WP2301

High-Side Current Limited Load Switch

1. General Description

The WP2301 is a single N-MOSFET high-side current limited load switch designed for USB applications. This switch operates with inputs ranging from 2.7V to 6.0V, making it ideal for both 3.3V and 5V systems. An integrated current-limiting circuit protects the input supply against large currents which may cause the supply to fall out of regulation. The WP2301 includes thermal shutdown protection that prevents damage to the device when a continuous over-current condition causes excessive heating by turning off the switch. The load of the switch can be up to 3A. The quiescent current is only 30μA in active mode. Fault flag ($\overline{FLT}$) can indicate over current and fault states.

The WP2301 is available in Pb-free packages and is specified over the -40℃ to +85℃ ambient temperature range.

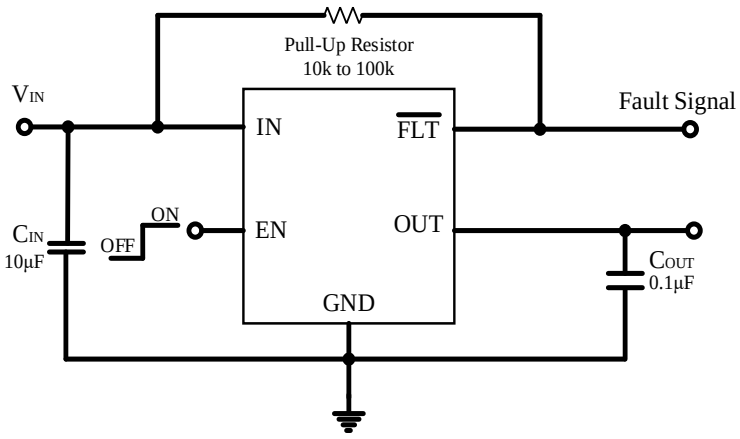
2. Features

- Input Voltage Range: 2.7V to 6.0V
- $R_{DS(ON)}$:60mΩ, N-MOSFET Switch
- Accurate Current Limit
- Reverse Current Blocking
- Very Low Quiescent Current: 30μA (Typ.)
- Fault flag output for over current and fault states
- Under-Voltage Lockout
- Thermal Shutdown
- 2kV ESD Rating
- Based on UL2367 Recognized, File Number E525559
- IEC62368-1 CB Scheme Certified Complete
- Package: SOT23-5

3. Applications

- Notebook PCs
- USB Peripherals

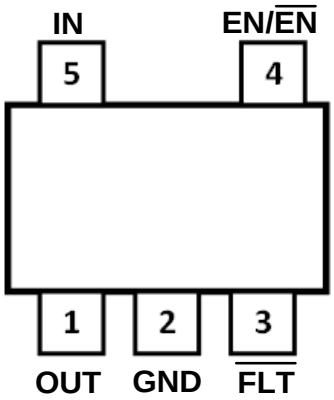
4. Typical Application



Note: Tantalum or Aluminum Electrolytic capacitors (C_{IN} and C_{OUT}) may be required for USB applications.

5. Pin Configuration

(Top View)



SOT23-5

6. Pin Description

PIN NUMBER	PIN NAME	I/O	PIN FUNCTION
1	OUT	O	Switch output.
2	GND		Common ground.
3	$\overline{FLT}$	O	Fault flag output. Open drain output that indicates an over current, supply under voltage or over temperature state.
4	EN/$\overline{EN}$	I	Enable input.
5	IN	I	Switch input.

7. Absolute Maximum Ratings [1]

Over operating free-air temperature range, unless otherwise noted.

SYMBOL	PARAMETER	RATING	UNIT
V_{IN}	IN Voltage	-0.3 to 7	V
V_{OUT}	OUT Voltage	-0.3 to V_{IN} + 0.3	V
V_{EN}	EN Voltage	-0.3 to 7	V
$V_{\overline{FLT}}$	$\overline{FLT}$ Voltage	-0.3 to 7	V
I_{OUT}	OUT Current	Internal Limited	A
P_D	Power Dissipation	1176	mW
$R_{\theta JA}$	Junction-to-ambient Thermal Resistance [2]	85	℃/W
$R_{\theta JB}$	Junction-to-board Thermal Resistance [2]	68	℃/W
$R_{\theta JC(top)}$	Junction-to-case(top) Thermal Resistance [2]	20	℃/W
$R_{\theta JC(bot)}$	Junction-to-case(bottom) Thermal Resistance [2]	24	℃/W
$T_{J(MAX)}$	Junction Temperature	150	℃
T_{STG}	Storage Temperature	-65 to 150	℃
T_{SDR}	Lead Temperature (Soldering, 10 sec)	260	℃
ESD	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001	±2000	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: Measured on 114.3mm×76.2mm 4-layer FR4 PCB board, 1 oz copper.

8. Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{IN}	Input Voltage Range	2.7	6.0	V
V_{EN}	EN Input Voltage		V_{IN}	V
T_A	Operating Ambient Temperature	-40	85	℃
T_J	Operating Junction Temperature	-40	125	℃

9. Electrical Characteristics

(V_{IN} = 5 V, V_{EN} = 5 V, C_{IN}=10μF, C_{OUT}=0.1μF, T_A=25℃, unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
I_{SHDN}	Shutdown Quiescent Current	Disabled, OUT floating			0.6		μA
I_Q	Quiescent Current	Enabled, OUT floating			30		μA
$R_{DS(ON)}$	Switch On-resistance	V_{IN}=5V			60		mΩ
I_{TRIP}	Over Current Trip Threshold	V_{IN}=5V, 100A/s	WP2301-A/B	0.65	0.89	1	A
			WP2301-C/D	1.05	1.4	1.5	
			WP2301-E/F	1.55	2.1	2.25	
			WP2301-G/H	2.05	2.8	3.2	
			WP2301-I/J	2.55	3.5	3.95	
			WP2301-K/L	3.05	4.2	4.95	
I_{LIM}	Current Limit	V_{IN}=5V, V_{OUT}=1V	WP2301-A/B	0.6	0.7	0.8	A
			WP2301-C/D	1	1.1	1.2	
			WP2301-E/F	1.5	1.65	1.8	
			WP2301-G/H	2	2.2	2.4	
			WP2301-I/J	2.5	2.75	3	
			WP2301-K/L	3	3.3	3.6	
V_{IL}	EN Input Logic Low Voltage	V_{IN} = 2.7V to 6.0V				0.75	V
V_{IH}	EN Input Logic High Voltage	V_{IN} = 2.7V to 6.0V		1.5			V
$R_{\overline{FLT}}$	$\overline{FLT}$ Output Resistance	I_{SINK} = 1mA			10		Ω
$I_{\overline{FLT}_OFF}$	$\overline{FLT}$ Off Current	$V_{\overline{FLT}}$=5V			0.01		μA

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{\overline{FLT}_DELAY}$	$\overline{FLT}$ Delay Time	From fault condition to $\overline{FLT}$ assertion		10		ms
V_{UVLO}	Input UVLO Threshold	V_{IN} rising			2.4	V
V_{UVLO_HYS}	Input UVLO Hysteresis	V_{IN} decreasing		0.1		V
I_{REV}	Reverse Leakage Current	V_{IN} = 0V, V_{OUT} = 5V, I_{REV} at V_{IN}			1	μA
t_{ON}	Output Turn-on Delay Time	From enable to 90% of V_{OUT}		1.2		ms
t_R	Output Turn-on Rise Time	10% to 90% of V_{OUT} rising		1		ms
$I_{LEAKAGE}$	Output Leakage Current	Disabled, V_{IN} = 5V, R_{LOAD} = 0Ω		0.5	1	μA
R_{DIS}	Output Discharge Resistance	Disabled, V_{IN} = 5V, V_{OUT}=1V		200		Ω
T_{SHDN} [3]	Thermal Shutdown Threshold			150		℃
T_{HYS} [3]	Thermal Shutdown Hysteresis			30		℃

Note3: Guaranteed by design, but not tested in production.

Note4: Limits over full temperature are guaranteed by design, but not tested in production.

10. Typical Performance Characteristics

(V_{IN} = 5V, V_{EN} = 5V, C_{IN}=1μF, C_{OUT}=1μF, T_A=25°C, unless otherwise noted)

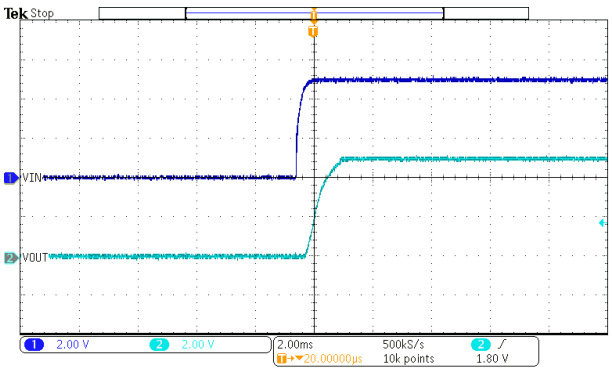


Figure 1. Turn On Response from IN

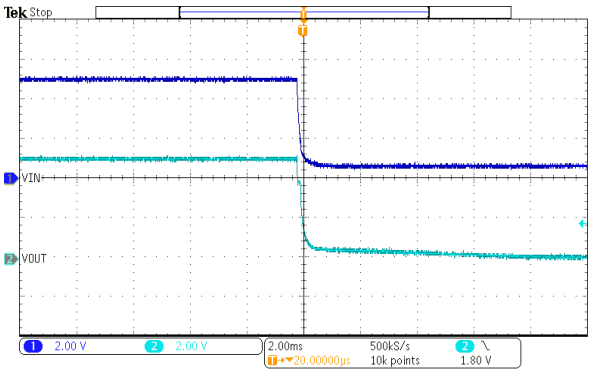


Figure 2. Turn Off Response from VIN

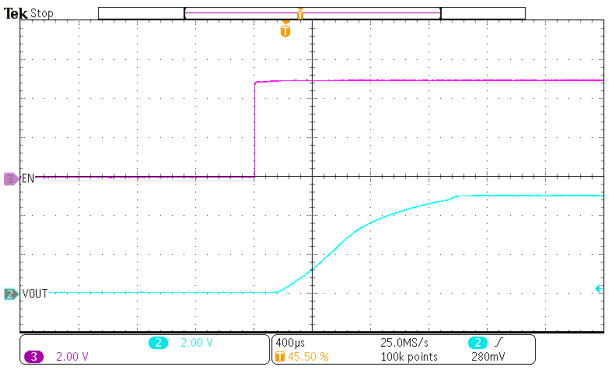


Figure 3. Turn On Response from EN

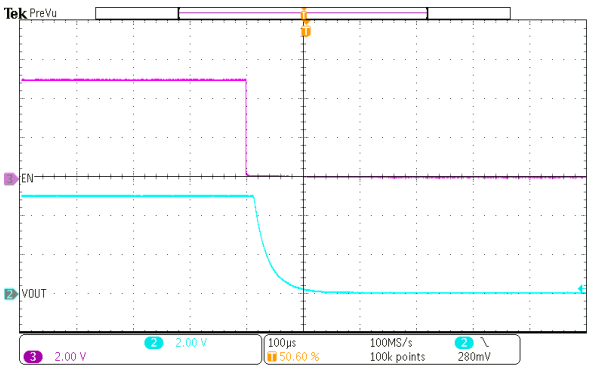


Figure 4. Turn Off Response from EN

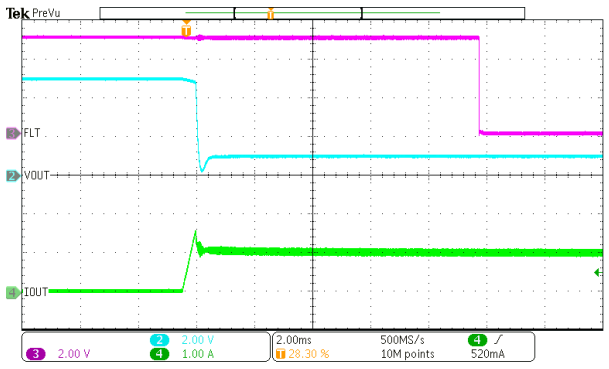


Figure 5. $\overline{FLT}$ Response

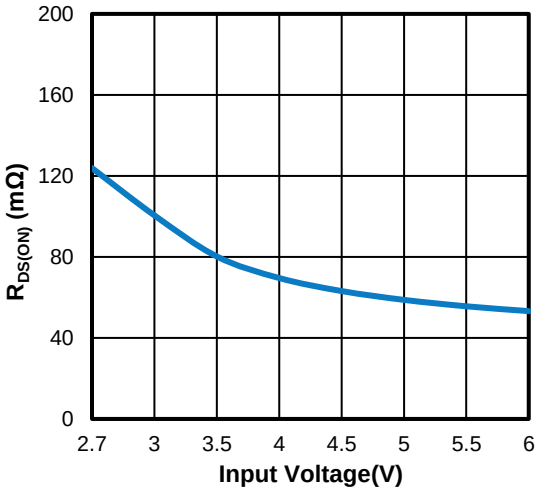


Figure 6. Switch On-Resistance vs. Input Voltage

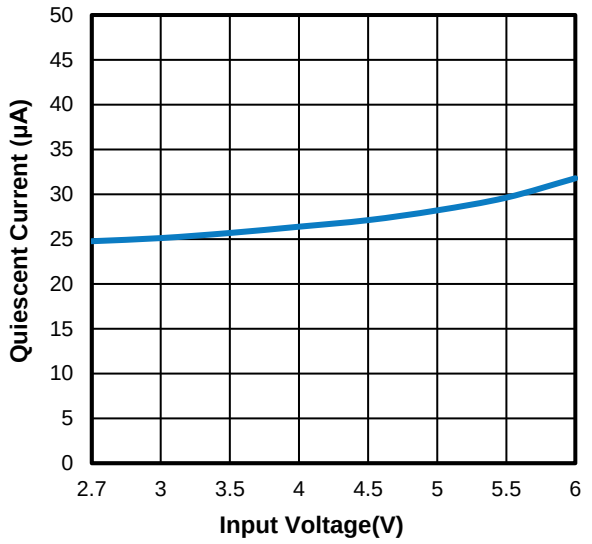


Figure 7. Quiescent Current vs. Input Voltage

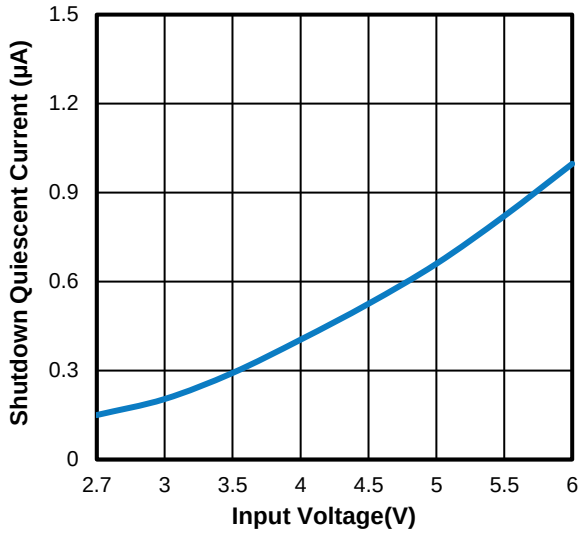


Figure 8. Shutdown Quiescent Current vs. Input Voltage

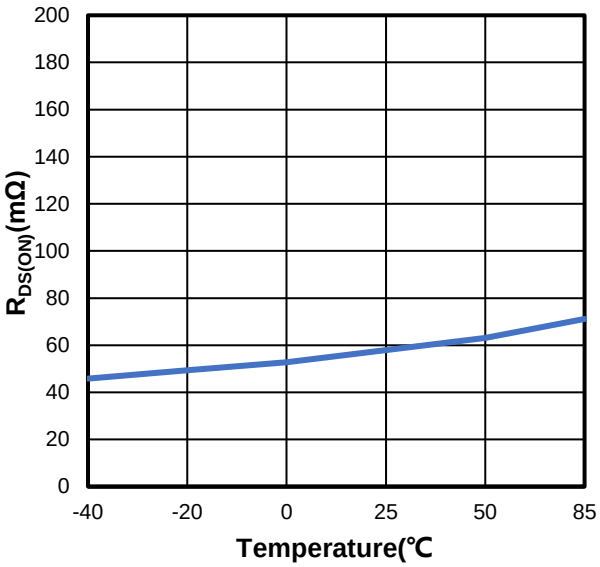


Figure 9. Switch On-Resistance vs. Ambient Temperature

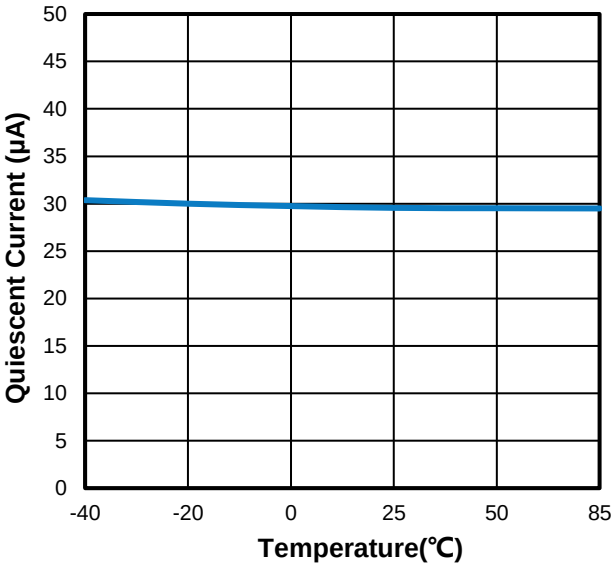


Figure 10. Quiescent Current vs. Ambient Temperature

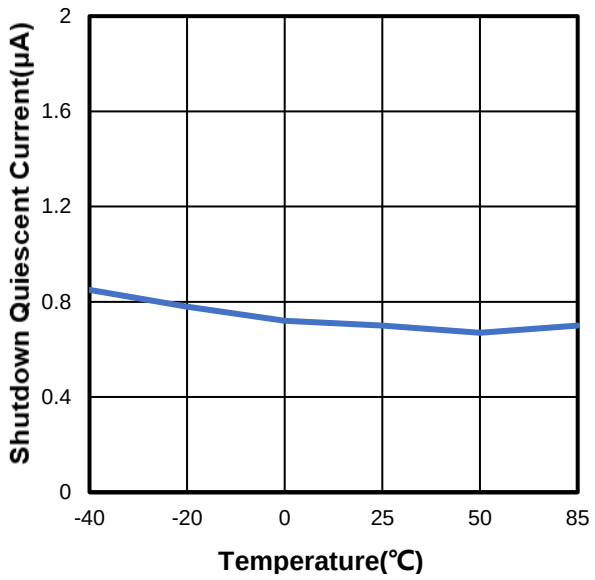


Figure 11. Shutdown Quiescent Current vs. Ambient Temperature

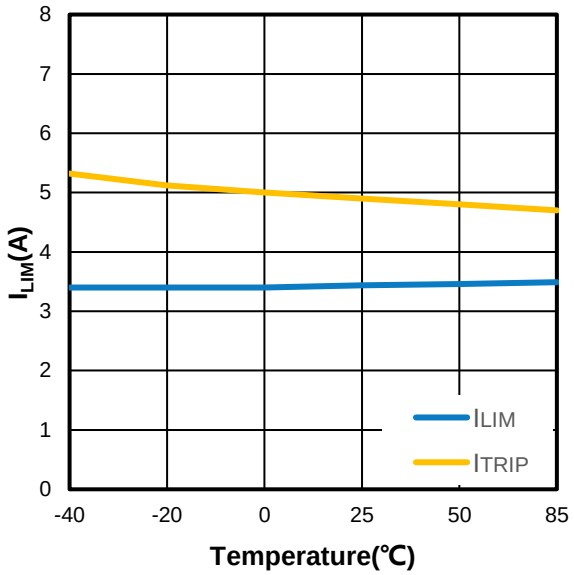


Figure 12. Current Limit vs. Ambient Temperature (WP2301-K/L)

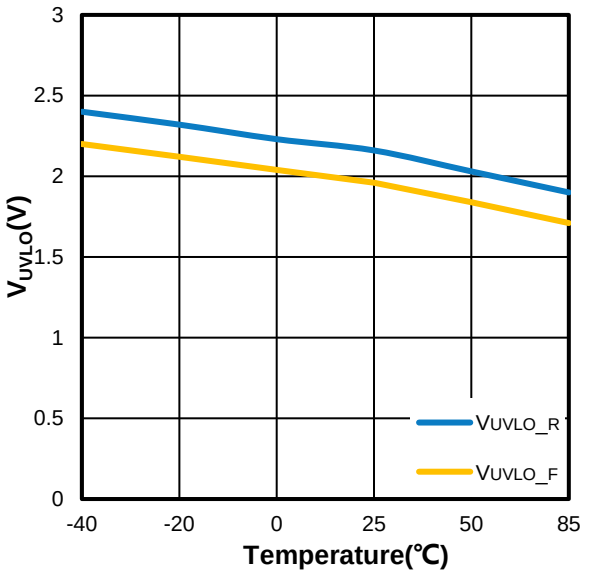


Figure 13. Input UVLO Threshold vs. Ambient Temperature

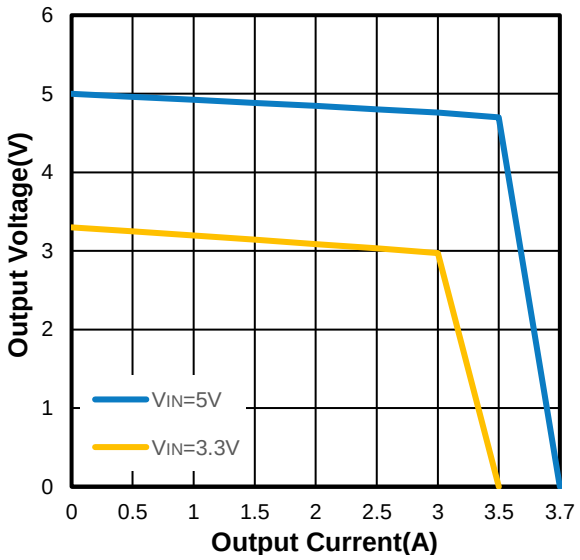


Figure 14. Output Voltage vs. Output Current

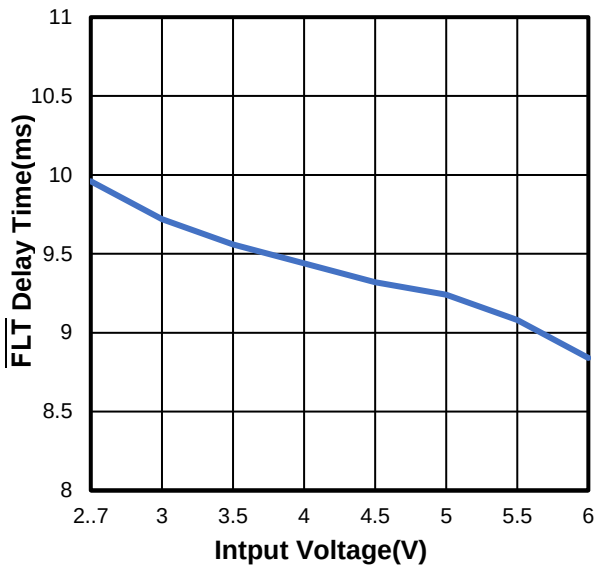


Figure 15. $\overline{FLT}$ Delay Time vs. Input Voltage

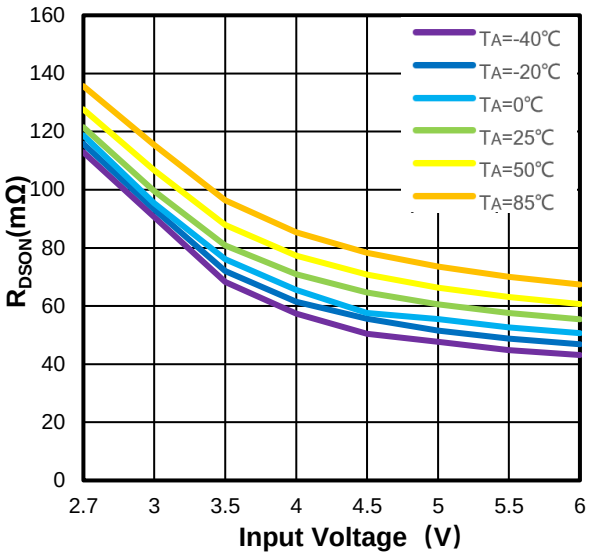


Figure 16. Switch On-Resistance vs. Input Voltage vs. Ambient Temperature

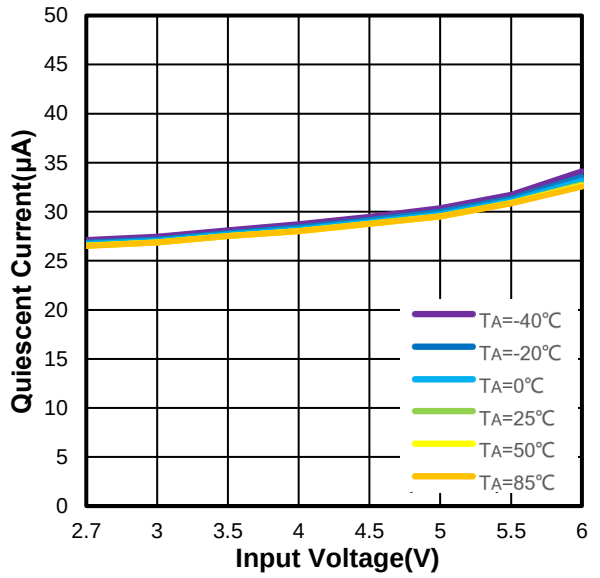


Figure 17. Quiescent Current vs. Input Voltage vs. Ambient Temperature

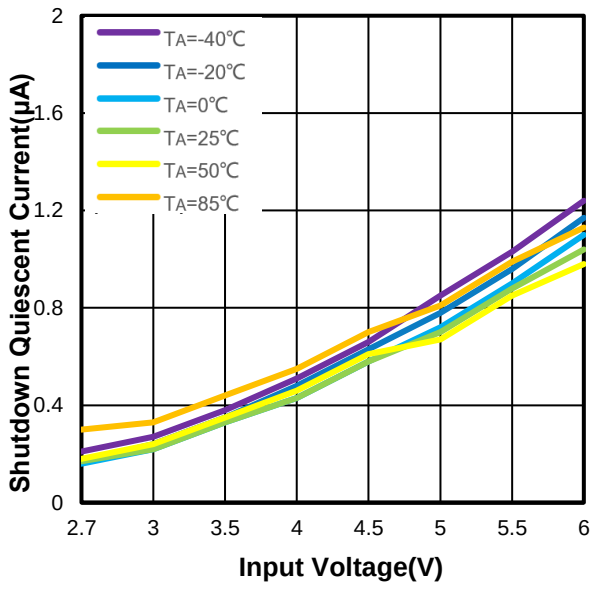


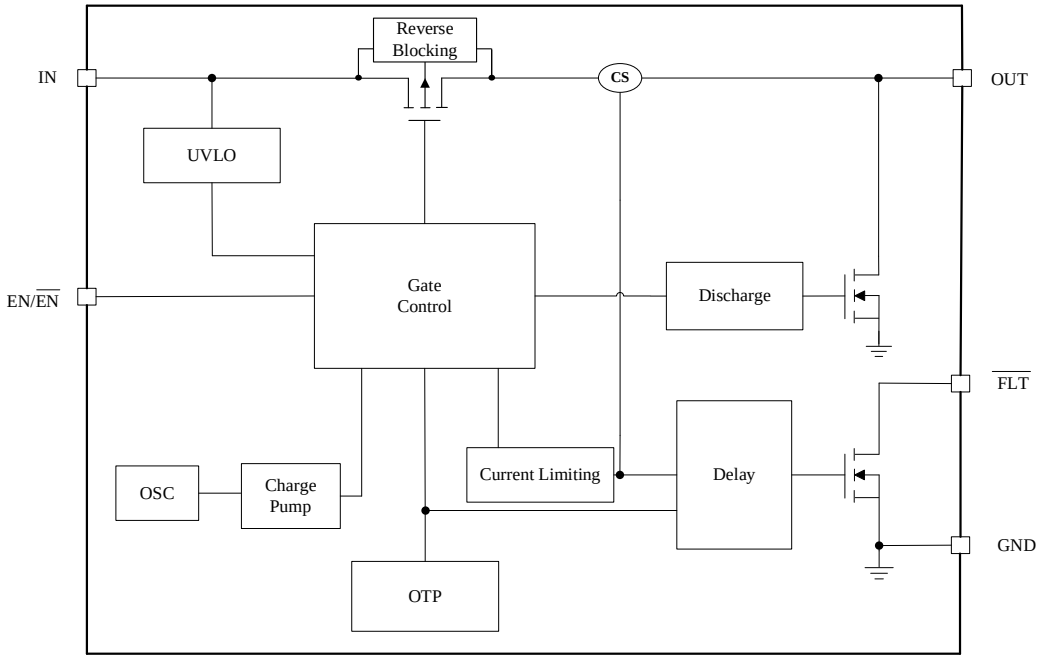
Figure 18. Shutdown Quiescent Current vs. Input Voltage vs. Ambient Temperature

11. Function Description

11.1 Overview

The WP2301 series are current limited load switches in a SOT23-5 package. The devices contain a 60 mΩ N-channel MOSFET that can operate over an input voltage range of 2.7 V to 6.0V. When the switch current reaches the over current trip threshold, the WP2301 operates in a constant-current mode to prohibit excessive currents from causing damage.

11.2 Block Diagram



11.3 Feature Description

11.3.1 Current Limiting

When the switch current reaches the over current trip threshold, the WP2301 operates in a constant-current mode to prohibit excessive currents from causing damage until the thermal shutdown occurs or the fault is removed.

11.3.2 Fault Reporting

When an overcurrent, input undervoltage, or overtemperature condition is detected, $\overline{FLT}$ is set active low to indicate the fault mode. $\overline{FLT}$ is an open-drain MOSFET and requires a pull up resistor.

11.3.3 Thermal Shutdown

Thermal shutdown protects the device from internally or externally generated excessive temperatures. During an overtemperature condition the switch is turned off. The switch automatically turns on again if the temperature of the die drops below the threshold temperature.

11.3.4 Quick Output Discharge

The WP2301 include the Quick Output Discharge (QOD) feature, in order to discharge the capacitor connected on OUT pin.

11.4 Functional Modes of the Device

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.

12. Application and Implementation

12.1 Application Information

12.1.1 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. An undervoltage lockout or thermal shutdown event will override the EN pin control and turn off the switch.

12.1.2 Input Capacitor

To limit the voltage dropped on the input supply caused by transient inrush current, a capacitor 10μF or larger must be placed between the IN and GND pins.

12.1.3 Output Capacitor

A 0.1μF 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.

12.1.4 Undervoltage Lockout

The undervoltage lockout turns off the switch if the input voltage drops below the undervoltage lockout threshold. Under-voltage detection functions only when the switch is enabled.

12.1.5 Power Dissipation and Junction Temperature

The junction temperature of the switch depends 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:

$$T_J = P_D \times R_{\theta JA} + T_A$$

Where:

T_A = Ambient temperature

$R_{\theta JA}$ = 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℃.

The derating curve in Figure 19 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation. (Measured on 114.3mm x 76.2mm 4-layer FR4 PCB board, 1 oz copper.)

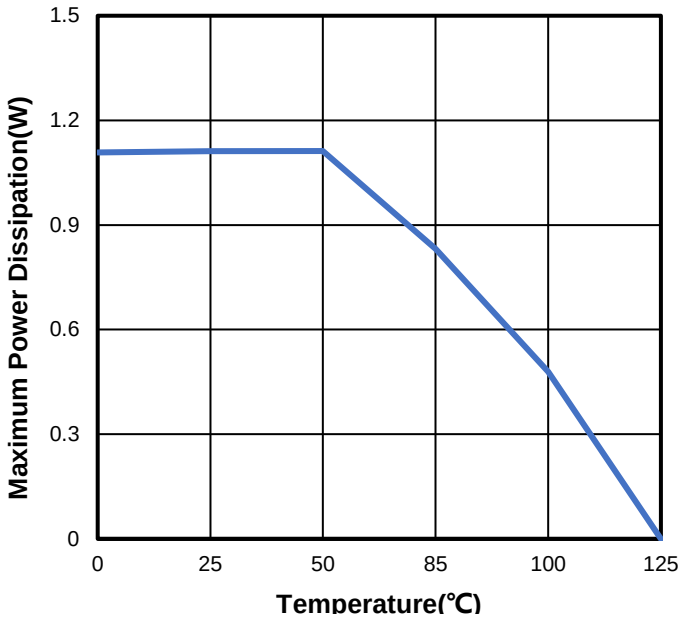


Figure 19. Derating Curve of Maximum Power Dissipation

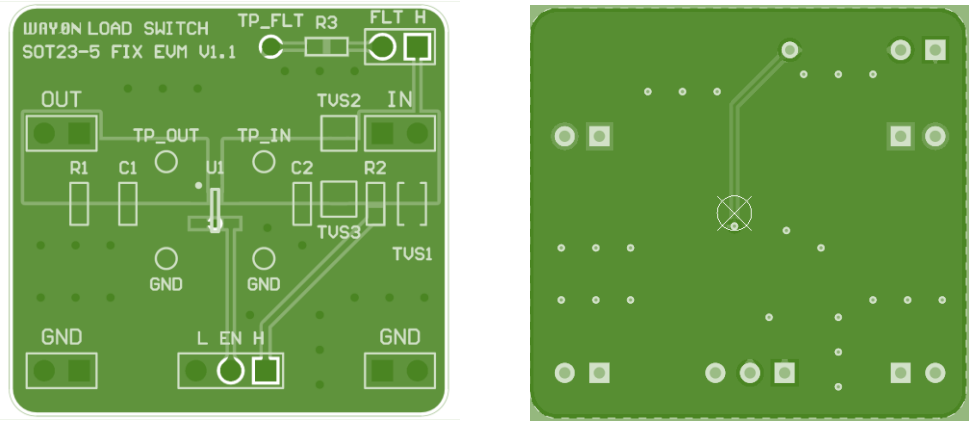
13. Power Supply Recommendations

The device is designed to operate from a VIN range of 2.7 V to 6.0 V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 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.

14. 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.

14.1 Layout Example



15. Evaluation Modules

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

The module names are listed in the following table.

NAME	PACKAGE	EVALUATION MODULE
WP2301	SOT23-5	WAYON LOAD SWITCH SOT23-5 FIX EVM V1.1

16. Naming Conventions

WP A B CC-DD EEE FF

WP: WAYON Protection IC;

A: Product Category –2: Load Switch;

B: Maximum Output Current –3: 3A;

CC: Serial number;

DD: Output Current: A/AN/B/BN:500mA;

C/CN/D/DN:1A;

E/EN/F/FN:1.5A;

G/GN/H/HN:2A;

I/IN/J/JN:2.5A;

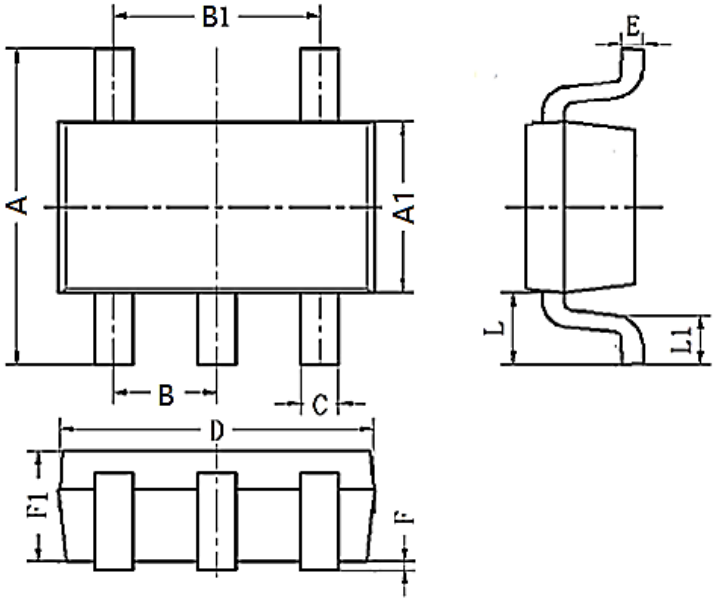
K/KN/L/LN:3A;

EEE: Package – B50: SOT23-5;

FF: RF-Reel

17. Package Information

SOT 23-5



SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	2.60	2.80	3.00
A1	1.50	1.60	1.70
B	0.85	0.95	1.05
B1	1.80	1.90	2.00
C	0.25	0.37	0.50
D	2.79	2.90	3.02
E	0.10	0.15	0.20
F	0.00	0.10	0.20
L	0.60REF		
L1	0.30	0.45	0.60
F1	0.85	1.10	1.30

18. Ordering Information

PART NUMBER	EN FUNCTION	QOD	CURRENT	PACKAGE	PACKING QUANTITY	MARKING*
WP2301-AB50RF	Active High	Yes	0.5A	SOT23-5	3k/Reel	301AXX
WP2301-BB50RF	Active Low	Yes	0.5A	SOT23-5	3k/Reel	301BXX
WP2301-ANB50RF	Active High	No	0.5A	SOT23-5	3k/Reel	301ANXX
WP2301-BNB50RF	Active Low	No	0.5A	SOT23-5	3k/Reel	301BNXX
WP2301-CB50RF	Active High	Yes	1A	SOT23-5	3k/Reel	301CXX
WP2301-DB50RF	Active Low	Yes	1A	SOT23-5	3k/Reel	301DXX
WP2301-CNB50RF	Active High	No	1A	SOT23-5	3k/Reel	301CNXX
WP2301-DNB50RF	Active Low	No	1A	SOT23-5	3k/Reel	301DNXX
WP2301-EB50RF	Active High	Yes	1.5A	SOT23-5	3k/Reel	301EXX
WP2301-FB50RF	Active Low	Yes	1.5A	SOT23-5	3k/Reel	301FXX
WP2301-ENB50RF	Active High	No	1.5A	SOT23-5	3k/Reel	301ENXX
WP2301-FNB50RF	Active Low	No	1.5A	SOT23-5	3k/Reel	301FNXX
WP2301-GB50RF	Active High	Yes	2A	SOT23-5	3k/Reel	301GXX
WP2301-HB50RF	Active Low	Yes	2A	SOT23-5	3k/Reel	301HXX
WP2301-GNB50RF	Active High	No	2A	SOT23-5	3k/Reel	301GNXX
WP2301-HNB50RF	Active Low	No	2A	SOT23-5	3k/Reel	301HNXX
WP2301-IB50RF	Active High	Yes	2.5A	SOT23-5	3k/Reel	301IXX
WP2301-JB50RF	Active Low	Yes	2.5A	SOT23-5	3k/Reel	301JXX
WP2301-INB50RF	Active High	No	2.5A	SOT23-5	3k/Reel	301INXX

PART NUMBER	EN FUNCTION	QOD	CURRENT	PACKAGE	PACKING QUANTITY	MARKING*
WP2301-JNB50RF	Active Low	No	2.5A	SOT23-5	3k/Reel	301JNXX
WP2301-KB50RF	Active High	Yes	3A	SOT23-5	3k/Reel	301KXX
WP2301-LB50RF	Active Low	Yes	3A	SOT23-5	3k/Reel	301LXX
WP2301-KNB50RF	Active High	No	3A	SOT23-5	3k/Reel	301KNXX
WP2301-LNB50RF	Active Low	No	3A	SOT23-5	3k/Reel	301LNXX

* XX is variable.

Contact Information

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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.