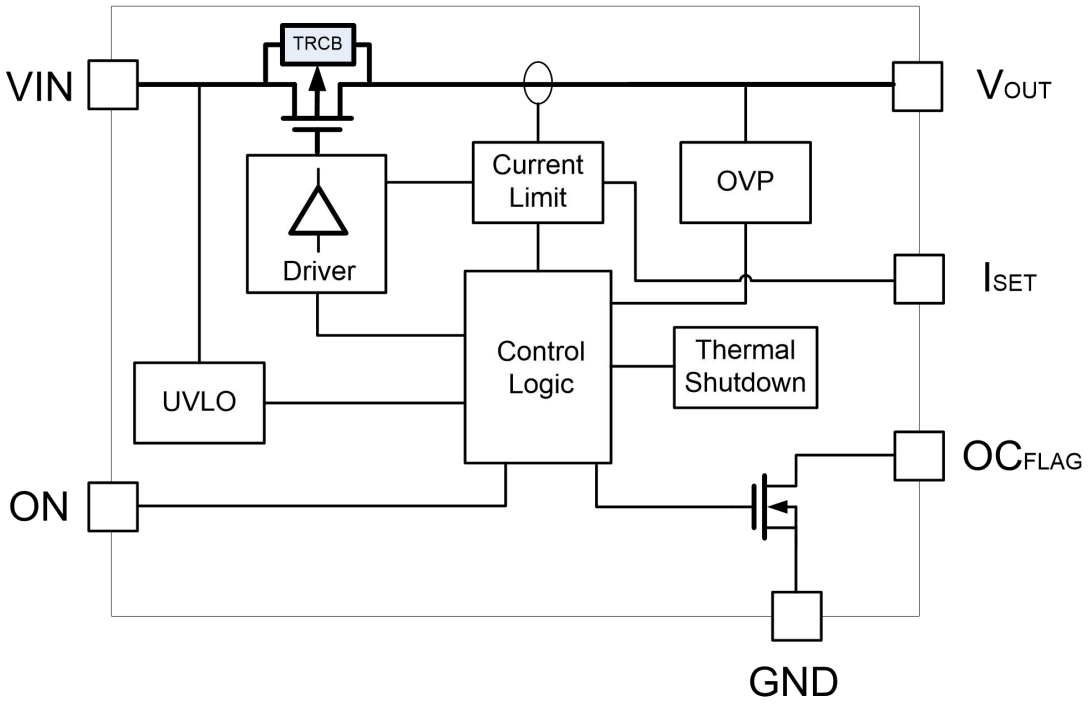


Figure 3, Block Diagram of OCP9227

■ Ordering Information

Part Number	Marking	Package Type	Package Qty	Temperature	Eco Plan	Ball Finish
OCP9227WPAD	PMP	WLCSP-12B	7-in reel 3000pcs/reel	-40～85℃	Green	Sn/Ag/Cu

■ Absolute Maximum Ratings[2] (TA=25°C, unless otherwise noted)

Parameter	Symbol	Rating	Unit
V_{OUT} Pin to GND, V_{OUT} Pin to V_{IN},	V_{OUT}	-0.3 to +36	V
V_{IN} Pins to GND	V_{IN}	-0.3 to 6	V
ON, I_{SET}, OCF_{LAG} Pins to GND	V_{IO}	-0.3 to 6	V
Maximum Continuous Switch Current[3]	I_{SW}	4	A
Storage Temperature Range	T_S	-55 to +150	℃
Operating Junction Temperature Range	T_J	-40 to +150	℃
Human Body Model	HBM	8	KV
Charged Device Model	CDM	2	KV
IEC61000-4-2 System Level Air Discharge (V_{OUT} to GND)		15	KV
IEC61000-4-2 System Level Contact Discharge (V_{OUT} to GND)		8	KV

Note 2: Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.
Note 3: Current limiting or high current use, the chip power consumption is large, need to consider thermal design.

Recommended Operating Conditions[3]

Parameter	Symbol	Rating	Unit
V_{IN} Pin Voltage to GND	V_{IN}	+2.5 to +5.5	V
Thermal Resistance	$R_{\theta JA}$	88	℃/W
Operating Temperature Range	T_{OP}	-40 to +85	℃

Note 4: The device is not guaranteed to function outside of its operating conditions.

■ Electrical Characteristics

(T_A = -40 to +85℃ unless otherwise noted. Typical values are at T_A= 25℃,V_{IN}=5.0V)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Basic Operation						
V_{IN}	Input Voltage		2.5	-	5.5	V
$I_{Q(OFF)}$	Off Supply Current	V_{ON} =GND, V_{OUT}=Open	-	0.1	2	μA
$I_{SD(OFF)}$	Shutdown Current	V_{IN} = 5V, V_{OUT}=0V， V_{ON} =GND	-	0.1	2	μA
I_Q	Input Quienscent Current	V_{IN} = 5V， V_{ON}=1.8V， I_{OUT}=0mA	-	65	100	μA
R_{ON}	Switch On Resistance	V_{IN} = 5V, I_{OUT} =1A	-	35	50	mΩ
		V_{IN} = 3.7V, I_{OUT} =1A		40	55	
V_{IH}	ON Input Logic HIGH Voltage	V_{IN}=2.5 V to 5.5V	0.95	-	-	V
V_{IL}	ON Input Logic Low Voltage	V_{IN}=2.5 V to 5.5V	-	-	0.4	V
I_{ON}	ON Input Logic HIGH Voltage	V_{ON}=0 V to V_{IN}	-	-	1	μA
R_{ON_PD}	Pull-Down Resistance at ON pin	V_{IN}=2.5~5.5 V, V_{ON}=HIGH	-	14	-	MΩ
V_{IL_FLAG}	Flag Output Logic Low Voltage	V_{IN}=5V, I_{SINK} =10mA		0.1	0.2	V
		V_{IN}=2.5V, I_{SINK} =10mA		0.15	0.3	
$I_{\_FLAG}$	Flag Output Logic High Leakage Current		-	-	1	μA
OVP Function						
V_{OVP}	Output OVP Level	V_{OUT} Rising Threshold	5.50	5.80	6.00	V
		OVP Hysteresis	-	0.3	-	
t_{OVP}	OVP Response Time(6)	I_{OUT}=0.5 A, C_L=1 μF, T_A=25°C, V_{OUT} from 5.5 V to 6.0 V	-	-	4	μs
OCP Function						
I_{LIM}	Current Limit(5)	V_{IN}=5V, R_{SET}=2kΩ, V_{OUT}=1.68V to 5V V_{OUT} = 1.68 to 5 V with 10% Accuracy	450	500	550	mA
		V_{IN}=5V, R_{SET}=1kΩ, V_{OUT}=1.68V to 5V V_{OUT} = 1.68 to 5 V with 10% Accuracy	900	1000	1100	
V_{UVLO}	Under-Voltage Lockout	V_{IN} Rising	-	2.4	-	V
		UVLO Hysteresis	-	0.2	-	
V_{T_RCB}	RCB Protection Trip Point	V_{OUT} - V_{IN}	-	50	-	mV
V_{R_RCB}	RCB Protection Release Trip Point	V_{IN} - V_{OUT}	-	50	-	mV
V_{RCB_HYS}	RCB Hysteresis		-	100	-	mV

t_{RCP}	RCB Response Time(6)	V_{IN}=5V, V_{ON}=High/Low	-	2	-	μs
I_{RCP}	RCB Current	V_{ON} =0V, V_{OUT}=5.5V	-	7	-	μA
t_{HOCP}	Short Protection Response Time(6)	Moderate Over-Current Condition, $I_{OUT} \geq I_{LIM}$, V_{OUT}=0 V	-	6	-	μs
t_{OCP}	Over-Current Response Time(6)	Moderate Over-Current Condition, $I_{OUT} \geq I_{LIM}$, $V_{OUT} \leq V_{IN}$	-	7	-	μs
$t_{OC-FLAG}$	Over-Current Flag Response Time	When Over-Current Occurs to Flag Pulling LOW	-	1	-	ms
Thermal Shutdown						
t_{SDN}	Thermal Shutdown(6)		-	150	-	℃
t_{SDN_HYS}	Thermal Shutdown Hysteresis		-	20	-	℃
Dynamic Characteristics						
t_{DON}	Turn-on Delay	V_{IN} = 5V, R_L=100Ω, C_L=1μF, T_A=25℃, R_{SET}=2040Ω	-	0.59	-	ms
t_R	V_{OUT} Rise Time		-	0.54	-	ms
t_{ON}	Turn-on Time		-	1.13	-	ms
t_{DOFF}	Turn-off Delay(6)		-	10	-	μs
t_F	V_{OUT} Fall Time(6)		-	220	-	μs
t_{OFF}	Turn-off Time(6)		-	230	-	μs

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

Note 5: Characterization based on 1% tolerance resistor. ILIM measured in regulated region (not during the transition when OCFLAGB is triggered).

Note 6: This parameter is guaranteed by design and characterization; not production tested.

Note 7: t_{DON} / t_{DOFF} / t_R / t_F / t_{ON} / t_{OFF} are defined in Figure 4 below.

Note 8: This parameter is guaranteed by design.

■ Timing Diagrams

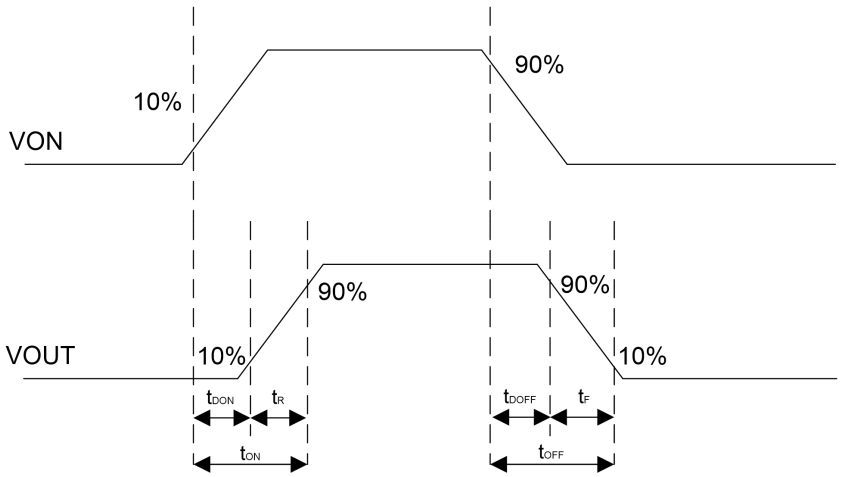


Figure 4, Timing Diagram

■ Detailed Functional Description

Enable

The OCP9227 is powered from VIN. Once VIN voltage is higher than VIN_UVLO and EN voltage is asserted high, internal switch is fully turned on after soft-startup which is shown in Figure 4. Even though EN is high before supplying VIN, switch-on delay time is counted after VIN is higher than VIN_UVLO. If VIN is dropped below than VIN_UVLO or EN is asserted low during operation, switch is turned off without delay time.

Current Limiting

The current limit ensures that the current through the switch does not exceed the maximum set value, while not limiting the minimum value. The current at which the part's limit is adjustable through the selection of the external resistor connected to the ISET pin. The device acts as a constant-current source when the load draws more than the maximum value set by the device until thermal shutdown occurs. The device recovers if the die temperature drops below the threshold temperature. The current limit is set with an external resistor connected between the ISET and GND pins. The resistor is selected using the formula:

ILIM (A) = ((0.4 / RSET Ω) x 2500)

Resistor tolerance of 1% or less is recommended.

Note: For the use of large current limits, the distance between the front-end power supply and the chip VIN should be as short as possible to prevent a large parasitic inductance between the front-end power output and the chip input. When the chip is protected off at a large current, the VIN will generate a ring, which will increase the VIN voltage, damage the VIN PIN, and make the chip unable to work.

True Reverse-Current Blocking

The true reverse-current blocking feature protects the input source against current flow from output to input regardless of whether the load switch is on or off.

Over Voltage Protection

When the VOUT voltage is higher than the V_{OVP}, the power field effect tube is turned off immediately. The power field effect tube will not open until the VOUT voltage is below 5.5V(Type.)

Under-Voltage Lockout (UVLO)

The under-voltage lockout turns the switch off if the input voltage drops below the lockout threshold. With the ON pin active, the input voltage rising above the UVLO threshold releases the lockout and enables the switch.

Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush current when the switch turns on into discharge load capacitor; a capacitor must be placed in between the V_{IN} and GND pins. A high-value capacitor on CIN can be used to reduce the voltage drop in high-current applications.

Output Capacito

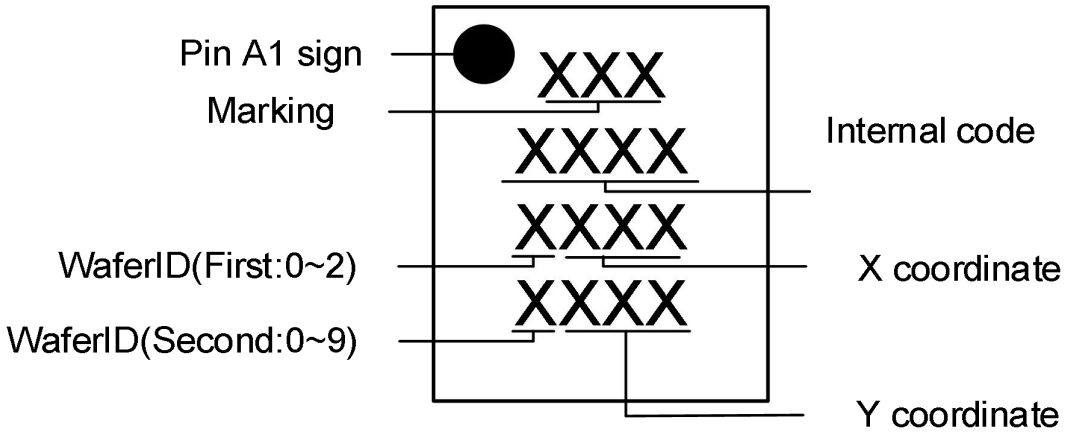
An output capacitor should be placed between the V_{OUT} and GND pins. This capacitor prevents parasitic board inductance from forcing V_{OUT} below GND when the switch is on. This capacitor also prevents reverse inrush current from creating a voltage spike that could damage the device in the case of a V_{OUT} short.

Thermal Shutdown

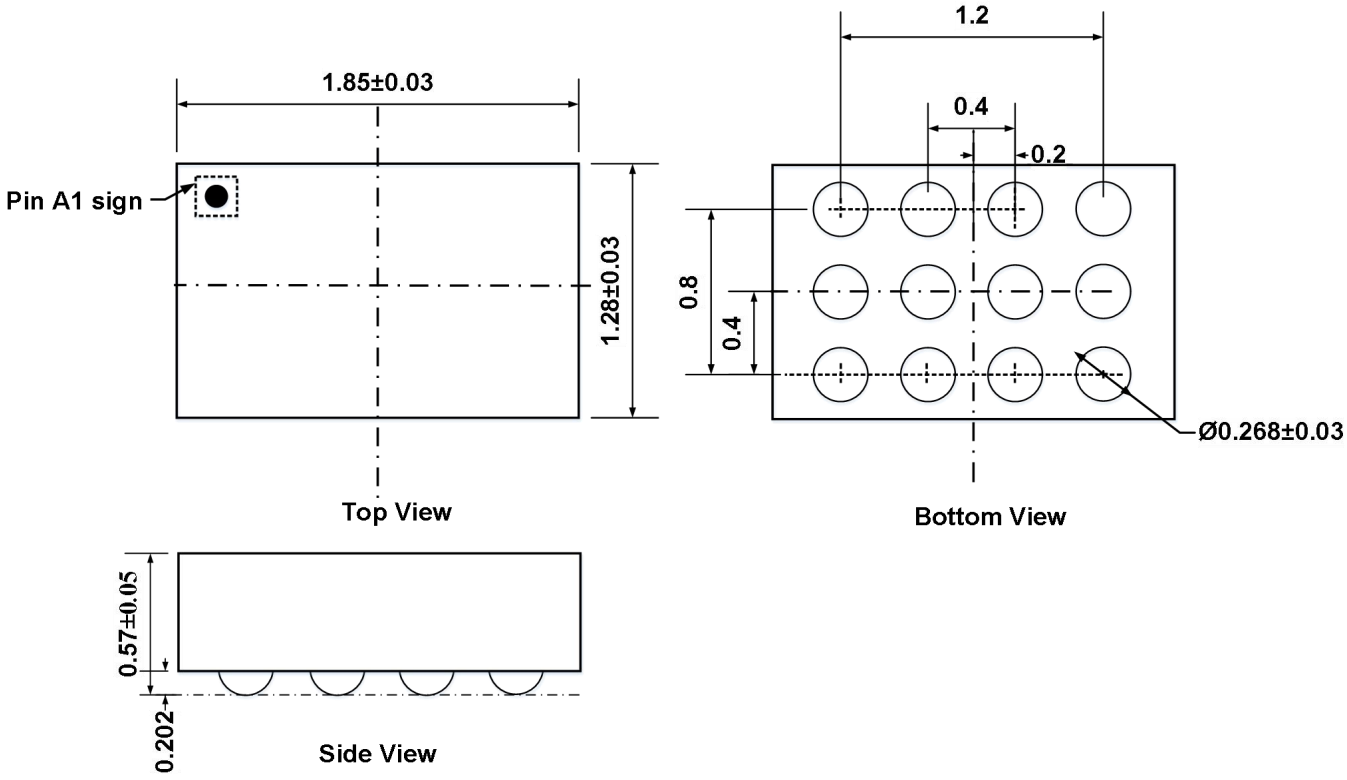
The thermal shutdown protects the die from internally or externally generated excessive temperature. During an over-temperature condition, the switch is turned off. The switch automatically turns on again if the temperature of the die drops below the threshold temperature.

■ Marking Information

WLCSP-12B

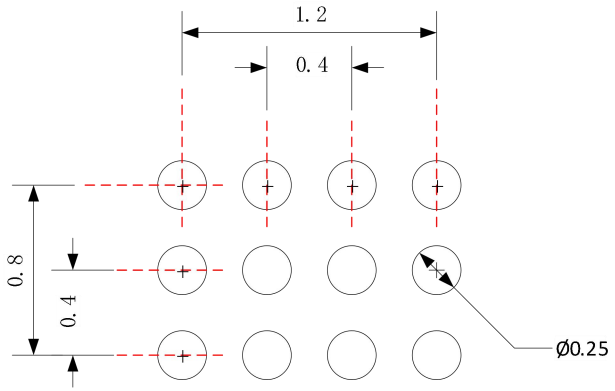


■ Package Information



NOTE: All dimensions are in millimeters.

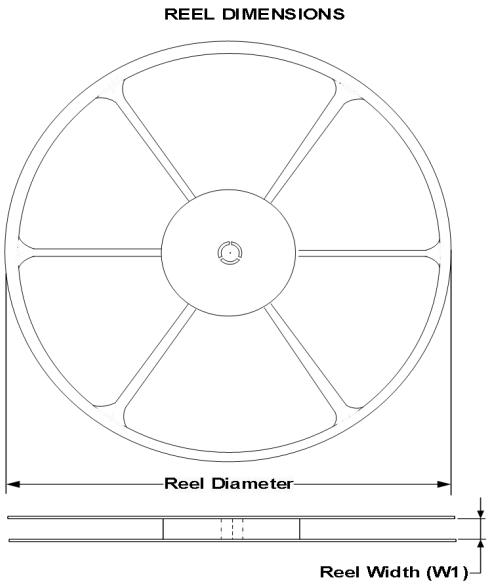
■ Recommended Land Pattern

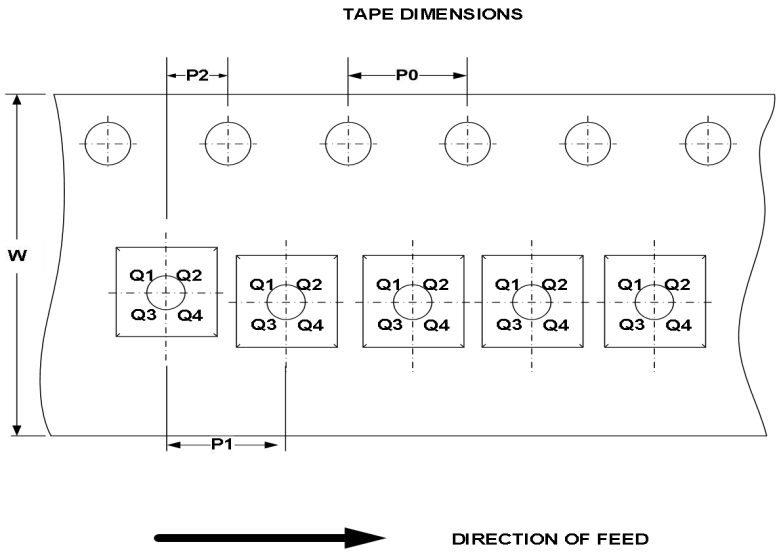


Recommended Land Pattern

■ Packing Information

WLCSP-12B





Package type	SPQ (PCS)	Reel Diameter (mm)	Reel Width W1(mm)	W (mm)	P0 (mm)	P1 (mm)	P2 (mm)	MSL	PIN A1 Quadrant
12-Ball WLCSP (WLCSP-12B)	3000	180	8.6	8	4.0	4.0	2.0	Level-1-260℃	Q1

Note: Carrier Tape Dimension, Reel Size and Packing Minimum.

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