

## DIO7290

### Ultra-Small, Low-Input Voltage, Low $r_{ON}$ Load Switch

#### Features

- Low-Input Voltage: 1.2V to 5.5V
- Ultra-Low ON-State Resistance
  - $r_{ON}=48m\Omega$  at  $V_{IN}=5.0V$
  - $r_{ON}=50m\Omega$  at  $V_{IN}=4.2V$
  - $r_{ON}=55m\Omega$  at  $V_{IN}=3.6V$
  - $r_{ON}=65m\Omega$  at  $V_{IN}=2.5V$
  - $r_{ON}=85m\Omega$  at  $V_{IN}=1.8V$
  - $r_{ON}=175m\Omega$  at  $V_{IN}=1.2V$
- DC Current Up to 2A
- Ultra-Low Quiescent Current: 67nA at 1.8V
- Ultra-Low Shutdown Current: 33nA at 1.8V
- Low Control Input Thresholds Enable Use of 1.2V/1.8V/3.6V/4.2V/5.0V Logic
- Controlled Slew Rate to Avoid Inrush Current
- Package: WLCSP-4 (0.4mm Pitch)

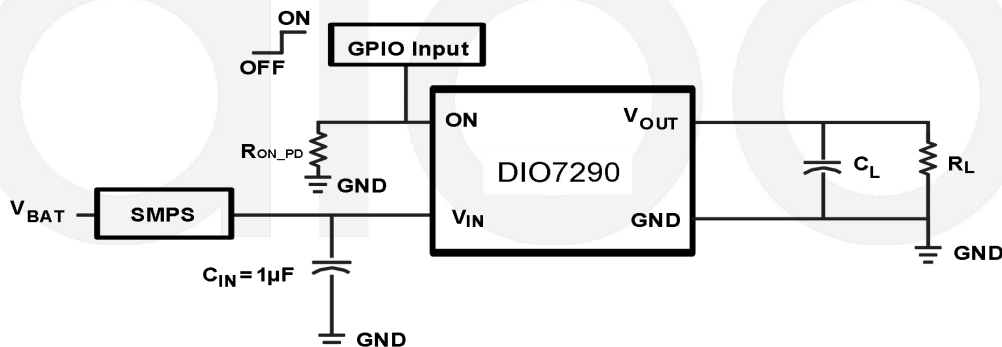
#### Descriptions

DIO7290 device is low  $R_{ON}$  MOSEFT controlled by external logic pin, allowing optimization of battery life, and portable device autonomy. It includes a P-channel MOSFET that operates over an input voltage range of 1.2V to 5.5V. An on/off input (ON) controls the switch that can interface with low voltage control signals. A 120 $\Omega$  on chip load resistor is added for output quick discharge when the switch is turned off. DIO7290 is packaged in WLCSP-4 with 0.4mm pitch. It is characterized for operation over the free-air temperature range of -40°C to 85°C.

#### Applications

- Cellular Phones
- GPS Devices
- Digital Cameras
- Peripheral Ports
- Portable Instrumentation
- RF Modules
- Personal Digital Assistants (PDAs)
- MP3 Players

#### Typical Application





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## Ordering Information

Order Part Number	Top Marking		$T_A$	Package	
DIO7290WL4	YWA	Green	-40 to 85°C	WLCSP-4	Tape & Reel, 3000

## Pin Assignment

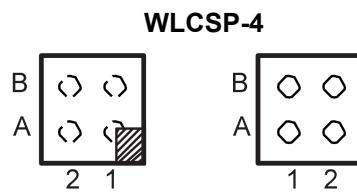


Figure 1. Top View & Bottom View

## Pin Descriptions

Name	NO.	Description
$V_{OUT}$	A1	Switch output
$V_{IN}$	A2	Switch input, bypass this input with a ceramic capacitor to ground
GND	B1	Ground
ON	B2	Switch control input, active high



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## Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Rating” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter	Rating	Unit
$V_{IN}$	Input voltage	-0.3 to 6	V
$V_{OUT}$	Output voltage	$V_{IN}+0.3$	V
$V_{ON}$	Input voltage	-0.3 to 6	V
$P_D$	Power dissipation at $T_A=25^{\circ}C$	0.48	W
$I_{MAX}$	Maximum continuous switch current	2	A
$T_A$	Operating free air temperature range	-40 to 85	$^{\circ}C$
$T_{lead}$	Maximum lead temperature (10s soldering time)	300	$^{\circ}C$
$T_{stg}$	Storage temperature	-45 to 145	$^{\circ}C$
$\theta_{JA}$	Thermal Resistance	189.1	$^{\circ}C/W$
ESD	HBM: All Pins	$\pm 4000$	V
	CDM	$\pm 2000$	
	MM	$\pm 200$	
Latch up		$\pm 400$	mA

## Recommend Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended Operating conditions are specified to ensure optimal performance to the datasheet specifications. DIOO does not Recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Rating	Unit
$V_{IN}$	Input voltage range	1.2 to 5.5	V
$V_{OUT}$	Output voltage range	$V_{IN}$	V
$C_{IN}$	Input capacitor	1	$\mu F$



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## Electrical Characteristics

$V_{IN}=1.2V$  to  $5.5V$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$ , unless otherwise specified.

Symbol	Parameter	Conditions	$T_A$	Min.	Typ.	Max.	Unit			
$I_{IN}$	Quiescent current	$I_{OUT}=0$ , $V_{IN}=V_{ON}$	$V_{IN}=1.2V$	25°C	31		nA			
				Full		43				
			$V_{IN}=1.8V$	25°C	67		nA			
				Full		90				
			$V_{IN}=3.6V$	25°C	176		nA			
				Full		270				
			$V_{IN}=4.2V$	25°C	210		nA			
				Full		300				
			$V_{IN}=5.0V$	25°C	260		nA			
				Full		350				
			$I_{IN(OFF)}$	OFF-state supply current	$V_{ON}=GND$ , $OUT=Open$	$V_{IN}=1.2V$	25°C	17		nA
							Full		200	
$V_{IN}=1.8V$	25°C	34					nA			
	Full					291				
$V_{IN}=3.6V$	25°C	87					nA			
	Full					600				
$V_{IN}=4.2V$	25°C	105					nA			
	Full					900				
$V_{IN}=5.0V$	25°C	138					nA			
	Full					1000				
$I_{IN(LEAKAGE)}$	OFF-state switch current	$V_{ON}=GND$ , $V_{OUT}=0$				$V_{IN}=1.2V$	25°C	17		nA
							Full		200	
			$V_{IN}=1.8V$	25°C	33		nA			
				Full		291				
			$V_{IN}=3.6V$	25°C	87		nA			
				Full		600				
			$V_{IN}=4.2V$	25°C	105		nA			
				Full		900				
			$V_{IN}=5.0V$	25°C	138		nA			
				Full		1000				
			$R_{ON}$	ON-state resistance	$I_{OUT}=-200mA$	$V_{IN}=5.0V$	25°C	48		mΩ
							Full		65	
$V_{IN}=4.2V$	25°C	50					mΩ			
	Full					70				
$V_{IN}=3.6V$	25°C	55					mΩ			
	Full					75				
$V_{IN}=2.5V$	25°C	65					mΩ			
	Full					80				



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			$V_{IN}=1.8V$	25°C		85		
				Full			100	
			$V_{IN}=1.2V$	25°C		175		
				Full			195	
$R_{ON\_PD}$	ON pull down resistance	$V_{ON}=1.2V$ to 3.6V or GND				6		MΩ
$R_{PD}$	Output pull down resistance	$V_{IN}=3.3V$ , $V_{ON}=0$ , $I_{OUT}=30mA$		25°C		95	120	Ω
$V_{IH}$	High level input voltage, ON	$V_{IN}=1.2V$ to 5.5V			1.0			V
$V_{IL}$	Low level input voltage, ON	$V_{IN}=1.2V$ to 5.5V					0.5	V

Specifications subject to change without notice.

## Switching Characteristics

$R_{L\_CHIP}=120\Omega$ ,  $T_A = 25^\circ C$ , unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b><math>V_{IN}=1.2V</math></b>						
$t_{ON}$	Turn on time	$R_L=500\Omega$	$C_L=0.1\mu F$		622	μs
			$C_L=1\mu F$		675	
			$C_L=3.3\mu F$		743	
$t_{OFF}$	Turn off time	$R_L=500\Omega$	$C_L=0.1\mu F$		16	μs
			$C_L=1\mu F$		88	
			$C_L=3.3\mu F$		267	
$t_r$	$V_{OUT}$ rise time	$R_L=500\Omega$	$C_L=0.1\mu F$		465	μs
			$C_L=1\mu F$		449	
			$C_L=3.3\mu F$		493	
$t_f$	$V_{OUT}$ fall time	$R_L=500\Omega$	$C_L=0.1\mu F$		27	μs
			$C_L=1\mu F$		248	
			$C_L=3.3\mu F$		942	
<b><math>V_{IN}=1.8V</math></b>						
$t_{ON}$	Turn on time	$R_L=500\Omega$	$C_L=0.1\mu F$		399	μs
			$C_L=1\mu F$		431	
			$C_L=3.3\mu F$		470	
$t_{OFF}$	Turn off time	$R_L=500\Omega$	$C_L=0.1\mu F$		10	μs
			$C_L=1\mu F$		64	
			$C_L=3.3\mu F$		166	



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$t_r$	$V_{OUT}$ rise time	$R_L=500\Omega$	$C_L=0.1\mu F$	322	$\mu s$
			$C_L=1\mu F$	314	
			$C_L=3.3\mu F$	330	
$t_f$	$V_{OUT}$ fall time	$R_L=500\Omega$	$C_L=0.1\mu F$	22	$\mu s$
			$C_L=1\mu F$	214	
			$C_L=3.3\mu F$	719	
<b><math>V_{IN}=2.5V</math></b>					
$t_{ON}$	Turn on time	$R_L=500\Omega$	$C_L=0.1\mu F$	301	$\mu s$
			$C_L=1\mu F$	324	
			$C_L=3.3\mu F$	348	
$t_{OFF}$	Turn off time	$R_L=500\Omega$	$C_L=0.1\mu F$	10	$\mu s$
			$C_L=1\mu F$	58	
			$C_L=3.3\mu F$	134	
$t_r$	$V_{OUT}$ rise time	$R_L=500\Omega$	$C_L=0.1\mu F$	265	$\mu s$
			$C_L=1\mu F$	256	
			$C_L=3.3\mu F$	260	
$t_f$	$V_{OUT}$ fall time	$R_L=500\Omega$	$C_L=0.1\mu F$	22	$\mu s$
			$C_L=1\mu F$	217	
			$C_L=3.3\mu F$	617	
<b><math>V_{IN}=3.0V</math></b>					
$t_{ON}$	Turn on time	$R_L=500\Omega$	$C_L=0.1\mu F$	261	$\mu s$
			$C_L=1\mu F$	278	
			$C_L=3.3\mu F$	298	
$t_{OFF}$	Turn off time	$R_L=500\Omega$	$C_L=0.1\mu F$	9	$\mu s$
			$C_L=1\mu F$	58	
			$C_L=3.3\mu F$	114	
$t_r$	$V_{OUT}$ rise time	$R_L=500\Omega$	$C_L=0.1\mu F$	245	$\mu s$
			$C_L=1\mu F$	241	
			$C_L=3.3\mu F$	239	
$t_f$	$V_{OUT}$ fall time	$R_L=500\Omega$	$C_L=0.1\mu F$	21	$\mu s$
			$C_L=1\mu F$	213	
			$C_L=3.3\mu F$	604	
<b><math>V_{IN}=3.6V</math></b>					
$t_{ON}$	Turn on time	$R_L=500\Omega$	$C_L=0.1\mu F$	233	$\mu s$
			$C_L=1\mu F$	244	
			$C_L=3.3\mu F$	262	



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$t_{OFF}$	Turn off time	$R_L=500\Omega$	$C_L=0.1\mu F$	9	$\mu s$
			$C_L=1\mu F$	55	
			$C_L=3.3\mu F$	99	
$t_r$	$V_{OUT}$ rise time	$R_L=500\Omega$	$C_L=0.1\mu F$	229	$\mu s$
			$C_L=1\mu F$	226	
			$C_L=3.3\mu F$	221	
$t_f$	$V_{OUT}$ fall time	$R_L=500\Omega$	$C_L=0.1\mu F$	21	$\mu s$
			$C_L=1\mu F$	210	
			$C_L=3.3\mu F$	563	
<b><math>V_{IN}=4.2V</math></b>					
$t_{ON}$	Turn on time	$R_L=500\Omega$	$C_L=0.1\mu F$	219	$\mu s$
			$C_L=1\mu F$	230	
			$C_L=3.3\mu F$	238	
$t_{OFF}$	Turn off time	$R_L=500\Omega$	$C_L=0.1\mu F$	9	$\mu s$
			$C_L=1\mu F$	56	
			$C_L=3.3\mu F$	85	
$t_r$	$V_{OUT}$ rise time	$R_L=500\Omega$	$C_L=0.1\mu F$	219	$\mu s$
			$C_L=1\mu F$	211	
			$C_L=3.3\mu F$	207	
$t_f$	$V_{OUT}$ fall time	$R_L=500\Omega$	$C_L=0.1\mu F$	21	$\mu s$
			$C_L=1\mu F$	210	
			$C_L=3.3\mu F$	499	
<b><math>V_{IN}=5.0V</math></b>					
$t_{ON}$	Turn on time	$R_L=500\Omega$	$C_L=0.1\mu F$	193	$\mu s$
			$C_L=1\mu F$	202	
			$C_L=3.3\mu F$	209	
$t_{OFF}$	Turn off time	$R_L=500\Omega$	$C_L=0.1\mu F$	8	$\mu s$
			$C_L=1\mu F$	48	
			$C_L=3.3\mu F$	69	
$t_r$	$V_{OUT}$ rise time	$R_L=500\Omega$	$C_L=0.1\mu F$	209	$\mu s$
			$C_L=1\mu F$	205	
			$C_L=3.3\mu F$	197	
$t_f$	$V_{OUT}$ fall time	$R_L=500\Omega$	$C_L=0.1\mu F$	20	$\mu s$
			$C_L=1\mu F$	202	
			$C_L=3.3\mu F$	465	

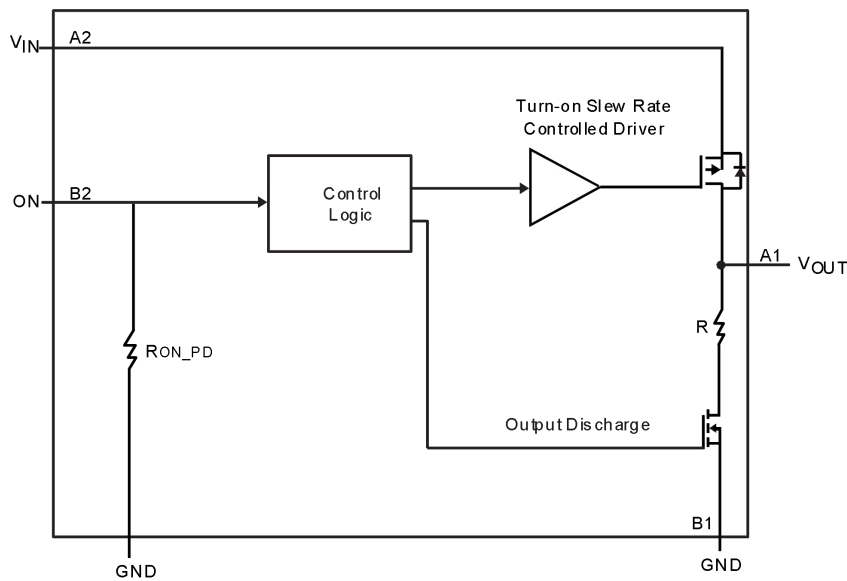
Specifications subject to change without notice.

## Detailed Description

### Overview

DIO7290 is a low ON-state resistance ( $r_{ON}$ ) load switch with controlled turn on. It contains a P-channel MOSFET and can be turned on with a range of battery from 1.2V to 5.5V. An on/off input (ON) controls the switch, which can interface with low-voltage control signals. A 120Ω on-chip load resistor is added for output quick discharge when the switch is turned off.

### Functional Block Diagram



**Figure 2. Block Diagram**

### Feature Description

#### ON/OFF Control

The state of the switch is controlled by the ON pin. When there is no fault, activating ON can let the switch to be in the on state. ON is active HI and has a low threshold making it capable of interfacing with low-voltage signals. The ON pin is compatible with standard GPIO logic threshold. It can be used with any microcontroller with 1.2V, 1.8V, 2.5V, 3.3V GPIOs.

#### Device Functional Modes

Table 1 lists the functional modes of the DIO7290.

**Table 1. Function Table**

ON (Control Input)	$V_{IN}$ to $V_{OUT}$	$V_{OUT}$ to GND
L	OFF	ON
H	ON	OFF



## Application and Implementation

### Application Information

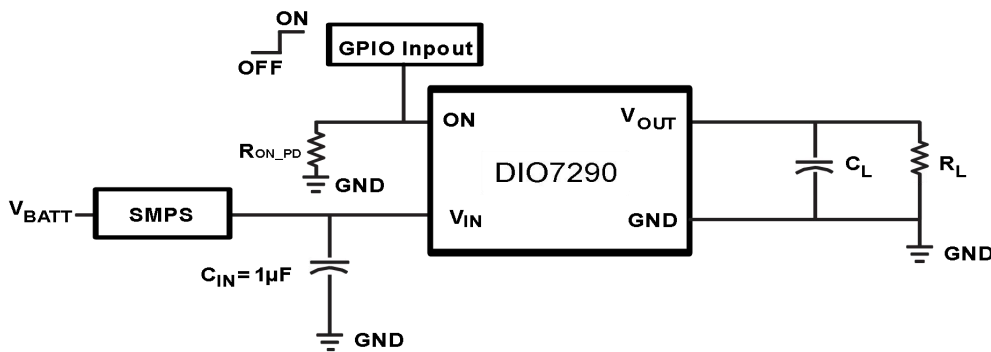
#### Input Capacitor

When the switch turns on into a discharged load capacitor or short-circuit, a capacitor needs to be placed between  $V_{IN}$  and GND to limit the voltage drop on the input supply caused by transient in-rush currents. A  $1\mu\text{F}$  ceramic capacitor,  $C_{IN}$ , placed close to the pins is usually sufficient.  $C_{IN}$ 's higher values can be used to further reduce the voltage drop during high current application. It is recommended to have an input capacitor approximately 10 times higher than the output capacitor to avoid excessive voltage drop when switching heavy loads.

#### Output Capacitor

A  $C_{IN}$  greater than  $C_L$  is highly recommended when the integral body diode in the PMOS switch. When the system supply is removed, a  $C_L$  greater than  $C_{IN}$  can cause  $V_{OUT}$  to exceed  $V_{IN}$ . This could result in current flow through the body diode from  $V_{OUT}$  to  $V_{IN}$ .

#### Typical Application



Note: SMPS: Switched mode power supply

**Figure 3. Powering a Downstream Module**

### Design Requirements

Table 2 lists the design parameters for the DIO7290 device.

**Table 2. Design Parameters**

Design Parameter	Example Value
$V_{IN}$	1.8V
Load Current	0.3A
Ambient Temperature	25°C



## DIO7290

### Detailed Design Procedure

#### $V_{IN}$ to $V_{OUT}$ Voltage Drop

The voltage drop from  $V_{IN}$  to  $V_{OUT}$  is determined by the ON-resistance of the device and the load current. The  $r_{ON}$  can be found in Electrical Characteristics and is dependent on temperature. When the value of  $r_{ON}$  is found, Equation 1 can be used to calculate the voltage drop across the device:

$$\Delta V = I_{LOAD} \times r_{ON} \quad (1)$$

Where

- $\Delta V$ = Voltage drop across the device
- $I_{LOAD}$ = Load current
- $r_{ON}$ = ON-resistance of the device

At  $V_{IN}=1.8V$ , the DIO7290 has a  $r_{ON}$  value of  $85m\Omega$ . Using this value and the defined load current, the above equation can be evaluated:

$$\Delta V = 0.30 A \times 85 m\Omega \quad (2)$$

Where,

$$\Delta V = 25.5 mV$$

Therefore, the voltage drop across the device will be 25.5mV.

### Power Supply Recommendations

The DIO7290 is designed to operate with a  $V_{IN}$  range of 1.2V to 5.5V. This supply must be well regulated and placed as close to the device terminals as possible. It must also be able to withstand all transient and load currents, using a recommended input capacitance of  $1\mu F$  if necessary. If the supply is more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of  $10\mu F$  may be sufficient.

### Layout

#### Layout Guidelines

All traces should be as short as possible for best performance. To be most effective, the input and output capacitors should be placed close to the DIO7290 to minimize the effects that parasitic trace inductances may have on normal and short circuit operation. Using wide traces for  $V_{IN}$ ,  $V_{OUT}$ , and GND helps minimize the parasitic electrical effects along with minimizing the case to ambient thermal impedance.

## Layout Example

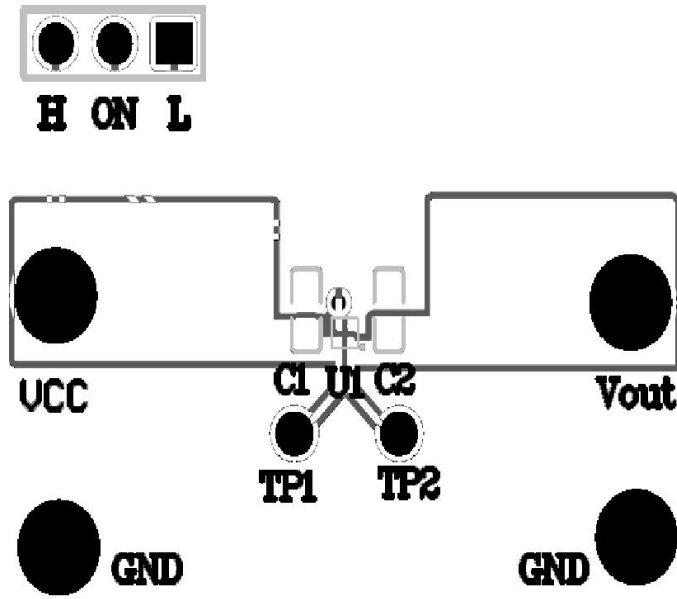
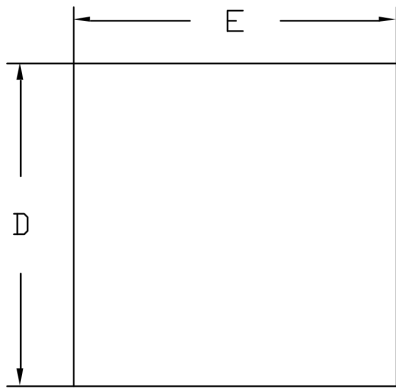
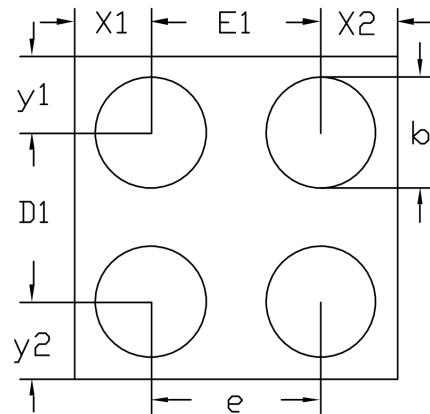


Figure 4. Recommended Board Layout

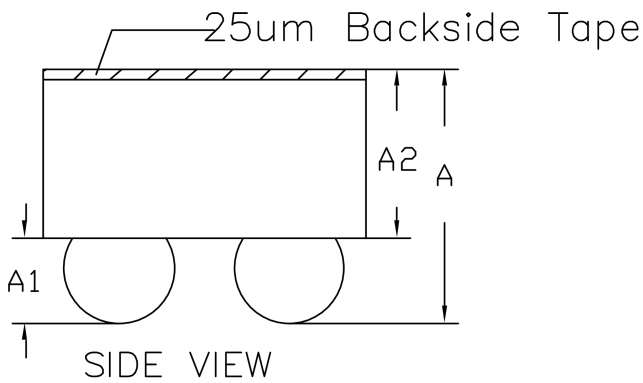
## Physical Dimensions: WLCSP-4



TOP VIEW  
(MARK SIDE)



BOTTOM VIEW  
(BALL SIDE)



COMMON DIMENSIONS (UNITS OF MEASURE=MILLIMETER)			
Symbol	MIN	NOM	MAX
A	0.475	0.500	0.525
A1	0.180	0.200	0.220
A2	0.275	0.300	0.325
D	0.730	0.760	0.790
D1	0.400 BSC		
E	0.730	0.760	0.790
E1	0.400 BSC		
b	0.240	0.260	0.280
e	0.400 BSC		
x1	0.180 REF		
x2	0.180 REF		
y1	0.180 REF		
y2	0.180 REF		



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### CONTACT US

Dioo is a professional design and sales corporation for high-quality and performance analog semiconductors. The company focuses on industry markets, such as, cell phone, handheld products, laptop, and medical equipment and so on. Dioo's product families include analog signal processing and amplifying, LED drivers and charger IC. Go to <http://www.dioo.com> for a complete list of Dioo product families.

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