Rev 1.0

DIO7290B

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}=48mΩ at V_{IN}=5.0V
  - r_{ON}=50mΩ at V_{IN}=4.2V
  - r_{ON}=55mΩ at V_{IN}=3.6V
  - r_{ON}=65mΩ at V_{IN}=2.5V
  - r_{ON}=85mΩ at V_{IN}=1.8V
  - r_{ON}=175mΩ at V_{IN}=1.2V
- DC Current Up to 1.5A
- 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)

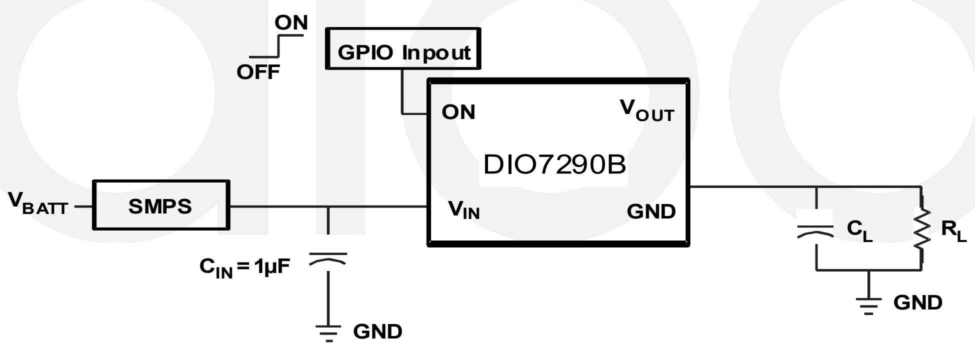
Descriptions

DIO7290B 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 120Ω on chip load resistor is added for output quick discharge when the switch is turned off. DIO7290B 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	
DIO7290BWL4	YWB	Green	-40 to 85°C	WLCSP-4	Tape & Reel, 3000

Pin Assignment

WLCSP-4

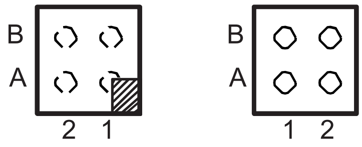

Figure 1. Top View & Bottom View

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°C	0.48	W
I_{MAX}	Maximum continuous switch current	2	A
T_A	Operating free air temperature range	-40 to 85	°C
T_{lead}	Maximum lead temperature (10s soldering time)	300	°C
T_{stg}	Storage temperature	-45 to 145	°C
θ_{JA}	Thermal Resistance	189.1	°C/W
ESD	HBM: All Pins	±4000	V
	CDM	±2000	
	MM	±200	
Latch up		±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	μF

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Electrical Characteristics

V_{IN}=1.2V to 5.5V, T_A = -40°C to 85°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		
				Full			90	
			V_{IN}=3.6V	25°C		176		
				Full			270	
			V_{IN}=4.2V	25°C		210		
				Full			300	
			V_{IN}=5.0V	25°C		260		
				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		
				Full			291	
			V_{IN}=3.6V	25°C		87		
				Full			600	
			V_{IN}=4.2V	25°C		105		
				Full			900	
			V_{IN}=5.0V	25°C		138		
				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		
				Full			291	
			V_{IN}=3.6V	25°C		87		
				Full			600	
			V_{IN}=4.2V	25°C		105		
				Full			900	
			V_{IN}=5.0V	25°C		138		
				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		
				Full			70	
			V_{IN}=3.6V	25°C		55		
				Full			75	
			V_{IN}=2.5V	25°C		65		
				Full			80	

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			V_{IN}=1.8V	25°C		85		
				Full			100	
			V_{IN}=1.2V	25°C		175		
				Full			180	
R_{PD}	Output pull down resistance	V_{IN}=3.3V, V_{ON}=0, I_{OUT}=30mA		25°C		95	120	Ω
I_{ON}	ON input leakage current	V_{ON}=1.2V to 5.5V or GND		Full			48	nA
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}=120Ω, T_A = 25°C, unless otherwise specified.

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

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

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t_{OFF}	Turn off time	R_L=500Ω	C_L=0.1μF		9		μs
			C_L=1μF		55		
			C_L=3.3μF		99		
t_r	V_{OUT} rise time	R_L=500Ω	C_L=0.1μF		229		μs
			C_L=1μF		226		
			C_L=3.3μF		221		
t_f	V_{OUT} fall time	R_L=500Ω	C_L=0.1μF		21		μs
			C_L=1μF		210		
			C_L=3.3μF		563		
V_{IN}=4.2V							
t_{ON}	Turn on time	R_L=500Ω	C_L=0.1μF		219		μs
			C_L=1μF		230		
			C_L=3.3μF		238		
t_{OFF}	Turn off time	R_L=500Ω	C_L=0.1μF		9		μs
			C_L=1μF		56		
			C_L=3.3μF		85		
t_r	V_{OUT} rise time	R_L=500Ω	C_L=0.1μF		219		μs
			C_L=1μF		211		
			C_L=3.3μF		207		
t_f	V_{OUT} fall time	R_L=500Ω	C_L=0.1μF		21		μs
			C_L=1μF		210		
			C_L=3.3μF		499		
V_{IN}=5.0V							
t_{ON}	Turn on time	R_L=500Ω	C_L=0.1μF		193		μs
			C_L=1μF		202		
			C_L=3.3μF		209		
t_{OFF}	Turn off time	R_L=500Ω	C_L=0.1μF		8		μs
			C_L=1μF		48		
			C_L=3.3μF		69		
t_r	V_{OUT} rise time	R_L=500Ω	C_L=0.1μF		209		μs
			C_L=1μF		205		
			C_L=3.3μF		197		
t_f	V_{OUT} fall time	R_L=500Ω	C_L=0.1μF		20		μs
			C_L=1μF		202		
			C_L=3.3μF		465		

Specifications subject to change without notice.

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Detailed Description

Overview

DIO7290B 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

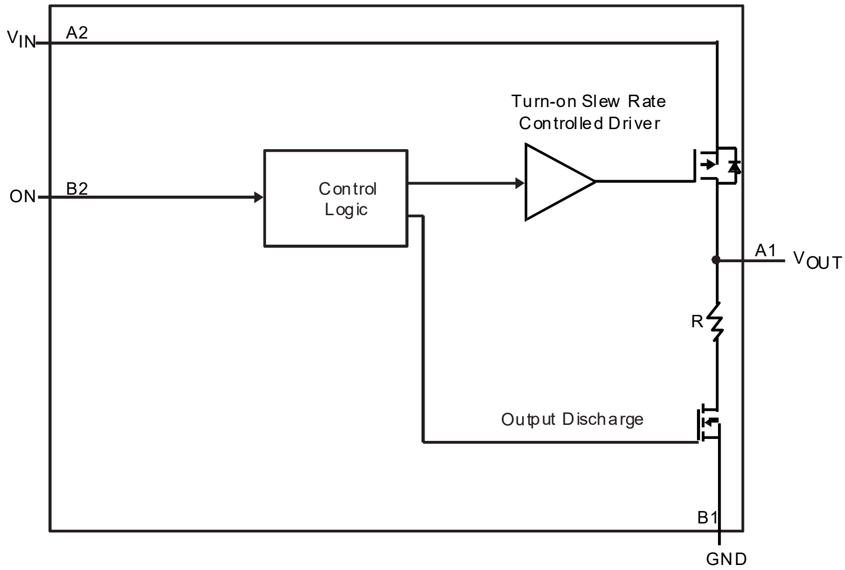

Figure 2. Block Diagram

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 DIO7290B.

Table 1. Function Table

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

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Application and Implementation

Application Information

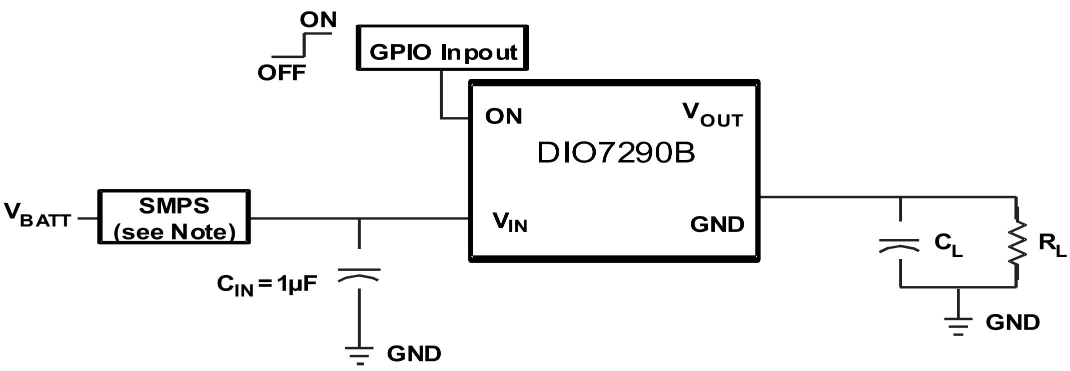
Input Capacitor

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 1μF ceramic capacitor, C_{IN}, place 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: Switched mode power supply

Figure 3. Powering a Downstream Module

Design Requirements

Table 2 lists the design parameters for the DIO7290B device.

Table 2. Design Parameters

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

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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

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

At V_{IN}=1.8V, the DIO7290B has a r_{ON} value of 85mΩ. 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 DIO7290B 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 1μF 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 10μF 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 DIO7290B 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.

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Layout Example

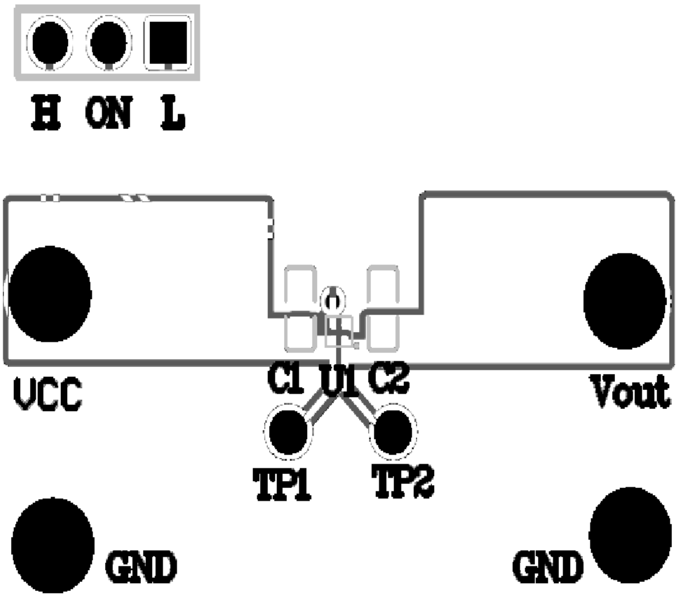

Figure 4. Recommended Board Layout

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