1.General Description

The WP25P041T5-B is a current limited P-channel MOSFET power switch designed for high-side load switching applications. This switch operates with inputs ranging from 2.5V to 5.2V, 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 WP25P041T5-B 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 0.25A. Current limit threshold is programmed with a resistor from SET to ground. The quiescent current is only 100μA in active mode while it is less than 1μA in shutdown mode.

The WP25P041T5-B is available in Pb-free packages and is characterized for operation over the free-air temperature range of - 40°C to 85°C.

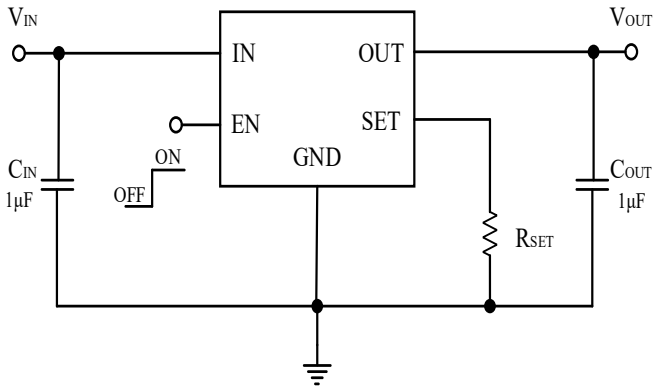
2. Features

- Input Voltage Range: 2.5V to 5.2V
- Programmable Current Limit (75mA to 400mA)
- Reverse Current Limit
- Low Quiescent Current: 100μA (Typ.)
- 1μA Max Shutdown Supply Current
- 15μs Short Circuit Response Typically
- Built-in Pull-up Resistor for EN Pin
- Automatic Output Discharge at Shutdown
- Output Over-voltage Protection
- Under-Voltage Lockout
- Thermal Shutdown
- 8kV ESD Rating
- Package: SOT23-5

3. Applications

- Laptop/Desktop Computers and Netbooks
- Smart Phones and PDAs
- LCD TVs and Monitors
- Set-Top-Boxes, Residential Gateways
- Printers, Docking Stations, HUBs

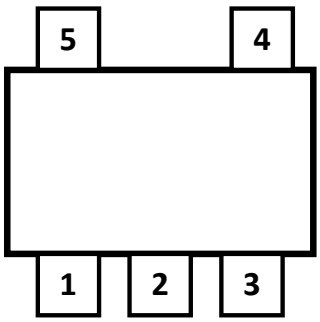
4. Typical Application



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	SET	O	Current limit programming pin. with a resistor R_{SET} from this pin to ground to program the current limit.
4	EN	I	Enable input. Active High.
5	IN	I	Switch input.

7. Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)[1]

PARAMETER	RATING	UNIT
IN, EN Voltage	-0.3 to 6	V
OUT Voltage	-0.3 to V_{IN} + 0.3	V
OUT Current	ADJ	A
Power Dissipation	400	mW
Package Thermal Resistance(θ_{JA})	250	°C/W
Operating Junction Temperature	-40 to 125	°C
Storage Temperature	-55 to 150	°C
Lead Temperature (Soldering, 10 sec)	260	°C
ESD(HBM)	8000	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.

8. Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{IN}	Input Voltage	2.5	5.2	V
T_A	Operating Ambient Temperature	-40	85	°C

9. Electrical Characteristics

(V_{IN} = 5 V, V_{EN} = 5 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, OUT floating or shorted to ground		0.3	1	μA
I_Q	Quiescent Current	Enabled, OUT floating		100	140	μA
$R_{DS(ON)}$	Switch on-resistance	V_{IN}=5V, I_{OUT}=0.1A	100	250	350	mΩ
I_{LIM}	Current Limit	V_{IN}=5V, V_{OUT}=4.5V, R_{SET}=12.7kΩ	320	400	480	mA
		V_{IN}=5V, V_{OUT}=4.5V, R_{SET}=16.9kΩ	240	300	360	
		V_{IN}=5V, V_{OUT}=4.5V, R_{SET}=24.9kΩ	160	200	240	
		V_{IN}=5V, V_{OUT}=4.5V, R_{SET}=64.9kΩ	60	75	90	
		V_{IN}=5V, V_{OUT}=4.5V, Open R_{SET}	320	400	480	
V_{IL}	EN Input Logic-Low Voltage	Note 2			0.5	V
V_{IH}	EN Input Logic-High Voltage	Note 2	1.5			V
I_{SINK}	EN Input leakage	V_{EN} =5V		0.01	1	μA
		V_{EN} =0V	-2	-0.25		μA
V_{UVLO}	Input UVLO Threshold	Enabled, V_{IN} rising	1.4	1.8	2.2	V
V_{UVLO_HYS}	Input UVLO Hysteresis			0.01		V
I_{REV}	Reverse Leakage Current	V_{IN} = 0V, V_{OUT} = 5V, I_{REV} at V_{IN}		0.1	1	μA
I_{ROCP}	Reverse-Current Trigger Point	V_{IN} = 5.0V, V_{OUT} = 5.2V, Open R_{SET}		0.2		A
t_{TRIG}	Deglitch time from reverse current trigger to MOSFET turn off	Note 4	0.5	0.7	1.0	ms

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNIT
V_{OVP}	Output over-voltage trip point	Note 5	5.3		5.6	V
t_R	Output Turn-on Rise Time	R_{LOAD}=100Ω	0.2	0.4	0.8	ms
R_{DIS}	Output Discharge Resistance	Disabled, V_{IN} = 5V, V_{OUT}=1V,		800		Ω
T_{SHDN}	Thermal Shutdown Threshold	Note 3		150		ºC
T_{HYS}	Thermal shutdown hysteresis	Note 3		20		ºC

Note2: EN includes a small pull-up current source, nominally 0.1μ A. When EN pin is floating, the chip is enabled.

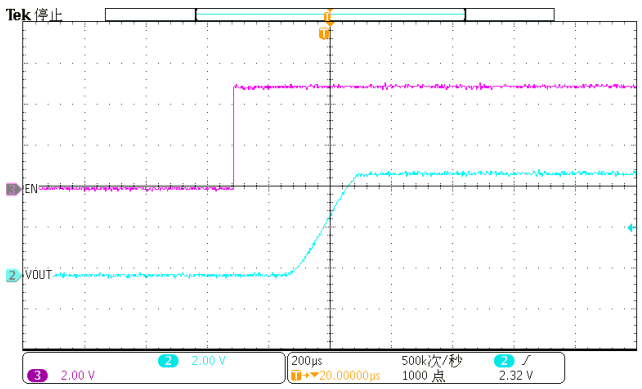
Note3: Guaranteed by design.

Note4: When reverse current triggers at I_{ROCP} =1/2 I_{LIM}, the reverse current is continuously clamped at I_{ROCP} for 0.7ms deglitch time until MOSFET is turned off.

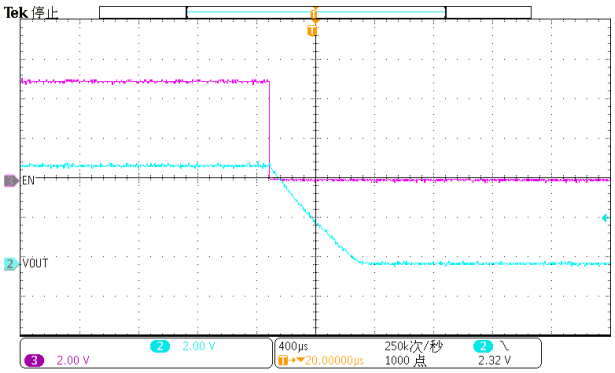
Note5: During output over-voltage protection, the output draws approximately 60μA current.

10. Typical Performance Characteristics

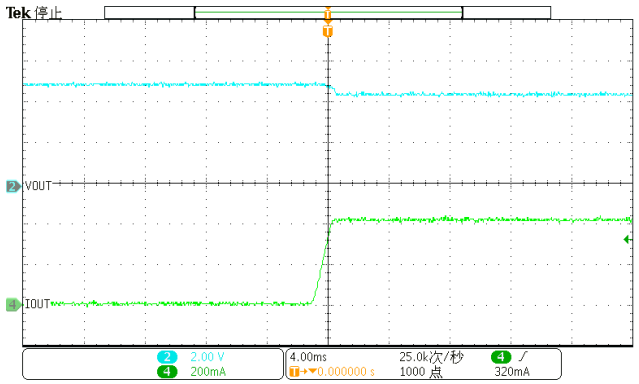
(V_{IN} = 5V, V_{EN} = 5V, C_{IN}=1μF, C_{OUT}=1μF, T_A=25°C, unless otherwise noted)



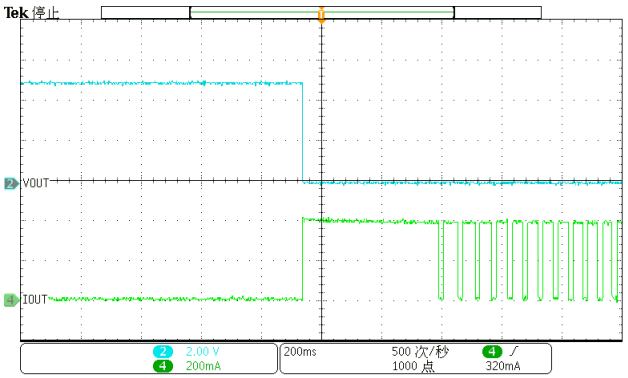
Turn On Response



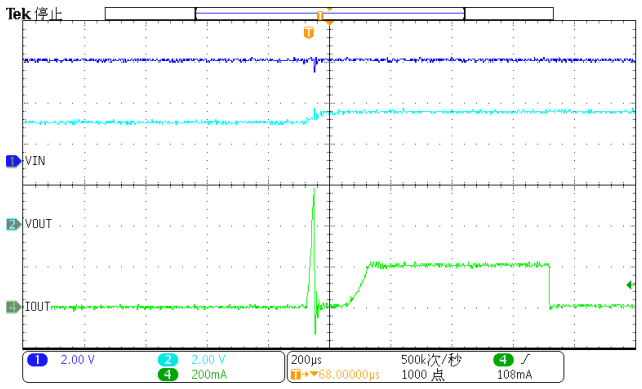
Turn Off Response



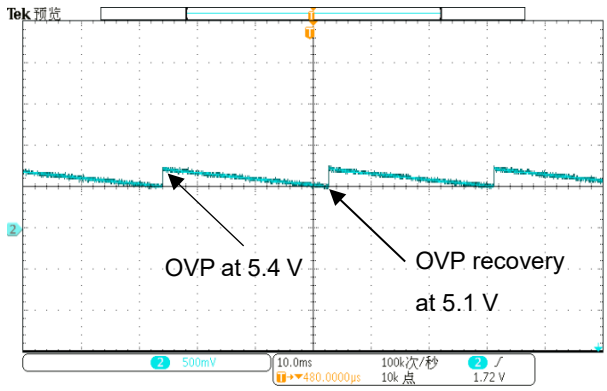
Overload Current-Limit (Open R_{SET})



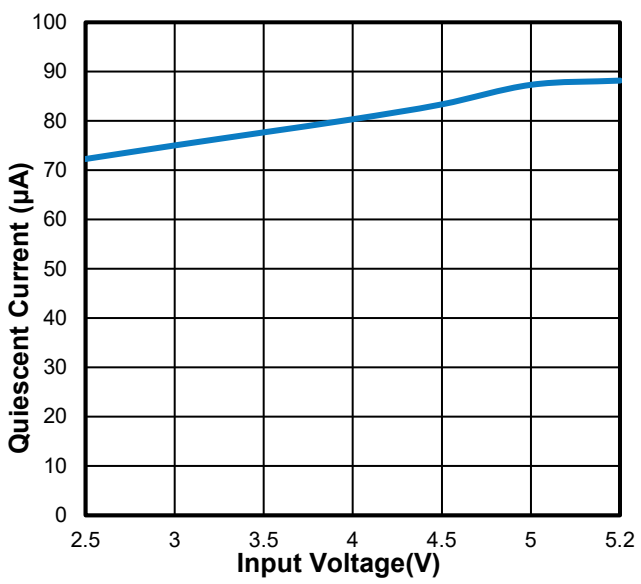
Short Current Response & Thermal Shutdown (Open R_{SET})



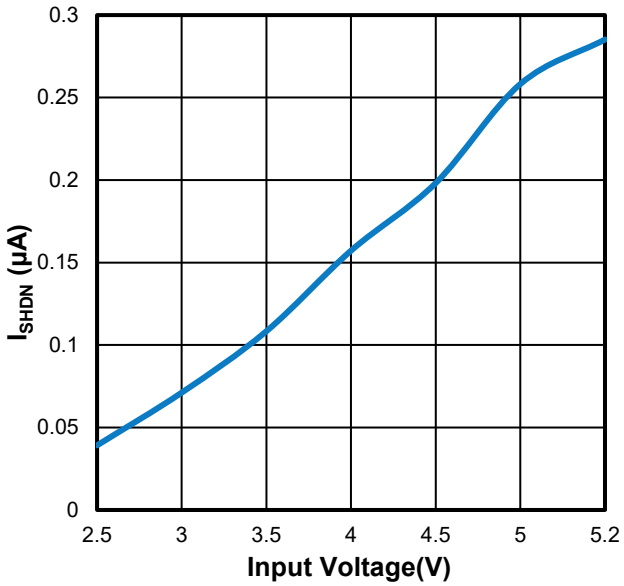
Reverse-Current Limit



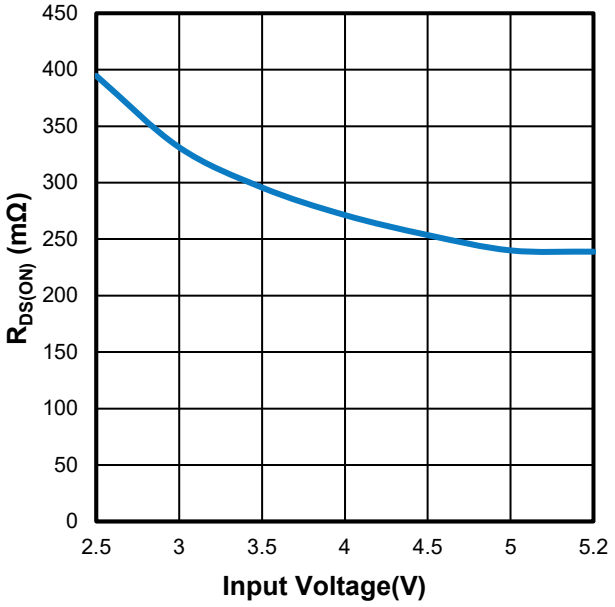
Output Over-Voltage Trip Point



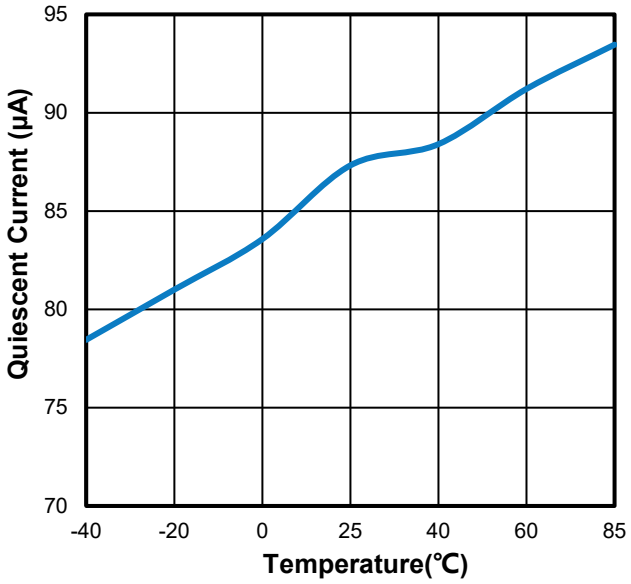
Quiescent Current vs. Input Voltage



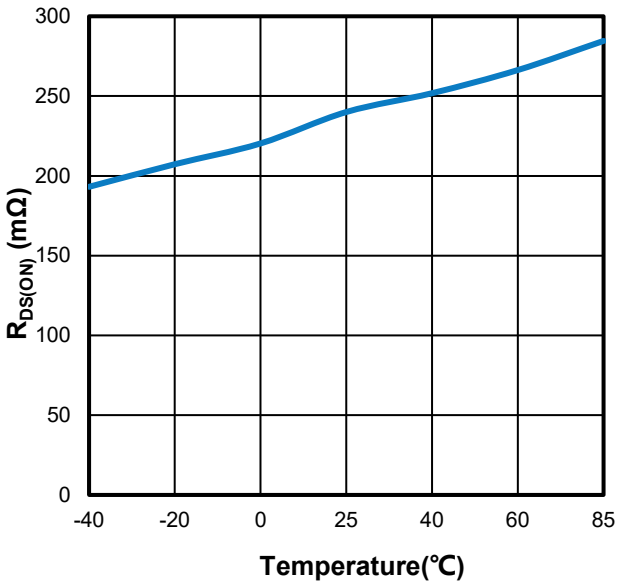
Shutdown Quiescent Current vs. Input Voltage



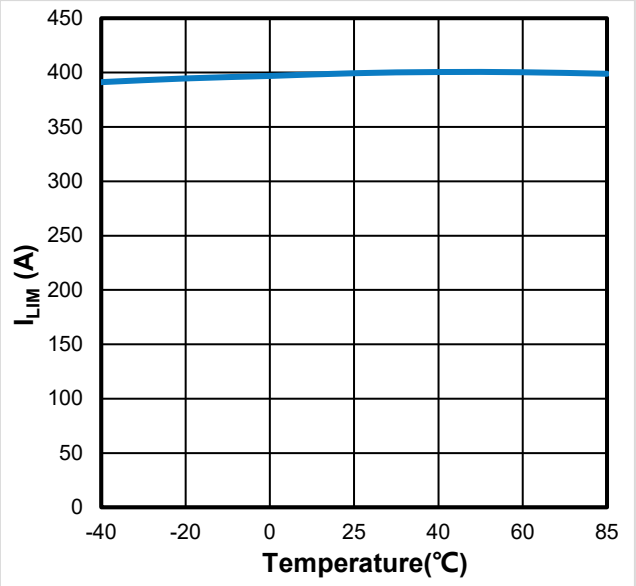
Switch On-Resistance vs. Input Voltage



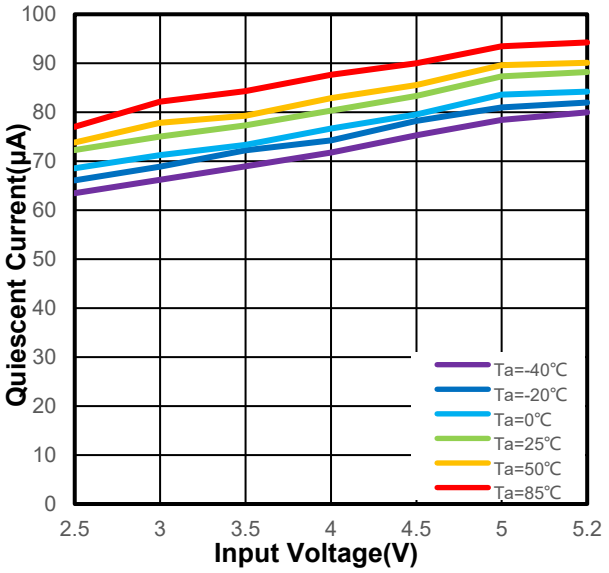
Quiescent Current vs. Ambient Temperature



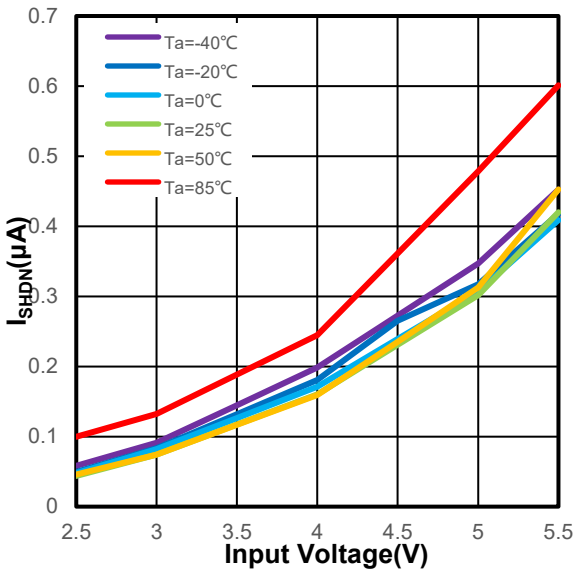
Switch On-Resistance vs. Ambient Temperature



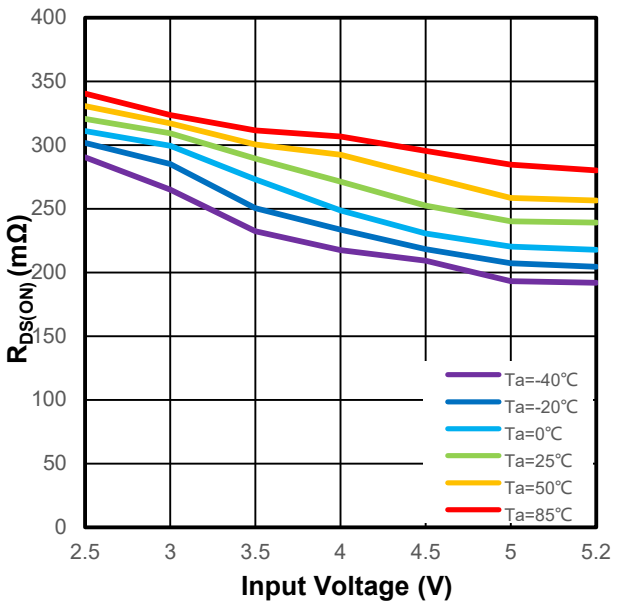
Current Limit vs. Ambient Temperature(Open R_{SET})



Quiescent Current vs. Input Voltage
vs. Ambient Temperature



Shutdown Quiescent Current vs. Input Voltage
vs. Ambient Temperature



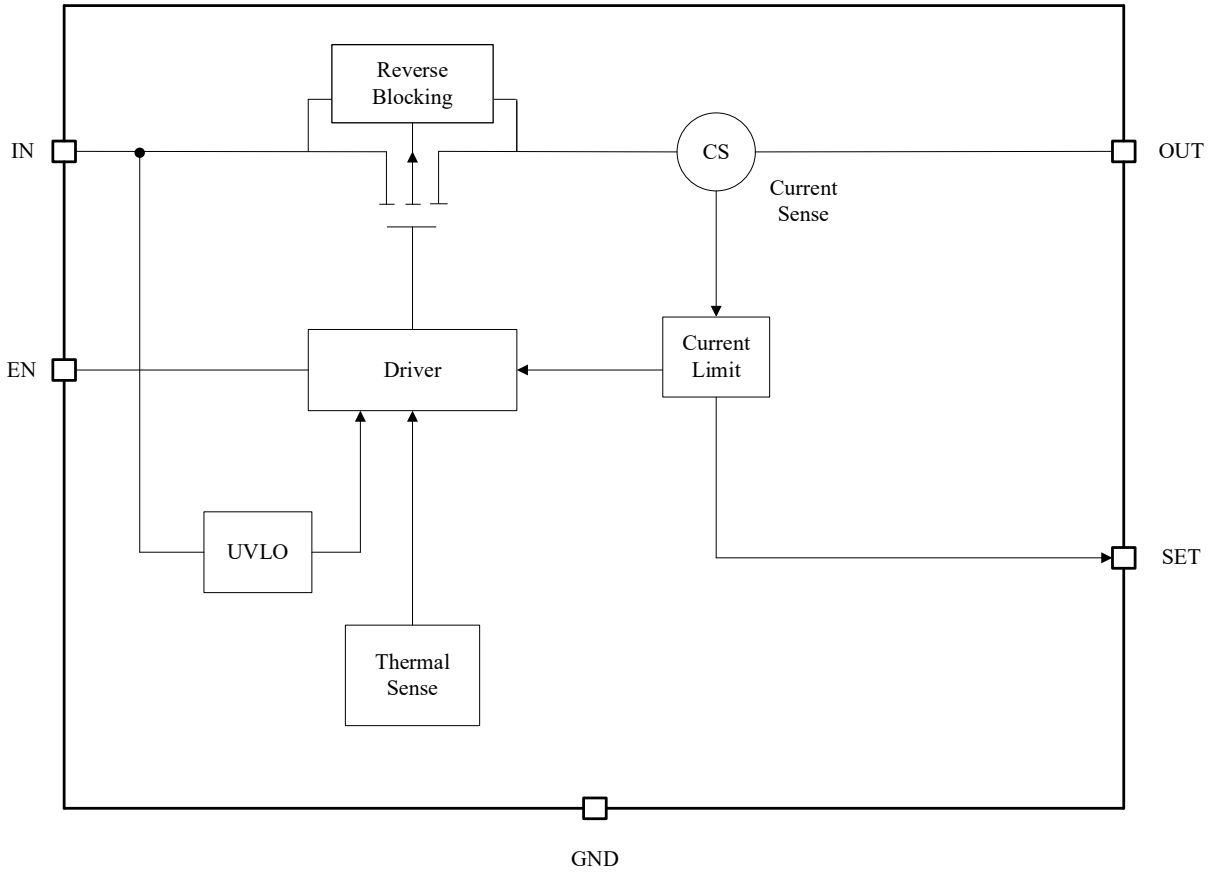
Switch On-Resistance vs. Input Voltage vs. Ambient Temperature

11. Function Description

11.1 Overview

The WP25P041T5-B load switches are 5.2V, current limited load switches in a SOT23-5 package. The devices contain a 250 mΩ current-limited P-channel MOSFET that can operate over an input voltage range of 2.5 V to 5.2V. When the switch current reaches the maximum limit, the WP25P041T5-B operates in a constant-current mode to prohibit excessive currents from causing damage. WP25P21XX-B has a programmable current limit (75mA to 400mA).

11.2 Block Diagram



11.3 Feature Description

11.3.1 Current Limiting

When the switch current reaches the maximum limit, the WP25P041T5-B operates in a constant-current mode to prohibit excessive currents from causing damage.

11.3.2 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.

11.3.3 Quick Output Discharge

The WP25P041T5-B include the Quick Output Discharge (QOD) feature, in order to discharge the application capacitor connected on OUT pin.

11.4 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 actively pulled low regardless of the fault condition, the switch will be turned off. In the event that the current limit is exceeded, the device will operate in a constant-current mode until the fault condition is removed. During thermal shutdown conditions, the switch will automatically turn off and will turn back on again if the temperature of the die drops below the threshold temperature.

11.5 Current Limiting Setting

Current limit is programmable. Connect the 1% accuracy resistor R_{SET} from SET pin to GND to program the current limit:

$$I_{LIM}\ (A) = 5000 / R_{SET}\ (\Omega)$$

The minimum current limit is 75mA. Current limit beyond 400mA is not recommended.

When $R_{SET} = \infty$ (SET Pin is floating), the current limit is 320mA～480mA.

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. EN is active high and has a low threshold, making it capable of interfacing with low-voltage signals.

12.1.2 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.

12.1.3 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.

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 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°C.

12.1.6 Over-Voltage Protection

The device has an output over-voltage protection that triggers when the output voltage reaches output over-voltage trip point. When this fault condition stays on for longer than 15μs, (This is called the “Debounce time from output over voltage to MOSFET turn off”) output device is disabled and shut down. Recovery from R_{OVP} occurs when the output voltage falls to 101% of input voltage.

12.1.7 Reverse-Current Protection

The USB specification does not allow an output device to source current back into the USB port. In a normal MOSFET switch, current will flow in reverse direction (from the output side to the input side) When the output voltage exceeds than input voltage. A reverse current limit feature is implemented in the WP25P041T5-B to limit such back currents. Reverse current limit is always active. Reverse current is limited to half of the I_{LIM} level and when the fault exists for more than 700μs, output device is disabled and shut down. This is called the "Deglitch time from reverse current trigger to MOSFET turn off.” The MOSFET will turn on again when the output voltage returns to t 101% of input voltage.

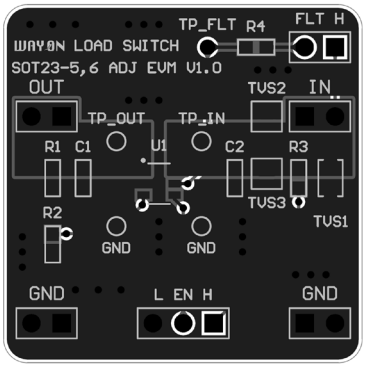
13. Power Supply Recommendations

The device is designed to operate from a V_{IN} range of 2.5 V to 5.2 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. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 10 μF may be sufficient

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. The V_{IN} terminal should be bypassed to ground with low ESR ceramic bypass capacitors. The typical recommended bypass capacitance is 1μF ceramic with X5R or X7R dielectric. This capacitor should be placed as close to the device terminals as possible. 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 by phone or address at the end to get the evaluation module or schematic.

The module names are listed in the table below.

NAME	PACKAGE	EVALUATION MODULE
WP25P041T5-B	SOT23-5	WAYON LOAD SWITCH SOT23-5 ADJ EVM V1.0

16. Naming Conventions

WP AB CCC D EE - F

WP: WAYON Protection IC;

A: Product Category –2: Load Switch;

B: Maximum Output Voltage – 5: ＜6V;

CCC: Maximum Current Limit– P04: 400mA；

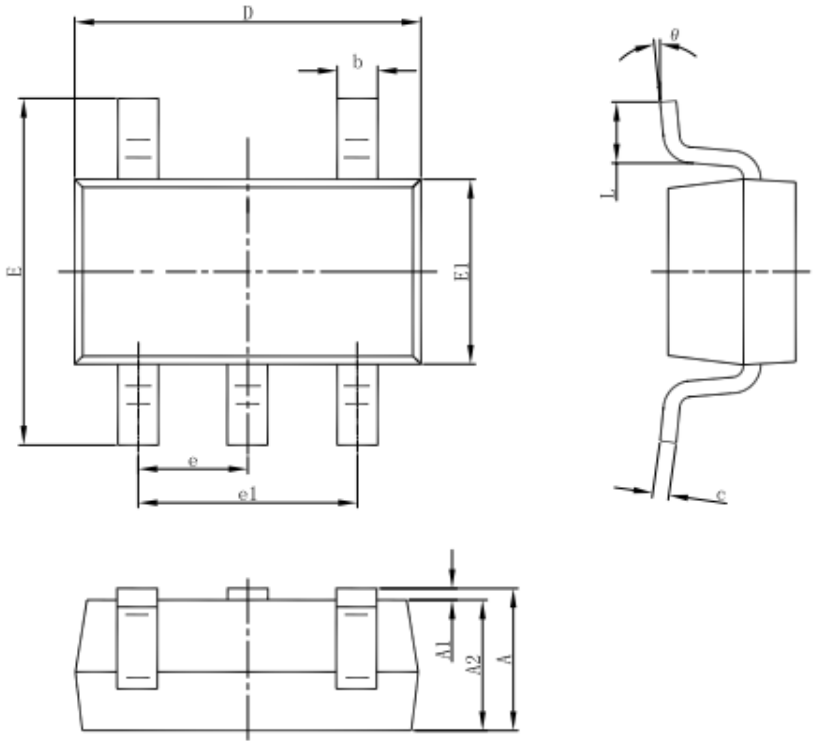
D: Serial number;

EE: Package –T5: SOT23-5;

F: Current Limit Accuracy – B: 20%

17. Package Information

SOT 23-5



SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	1.000	1.175	1.350
A1	0.000	0.075	0.150
A2	1.000	1.100	1.200
b	0.300	0.400	0.500
c	0.100	0.150	0.200
D	2.820	2.920	3.020
E1	1.500	1.600	1.700
E	2.600	2.800	3.000
e	0.950(BSC)		
e1	1.800	1.900	2.000
L	0.300	0.450	0.600
θ	0°	4°	8°

18. Ordering Information

PART NUMBER	CURRENT LIMIT	PACKAGE	PACKING QUANTITY	MARKING*
WP25P041T5-B	ADJ	SOT23-5	3k/Reel	5P041 XXXX

* XXXX is variable.

STATEMENTS

WAY-ON provides data sheets based on the actual performance of the device, and users should verify actual device performance in their specific applications. The device characteristics and parameters in this data sheet can and do vary from application to application, and actual device performance may change over time. This information is intended for developers designing with WAY-ON products. Users are responsible for selecting the appropriate WAY-ON product for their application and for designing and verifying the application to ensure that your application meets the appropriate standards or other requirements, and users are responsible for all consequences. Specifications are subject to change without notice.

Contact Information

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WAYON website: http://www.way-on.com
For additional information, please contact your local Sales Representative.
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Specifications are subject to change without notice.
The device characteristics and parameters in this data sheet can and do vary in different applications and actual device performance may vary over time.
Users should verify actual device performance in their specific applications.