WP2101

Ultra-Small Load Switch with Slew Rate Control

1. General Description

The WP2101 is a single channel P-channel MOSFET load switch with output slew rate control, which limits inrush currents during turn on to protect downstream devices. This switch operates with wide inputs ranging from 1.2V to 5.5V.

In addition, the WP2101 has QOD function which can prevent the output from floating. There is a Reverse Current Block (RCB) function for WP2101-AC04R, WP2101-BC04R, WP2101-AZER and WP2101-BZER.

The WP2101 series have 4 versions（A/B/C/D）according to EN high active or low active and reverse block function is or not.

The WP2101 is available in Pb-free packages and is characterized for operation over the free-air temperature range of - 40℃ to 85℃.

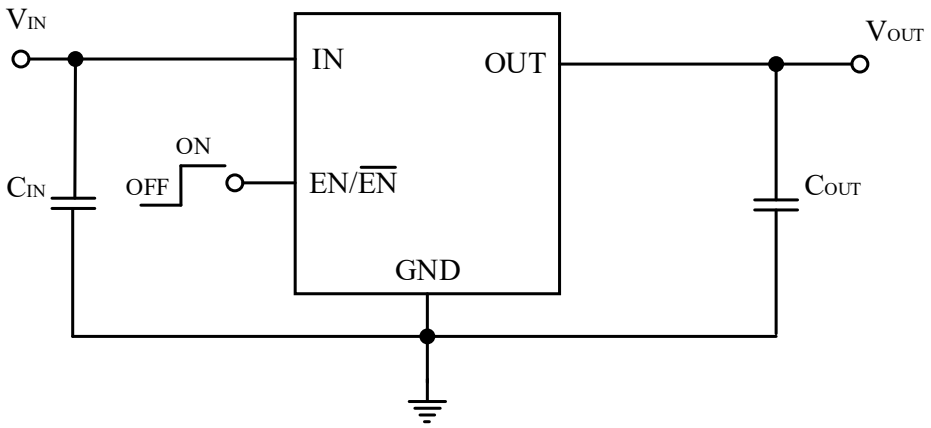
2. Features

- Input Voltage Range: 1.2V to 5.5V
- $R_{DS(ON)}$ =50mΩ(Typ.) @V_{IN}=5.5V
- Built-in Slew Rate Control
- Ultra-low shutdown current
- Quick Output Discharge (QOD)
- 2A Maximum Continuous Switch Current
- Reverse Current Block
- 4kV ESD Rating
- Package: WLCSP4, PLDFN0909-4L

3. Applications

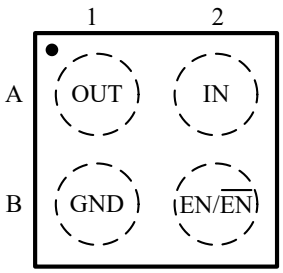
- Smartphones and Tablets
- Portable Devices
- Wearables

4. Typical Application

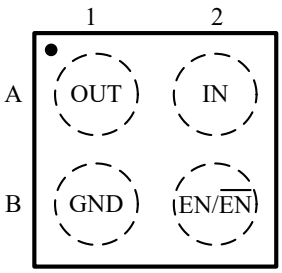


5. Pin Configuration

(Top View)



WLCSP4



PLDFN0909-4L

6. Pin Description

PIN NUMBER	PIN NAME	I/O	PIN FUNCTION
A1	OUT	O	Switch output.
A2	IN	I	Switch input.
B1	GND		Ground.
B2	EN/$\overline{EN}$	I	Enable input. Active High for A/C Version, Active Low for B/D Version.

7. Production Modes

PART NUMBER	EN ACTIVITY	QOD	RCB
WP2101-AC04R	Active High	Y	Y
WP2101-BC04R	Active Low	Y	Y
WP2101-CC04R	Active High	Y	N
WP2101-DC04R	Active Low	Y	N
WP2101-AZER	Active High	Y	Y
WP2101-BZER	Active Low	Y	Y
WP2101-CZER	Active High	Y	N
WP2101-DZER	Active Low	Y	N

8. Absolute Maximum Ratings [1]

T_A=25℃, unless otherwise noted.

SYMBOL	PARAMETER	RATING	UNIT
V_{IN}	IN Voltage	-0.3 to 6.0	V
V_{EN}	EN/$\overline{EN}$ Voltage	-0.3 to 6.0	V
V_{OUT}	OUT Voltage	-0.3 to 6.0	V
I_{OUT}	Maximum Continuous Switch Current for V_{IN}≥2V [2]	2	A
$R_{\theta JA}$	Junction-to-ambient Thermal Resistance	155	℃/W
$R_{\theta JB}$	Junction-to-board Thermal Resistance	86	℃/W
$R_{\theta JC(top)}$	Junction-to-case(top) Thermal Resistance	12	℃/W
$R_{\theta JC(bot)}$	Junction-to-case(bottom) Thermal Resistance	13	℃/W
$T_{J(MAX)}$	Junction Temperature	150	℃
T_{STG}	Storage Temperature	-65 to 150	℃
T_{SDR}	Lead Temperature (Soldering, 10 sec)	260	℃
V_{ESD}	ESD(HBM)	4000	V

Note1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Note2: Limited by thermal design.

9. Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{IN}	Input Voltage	1.2	5.5	V
V_{EN}	EN Input Voltage	0	5.5	V
T_A	Operating Ambient Temperature	-40	85	℃

10. Electrical Characteristics [3]

(V_{IN} = 3.3 V, C_{IN}=1μF, C_{OUT}=1μF, T_A=25°C, unless otherwise noted)

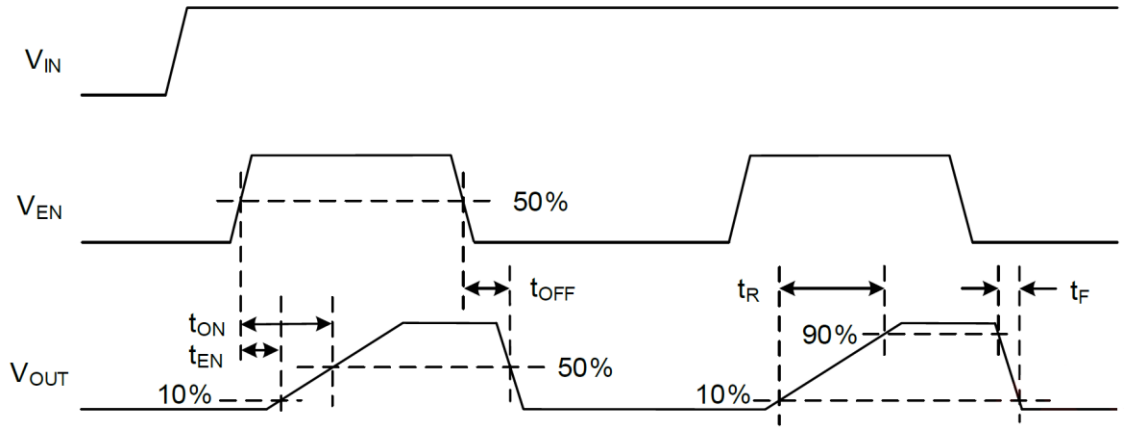
SYMBOL	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
I_{SHDN}	Shutdown Quiescent Current	Disabled, V_{IN}=1.2V, OUT floating			3	18	nA
		Disabled, V_{IN}=1.8V, OUT floating			5	20	
		Disabled, V_{IN}=3.3V, OUT floating			8	45	
		Disabled, V_{IN}=4.5V, OUT floating			10	65	
		Disabled, V_{IN}=5.5V, OUT floating			20	95	
I_Q	Quiescent Current	A	Enabled, V_{IN}=3.3V, OUT floating		280		nA
			Enabled, V_{IN}=5.5V, OUT floating		480		
		B	Enabled, V_{IN}=3.3V, OUT floating		560		
			Enabled, V_{IN}=5.5V, OUT floating		1000		
		C	Enabled, V_{IN}=3.3V, OUT floating		2	70	
			Enabled, V_{IN}=5.5V, OUT floating		5	90	
		D	Enabled, V_{IN}=3.3V, OUT floating		330		
			Enabled, V_{IN}=5.5V, OUT floating		550		
$R_{DS(ON)}$	Switch On-resistance	V_{IN}=1.2V, I_{OUT}=0.2A			225	260	mΩ
		V_{IN}=1.8V, I_{OUT}=0.2A			100	140	
		V_{IN}=3.3V, I_{OUT}=0.2A			70	90	
		V_{IN}=5.5V, I_{OUT}=0.2A			50	70	
I_{LEAKEN}	EN Input leakage	V_{IN} =0V, V_{EN}=5V		-1000	460	1000	nA

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IH}	EN Input Logic High Voltage		1.2			V
V_{IL}	EN Input Logic Low Voltage				0.4	V
R_{EN}	EN Pin Resistor			12.4		MΩ
R_{DIS}	OUT Discharge Resistor	Disabled, V_{IN} =3.3V, I_{SINK}=2mA		90		Ω
t_R	OUT Rise Time	V_{IN} =3.3V, C_{OUT}=1μF, R_{LOAD}=30Ω		900		μs
t_F	OUT Fall Time	V_{IN} =3.3V, C_{OUT}=1μF, R_{LOAD} =30Ω		55		μs
t_{ON}	OUT Turn-on Time	V_{IN} =3.3V, C_{OUT}=1μF, R_{LOAD} =30Ω		1100		μs
t_{OFF}	OUT Turn-off Time	V_{IN} =3.3V, C_{OUT}=1μF, R_{LOAD} =30Ω		20		μs
t_{EN}	Enable Time	V_{IN} =3.3V, C_{OUT}=1μF, R_{LOAD} =30Ω		700		μs
Reverse Current Block (Only for WP2101-A/B Version)						
V_{REV}	Reverse Current Voltage Threshold	V_{IN} =3.3V, C_{OUT}=1μF,		60		mV
V_{REV_HYS}	Reverse Current Voltage Hysteresis	V_{IN} =3.3V, C_{OUT}=1μF,		36		mV
$I_{REV-ACT}$ [4]	Reverse Activation Current	V_{IN} =3.3V, C_{OUT}=1μF, V_{OUT} > V_{IN}		0.8		A
I_{RCB}	Reverse Block Leakage	V_{OUT} - V_{IN} > V_{REV}		0.2		μA

Note3: Limits over full temperature are guaranteed by design, but not tested in production.

Note4: Guaranteed by design.

11. Timing Diagram



12. Typical Performance Characteristics

(C_{IN}=1μF, C_{OUT}=1μF, T_A=25°C, unless otherwise noted)

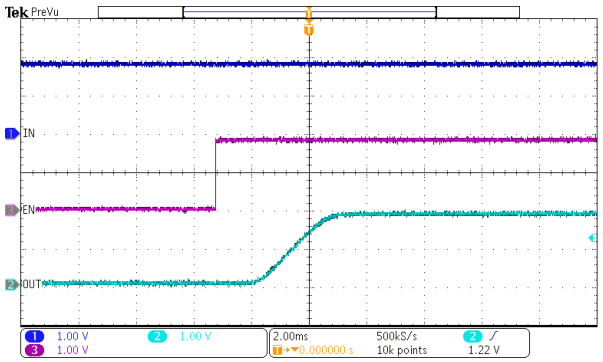


Figure 1. Turn On Response
(V_{IN}=1.8V, C_{IN}=1μF, C_{OUT}=1μF, R_{LOAD}=30Ω)

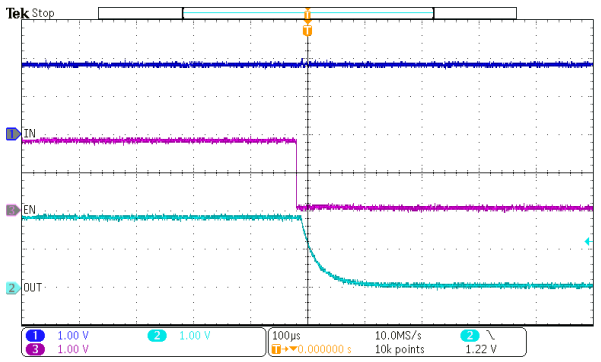


Figure 2. Turn Off Response
(V_{IN}=1.8V, C_{IN}=1μF, C_{OUT}=1μF, R_{LOAD}=30Ω)

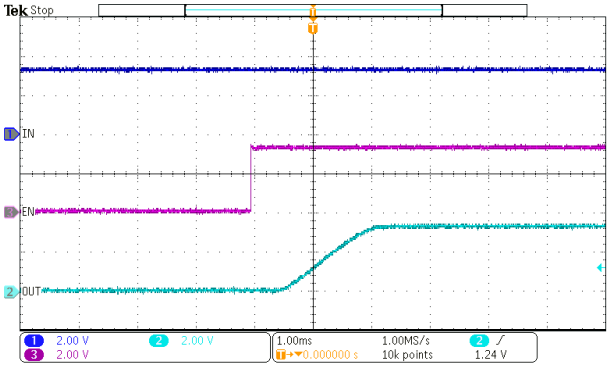


Figure 3. Turn On Response
(V_{IN}=3.3V, C_{IN}=1μF, C_{OUT}=1μF, R_{LOAD}=30Ω)

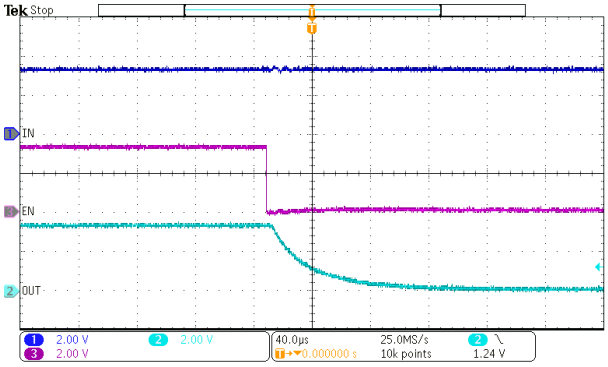


Figure 4. Turn Off Response
(V_{IN}=3.3V, C_{IN}=1μF, C_{OUT}=1μF, R_{LOAD}=30Ω)

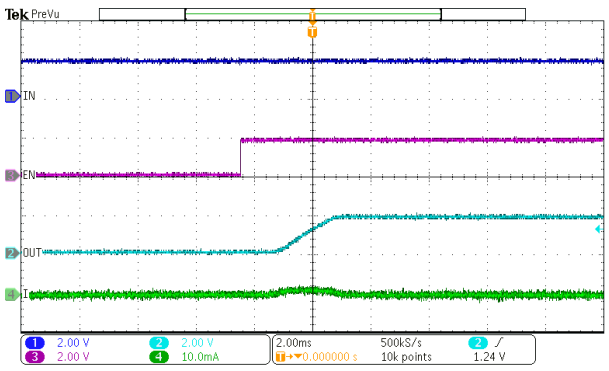


Figure 5. Inrush Current
(V_{IN}=1.8V, C_{IN}=1μF, C_{OUT}=1μF, no R_{LOAD})

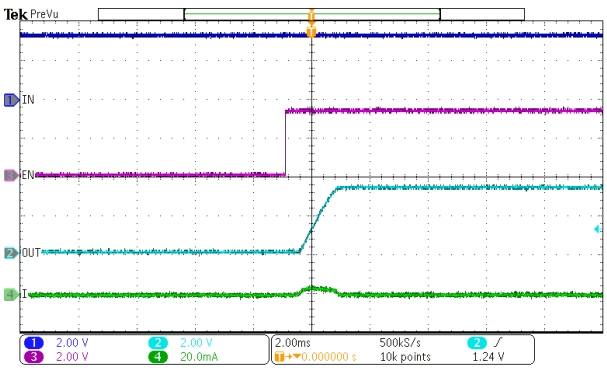


Figure 6. Inrush Current
(V_{IN}=3.3V, C_{IN}=1μF, C_{OUT}=1μF, no R_{LOAD})

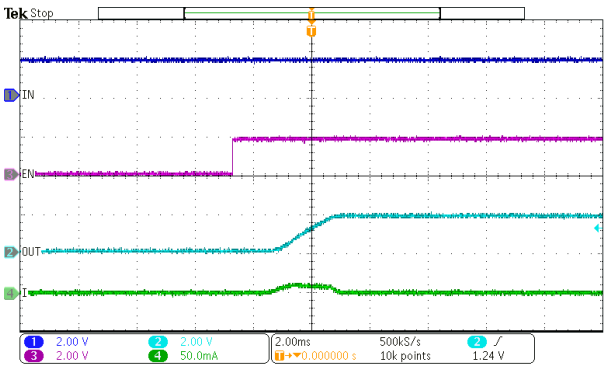


Figure 7. Inrush Current
(V_{IN}=1.8V, C_{IN}=1μF, C_{OUT}=10μF, no R_{LOAD})

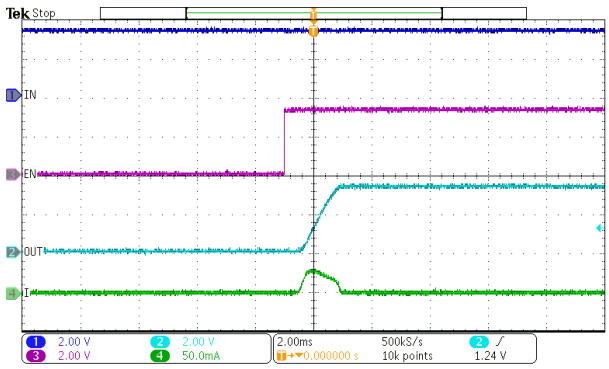


Figure 8. Inrush Current
(V_{IN}=3.3V, C_{IN}=1μF, C_{OUT}=10μF, no R_{LOAD})

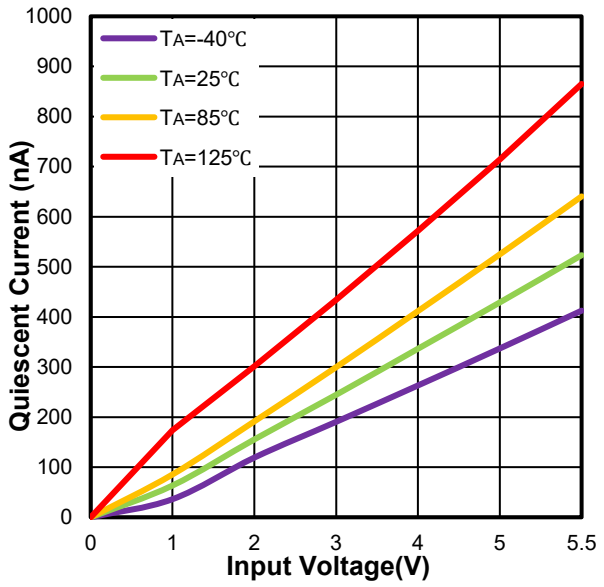


Figure 9. Quiescent Current vs. Input Voltage vs. Ambient Temperature (WP2101-AC04R)

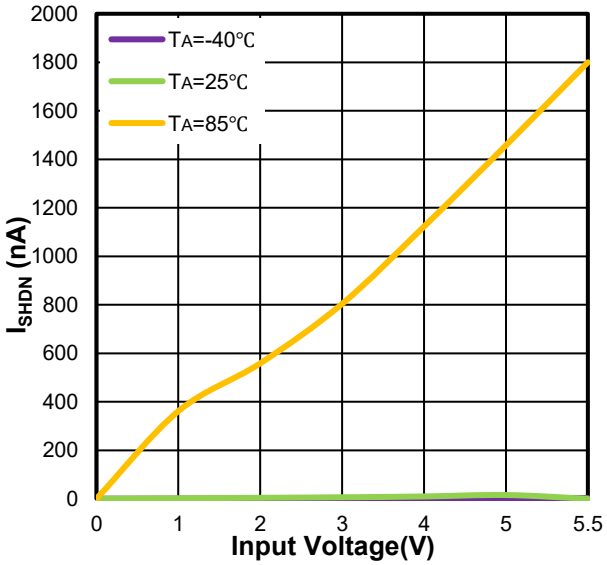


Figure 10. Shutdown Quiescent Current vs. Input Voltage vs. Ambient Temperature (WP2101-AC04R)

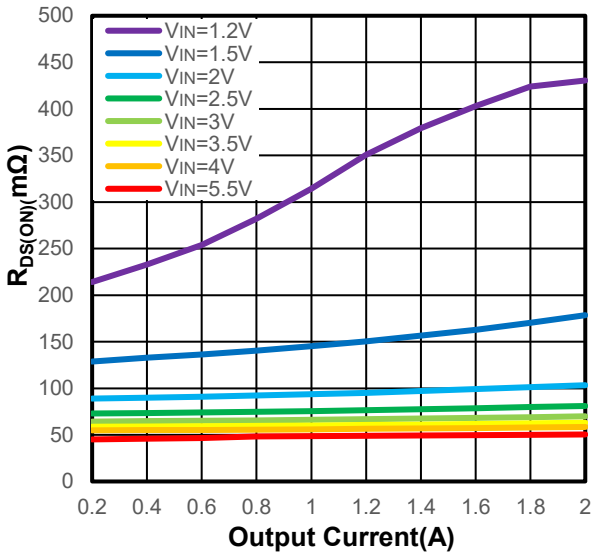


Figure 11. Switch On-Resistance vs. Input Voltage vs. Output Current

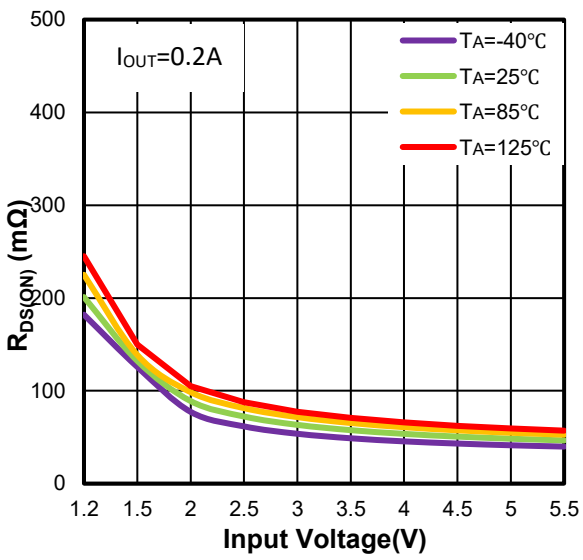


Figure 12. Switch On-Resistance vs. Input Voltage vs. Ambient Temperature

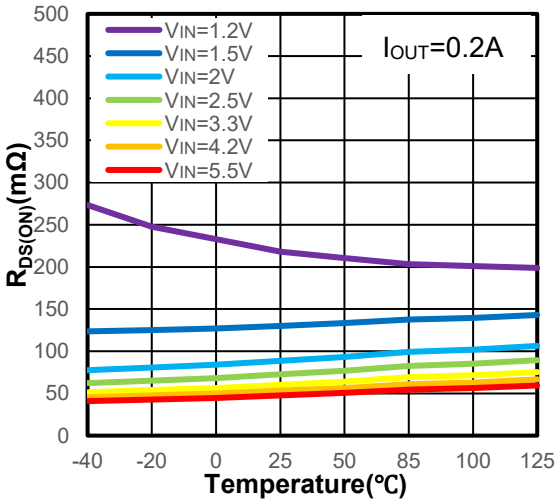


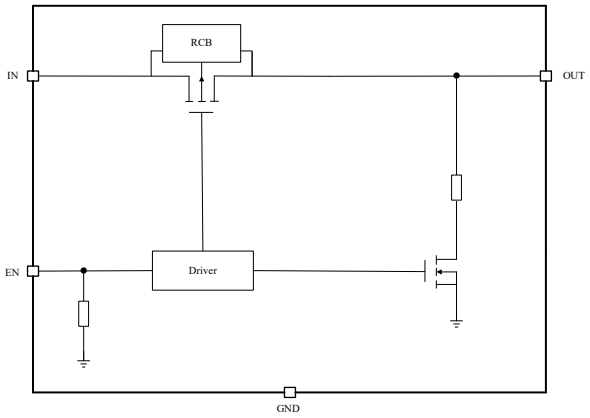
Figure 13. Switch On-Resistance vs. Input Voltage vs. Ambient Temperature

13. Function Description

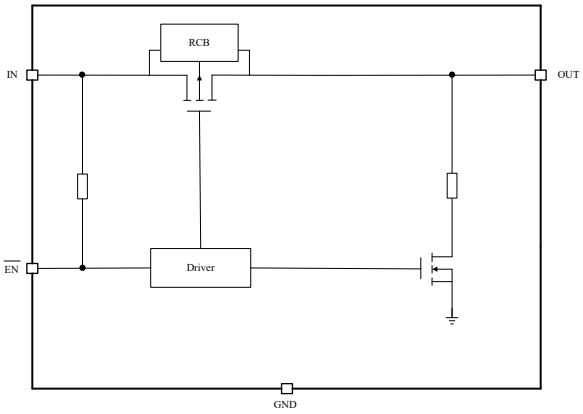
13.1 Overview

The WP2101 series are 5.5V load switches in WLCSP4 or PLDFN0909-4L package. The devices contain a 50 mΩ current-limited P-channel MOSFET that can operate over an input voltage range of 1.2 V to 5.5V. The WP2101 series has 4 versions（A/B/C/D）according with EN high active or low active and reverse block function is or not.

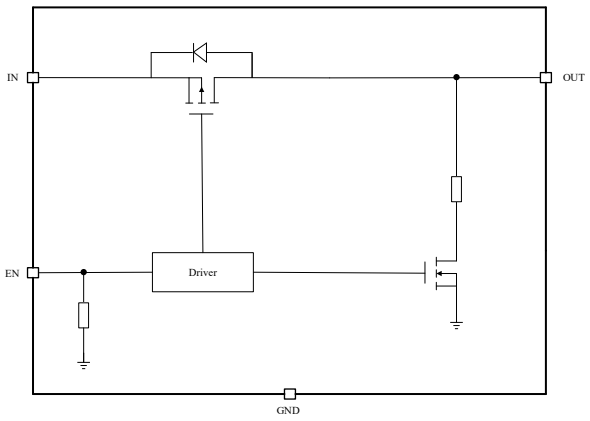
13.2 Block Diagram



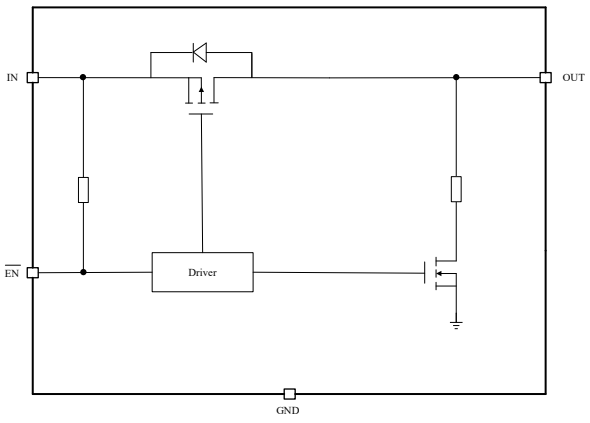
Version A



Version B



Version C



Version D

13.3 Feature Description

13.3.1 Quick Output Discharge

The WP2101 include the Quick Output Discharge (QOD) feature, in order to discharge the application capacitor connected on OUT pin.

13.3.2 Slew Rate Control

When the switch is enabled, the device regulates the gate voltage of MOSFET and controls the VOUT slew rate during t_R to avoid a large input inrush current. The feature reduces the interference to the power supply.

13.3.3 EN Control

EN is high active for A and C version, and low active for B and D version. The device integrates 12.4MΩ pull down resistor for high active version and 12.4MΩ pull up resistor for low active version.

13.3.4 Reverse Current Block (Only for WP2101-A/B Version)

There is a Reverse Current Block function for A and B version when V_{OUT} is 60mV greater than V_{IN}, which can prevent the current to flowing through the P-MOSFET or the body diode.

13.4 Device Functional Modes

When the EN pin is actively pulled high and no fault conditions are present, the switch will be turned on, connecting V_{IN} to V_{OUT}. When the EN pin is disabled regardless of the fault condition, the switch will be turned off.

14. Application and Implementation

14.1 EN Control

The EN pin controls the state of the switch. Activating EN continuously holds the switch in the on state as long as there is no fault.

14.2 Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush current, a capacitor 1μF or larger must be placed between the IN and GND pins.

14.3 Output Capacitor

A 1μF or larger capacitor should be placed between the OUT and GND pins. This capacitor will prevent parasitic board inductances from forcing OUT below GND when the switch turns off.

14.4 Power Dissipation and Junction Temperature

The junction temperature of the switch depend on several factors such as the load, PCB layout, ambient temperature and package type. Power dissipation can be calculated based on the output current and the $R_{DS(ON)}$ of the switch as below.

$$P_D = R_{DS(ON)} \times I^2$$

The junction temperature can be estimated by the following thermal equation:

$$T_J = P_D \times \theta_{JA} + T_A$$

Where:

T_A = Ambient temperature

θ_{JA} = Thermal resistance

P_D = Total power dissipation

With all possible conditions, the junction temperature must be within the range specified under operating conditions. The maximum output current must be derated at higher ambient temperature to ensure the junction temperature does not exceed the maximum junction temperature which is 125℃.

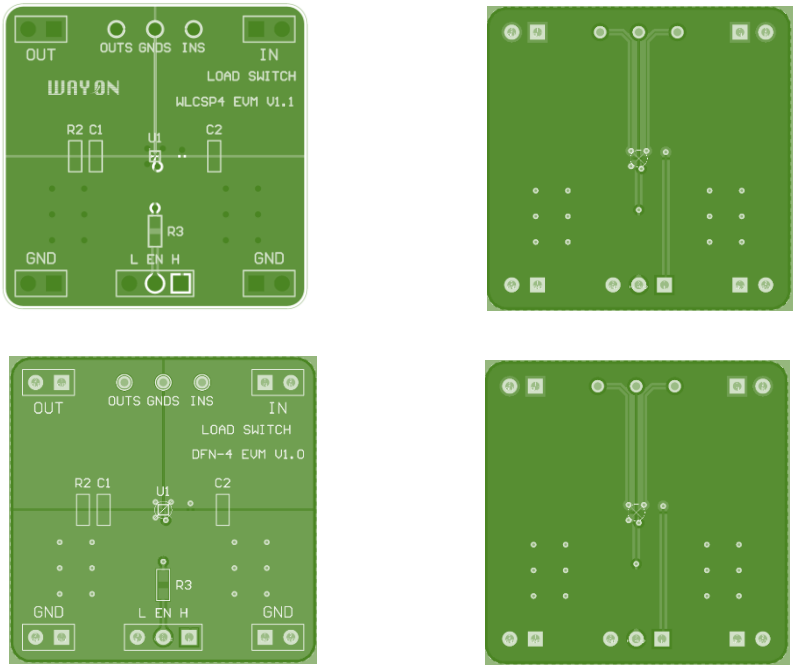
15. Power Supply Recommendations

The device is designed to operate from a V_{IN} range of 1.2V to 5.5 V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 1μF bypass capacitor. If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors.

16. Layout

For best performance, all traces should be as short as possible, the input and output capacitors should be placed close to the device 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 will help minimize parasitic electrical effects along with minimizing the case to ambient thermal impedance.

16.1 Layout Example



17. Evaluation Modules

Evaluation Modules (EVMs) are available to help evaluate the device performance. We have evaluation modules for different packages, you can contact us at the end to get the evaluation module or schematic.

The module names are listed in the table below.

NAME	PACKAGE	EVALUATION MODULE
WP2101	WLCSP4	LOAD SWITCH WLCSP4 EVM V1.1
WP2101	PLDFN0909-4L	LOAD SWITCH DFN-4 EVM V1.0

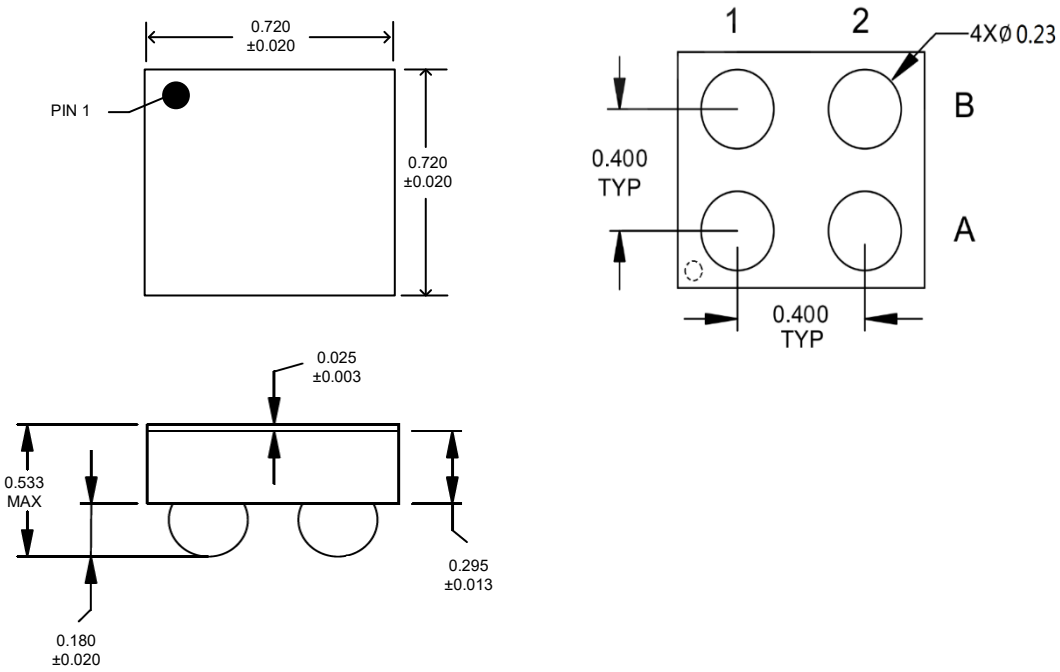
18. Naming Conventions

WP AB CC-D EEE F

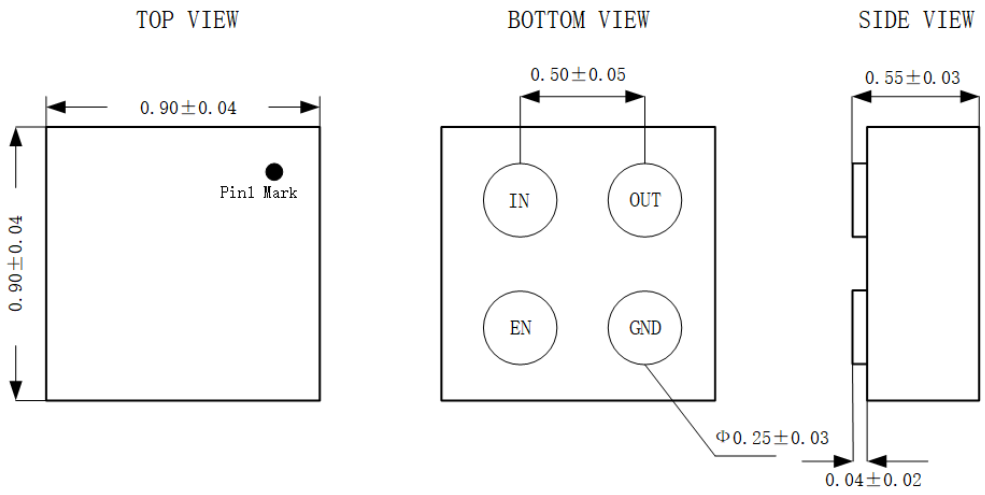
WP: WAYON Protection IC;
A: Product Category –2: Load Switch;
B: Maximum Output Current – 1: ≤2A;
CC: Serial number;
D: EN Enable (High/Low) – A/C: EN High Enable;
B/D: EN Low Enable;
EEE: Package – C04: WLCSP4;
ZE: PLDFN0909-4L;
F: R-Reel & T-tube;

19. Package Information

WLCSP4



PLDFN0909-4L



20. Ordering Information

PART NUMBER	OUTPUT CURRENT	PACKAGE	PACKING QUANTITY	MARKING*
WP2101-AC04R	2A	WLCSP4	3k/Reel	AXX
WP2101-BC04R	2A	WLCSP4	3k/Reel	BXX
WP2101-CC04R	2A	WLCSP4	3k/Reel	CXX
WP2101-DC04R	2A	WLCSP4	3k/Reel	DXX
WP2101-AZER	2A	PLDFN0909-4L	5k/Reel	A
WP2101-BZER	2A	PLDFN0909-4L	5k/Reel	B
WP2101-CZER	2A	PLDFN0909-4L	5k/Reel	C
WP2101-DZER	2A	PLDFN0909-4L	5k/Reel	D

* XX is variable.

Contact Information

No.1001, Shiwan(7) Road, Pudong District, Shanghai, P.R.China.201207
Tel: 86-21-50310888 Fax: 86-21-50757680 Email: market@way-on.com
WAYON website: http://www.way-on.com
For additional information, please contact your local Sales Representative.
WAYON® is registered trademark of Wayon Corporation.

Product Specification Statement

1.The product specification aims to provide users with a reference regarding various product parameters, performance, and usage. It presents certain aspects of the product's performance in graphical form and is intended solely for users to select product and make product comparisons, enabling users to better understand and evaluate the characteristics and advantages of the product. It does not constitute any commitment, warranty, or guarantee.

2.The product parameters described in the product specification are numerical values, characteristics, and functions obtained through actual testing or theoretical calculations of the product in an independent or ideal state. Due to the complexity of product applications and variations in test conditions and equipment, there may be slight fluctuations in parameter test values. WAYON shall not guarantee that the actual performance of the product when installed in the customer's system or equipment will be entirely consistent with the product specification, especially concerning dynamic parameters. It is recommended that users consult with professionals for product selection and system design. Users should also thoroughly validate and assess whether the actual parameters and performance when installed in their respective systems or equipment meet their requirements or expectations. Additionally, users should exercise caution in verifying product compatibility issues, and WAYON assumes no responsibility for the application of the product.

3.WAYON strives to provide accurate and up-to-date information to the best of our ability. However, due to technical, human, or other reasons, WAYON cannot guarantee that the information provided in the product specification is entirely accurate and error-free. WAYON shall not be held responsible for any losses or damages resulting from the use or reliance on any information in these product specifications. WAYON reserves the right to revise or update the product specification and the products at any time without prior notice, and the user's continued use of the product specification is considered an acceptance of these revisions and updates. Prior to purchasing and using the product, users should verify the above information with WAYON to ensure that the product specification is the most current, effective, and complete. If users are particularly concerned about product parameters, please consult WAYON in detail or request relevant product test reports. Any data not explicitly mentioned in the product specification shall be subject to separate agreement.

4.Users are advised to pay attention to the parameter limit values specified in the product specification and maintain a certain margin in design or application to ensure that the product does not exceed the parameter limit values defined in the product specification. This precaution should be taken to avoid exceeding one or more of the limit values, which may result in permanent irreversible damage to the product, ultimately affecting the quality and reliability of the system or equipment.

5.The design of the product is intended to meet civilian needs and is not guaranteed for use in harsh environments or precision equipment. It is not recommended for use in systems or equipment such as medical devices, aircraft, nuclear power, and similar systems, where failures in these systems or equipment could reasonably be expected to result in personal injury. WAYON shall assume no responsibility for any consequences resulting from such usage.

6.Users should also comply with relevant laws, regulations, policies, and standards when using the product specification. Users are responsible for the risks and liabilities arising from the use of the product specification and must ensure that it is not used for illegal purposes. Additionally, users should respect the intellectual property rights related to the product specification and refrain from infringing upon any third-party legal rights. WAYON shall assume no responsibility for any disputes or controversies arising from the above-mentioned issues in any form.