LPW5202

High-Side Load Switch with Over-Current Protection

Features

- 2.4V to 6V input voltage range
- Low on-state resistance to 70mΩ
- 30µA low current consumption
- Ultra-low shutdown current (<100nA)
- Fixed or adjustable current limit
- Under-voltage lockout
- Blocking reverse current
- Thermal shutdown protection
- Fast current limit response
- ESD Protection:
    - Human Body Model: 4kV
    - Charged Device Model: 0.5kV
- SOT23-5 Package

Applications

- Notebook and PC
- Cell phone and PDAs
- USB or other peripheral ports
- Camera

General Description

The LPW5202 is a series of load switches which provide full protection to systems and loads which may encounter large current conditions.

The device contains a 70mΩ current-limited P-channel MOSFET which can operate over an input voltage range from 2.4V to 6V. The current limit is fixed or could be settable using an external resistor. When the current reaches the threshold, the device will limit the current to constant value to prohibit excessive currents from causing damage. Internally, current is prevented from flowing when the MOSFET is off and the output voltage is higher than the input voltage. Switch is controlled by an active-high logic pin. Thermal shutdown protection is integrated which shuts off the switch to prevent damage to the part when a continuous over-current condition causes excessive heating.

These parts are available in a space-saving 5 pin SOT23 package.

SOT23-5

Ordering and Marking Information

| Device	Marking	Current Limiting (minimum)	Output Discharge	Flag indicator	Package	Shipping
LPW5202AB5F		Adjustable	No	No	SOT23-5	3K/REEL
LPW5202ADB5F		Adjustable	Yes	No	SOT23-5	3K/REEL
LPW5202FB5F21		2.1A	No	Yes	SOT23-5	3K/REEL
LPW5202FDB5F21		2.1A	Yes	Yes	SOT23-5	3K/REEL
LPW5202FB5F11		1.1A	No	Yes	SOT23-5	3K/REEL
LPW5202FDB5F11		1.1A	Yes	Yes	SOT23-5	3K/REEL
LPW5202FB5F06		0.6A	No	Yes	SOT23-5	3K/REEL
LPW5202FDB5F06		0.6A	Yes	Yes	SOT23-5	3K/REEL
LPW5202SB5F21		2.1A	No	No	SOT23-5	3K/REEL
LPW5202SDB5F21		2.1A	Yes	No	SOT23-5	3K/REEL
LPW5202SB5F11		1.1A	No	No	SOT23-5	3K/REEL
LPW5202SDB5F11		1.1A	Yes	No	SOT23-5	3K/REEL
LPW5202SB5F06		0.6A	No	No	SOT23-5	3K/REEL
LPW5202SDB5F06		0.6A	Yes	No	SOT23-5	3K/REEL

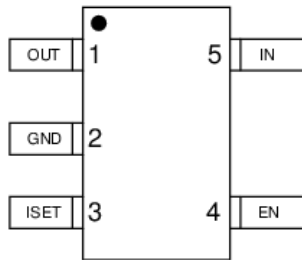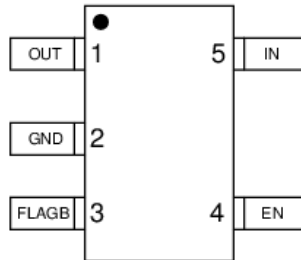## Typical Application Circuitry
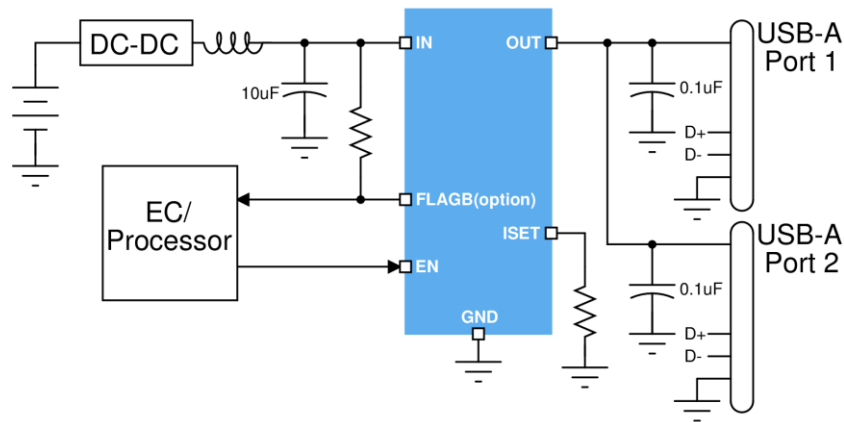
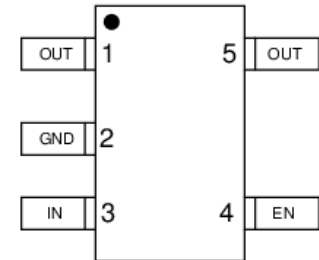**Figure 1. Typical Application Circuitry**

Pin Configuration

SOT23-5 (Top View)
for LPW5202A

SOT23-5 (Top View)
for LPW5202F

SOT23-5 (Top View)
for LPW5202S

Pin Description

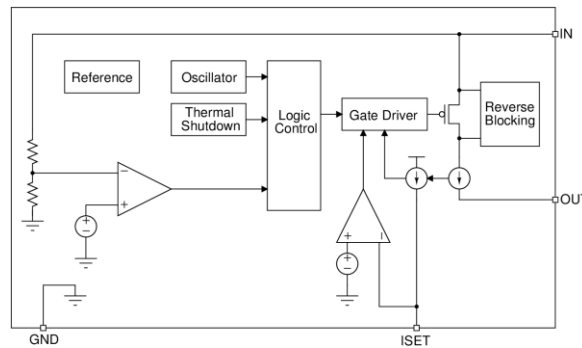| Pin	Description
GND	Ground
IN	Power supply and input of power switch
OUT	Output of power switch
ISET	Current limit setting pin to connect a resistor to ground
FLAGB	Open-drain active-low flag pin to indicate fault condition
EN	Active-high device enable pin

Functional Block Diagram

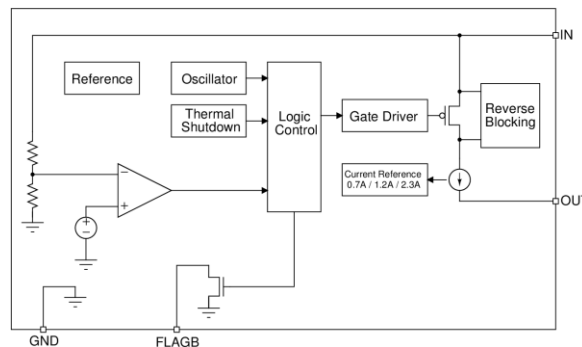

Figure 2. Internal Block Diagram (LPW5202A)

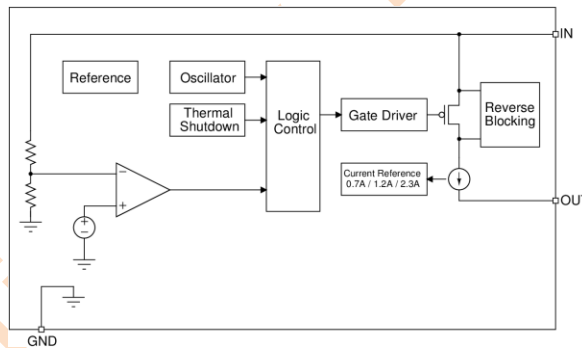
Figure 3. Internal Block Diagram (LPW5202F)

Figure 4. Internal Block Diagram (LPW5202S)

Absolute Maximum Ratings (Note 1)

- IN to GND -- -0.3V to 7V
- OUT to GND --- -0.3V to 7V
- EN to GND --- -0.3V to 7V
- ISET to GND -- -0.3V to 7V
- FLAGB to GND --- -0.3V to 7V
- Maximum Junction Temperature (T$_A$) --- 150°C
- Maximum Soldering Temperature (at leads, 10 seconds) --- 260°C

Note 1: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, instead of functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Information

- Maximum Power Dissipation (P_D, T_A <= 25℃) -- 0.6W
- Thermal Resistance (θJ$_A$) [Note 2] --- 203°C/W

Note 2: It is based on 2S2P JEDEC standard PCB.

ESD Ratings

- HBM (Human Body Model, JEDEC JS-001) --- ±4000V
- CDM (Charged Device Model, JEDEC JS-002) --- ±500V

Recommended Operating Conditions

- Input Voltage --- 2.4V to 6.0V
- Enable Voltage --- 0V to 6V
- Ambient Temperature -- -40°C to 85°C

Electrical Characteristics

The following parameters are guaranteed under condition V_{IN} =5V, T_A = -40°C to 85°C unless otherwise noted, T_A = 25°C for typical value.

Parameters		Symbol	Test conditions	Min	Typ	Max	Unit
On-resistance		$R_{DS(ON)}$	V_{IN} = 5V, I_{OUT}=200mA, T_A=25°C		70	100	mΩ
Input quiescent current		I_Q	V_{IN} = 5V, OUT floating, V_{EN} = 5V		30	50	µA
Input shutdown current		I_{SD}	V_{IN} = 5V, OUT grounded, V_{EN} = 0V			200	nA
Under voltage lockout level		V_{UVLO_F}	IN voltage falling		2.1		V
		V_{UVLO_R}	IN voltage rising		2.2		V
Over current trigger level	LPW5202Axxx	I_{OCP}	Refer to **Figure 6**				A
	LPW5202xxx21		V_{IN} = 5V, T_A=25°C		2.14		
	LPW5202xxx11		V_{IN} = 5V, T_A=25°C		1.12		
	LPW5202xxx06		V_{IN} = 5V, T_A=25°C		0.65		
Current limit level	LPW5202Axxx	I_{LIM}	Refer to **Figure 6** and **Equation (1)**				A
	LPW5202xxx21		V_{IN} = 5V, V_{OUT} = 4.5V, T_A=25°C		2.3		
	LPW5202xxx11		V_{IN} = 5V, V_{OUT} = 4.5V, T_A=25°C		1.2		
	LPW5202xxx06		V_{IN} = 5V, V_{OUT} = 4.5V, T_A=25°C		0.7		
Short circuit protection level		I_{SHORT}	V_{IN} = 5V, T_A=25°C		7		A
Output auto discharge		R_{DIS}	V_{IN} = 5V, V_{EN} = 0V		100		Ω

Reverse voltage protection[3]	V_{RVP}	V_{IN} = 5V, V_{OUT} - V_{IN} level to trigger off		115		mV
Enable logic high voltage level	V_{IH}	V_{IN} = 2.4V to 6V	1.4			V
Enable logic high voltage level	V_{IL}	V_{IN} = 2.4V to 6V			0.4	V
Output logic low voltage level	V_{OL}	V_{IN} = 2.4V to 6V, I_{FLAGB} = 10mA			0.1	V
Leakage on FLAGB pin	I_{LKG_FLAGB}	V_{IN} = 5V, V_{FLAGB} = 5V			0.1	μA
FLAGB de-bounce time	t_{DEB_FLAGB}	V_{IN} = 5V, R_{FLAG_PU} = 10kΩ, T_A = 25°C, time from I_{OUT} hits I_{OCP} to V_{FLAGB} = 0.1V		10		ms
OCP response time	t_{OCP}	V_{IN} = 5V, T_A = 25°C, time from I_{OUT} hits I_{OCP} to I_{OUT} stop rising				μs
Short circuit protection time	t_{SHORT}	V_{IN} = 5V, T_A = 25°C, time from I_{OUT} hits I_{SHORT} to switch turned off		300		ns
Load switch turned on delay	t_{DON}	V_{IN} = 5V, R_{OUT} = 500Ω, C_{OUT} = 10μF, time from enabled to V_{OUT} = 0.5		500		μs
Output rising time	t_R	V_{IN} = 5V, R_{OUT} = 500Ω, C_{OUT} = 10μF, time from V_{OUT} = 0.1×V_{IN} to 0.9×V_{IN}		450		μs
Load switch turned off delay	t_{OFF}	V_{IN} = 5V, R_{OUT} = 500Ω, C_{OUT} = 0.1μF, time from disabled to V_{OUT} = 0.9×V_{IN}		5.5		μs
Thermal shutdown trigger	T_{SD}	Temperature rising		150		°C
Thermal shutdown release	T_{SD_REL}	Temperature falling		130		°C

Note 3. The parameter is guaranteed by design and characterization.
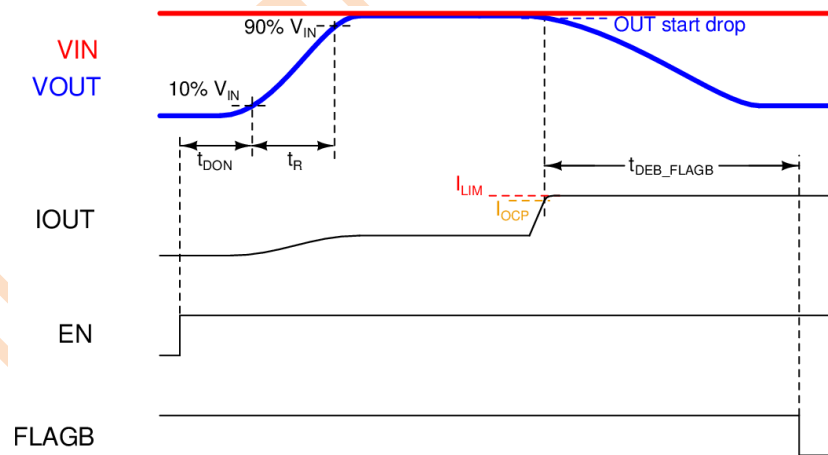
Typical Timing Diagram

Figure 5. Start-up and over current protection

Function Description

LPW5202 series are current limited switches that protect systems and loads which can be damaged or disrupted by the application of high currents. The devices all contain a 70mΩ P-channel MOSFET and a controller capable of working over a wide input operating range of 2.4V to 6V. The controller protects against system malfunctions through current limiting, under-voltage lockout and thermal shutdown. The current limit is adjustable from 400mA to 2.5A through an external resistor, or fixed value to allow 0.6A, 1.1A or 2.1A applications.

Enable control

The EN pin controls the state of the switch. When EN is pulled high, the load switch is turned on. Activating EN continuously holds the switch in the on state so long as there is no fault. For all versions, an under-voltage on IN or a junction temperature in excess of 150°C overrides the EN control to turn off the switch. The LPW5202 does not turn off in response to an over current condition but instead remains operating in a constant current mode as long as EN is active and the thermal shutdown or under-voltage lockout have not activated.

The enable pin EN's control voltage and IN pin have independent recommended operating ranges. The EN pin voltage can be driven by a voltage level higher than the input voltage.

Reverse Voltage Protection

The LPW5202 has a reverse voltage protection feature that protects the input when output voltage is higher than the input. For a standard USB power design, this is an important feature to protect the USB host from being damaged due to the current flow from VBUS.

When the load switch is OFF, no current flows from the output to the input. If the switch is turned on and V_{OUT} - V_{IN} is higher than V_{RVP}, this feature is activated and turns off the switch. This prevents any current flow from output to input. The reverse voltage protection feature will be deactivated if the V_{OUT} is smaller than V_{IN}. FLAGB operation is independent of the reverse voltage protection and does not report a fault condition if this feature is activated

Current Limit

The current limit ensures that the current through the switch doesn't exceed a maximum value while not limiting at less than a minimum value. The current at which the parts will limit is fixed (LPW5202F/S) or adjustable through the selection of an external resistor connected to ISET (LPW5202A). The LPW5202F have a de-bounce time of 10ms, nominally, for indicator pin. At the end of this time, the FLAGB will be internally pulled down. As long as the heavy load condition continued, the LPW5202 will remain in a constant current state until the EN pin is deactivated or the thermal shutdown turns-off the switch.

Under-Voltage Lockout

The under-voltage lockout turns-off the switch if the input voltage drops below the under-voltage lockout threshold. With the EN pin active, the input voltage rising above the under-voltage lockout threshold will cause a controlled turn-on of the switch which limits current over-shoots.

Thermal Shutdown

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

Application Information

The LPW5202A current limit is set with an external resistor connected between ISET pin and GND. This resistor is selected using the following equation:

$$R_{SET} = \frac{7700}{I_{LIM}}$$

(1)

Where, R_{SET}, united as kΩ, is the resistor connected to ISET. I_{LIM} is the expected current limit value in mA. Resistor tolerance of 1% or less is recommended.

The relationship between R_{SET} and I_{LIM} could also be found as below diagram:
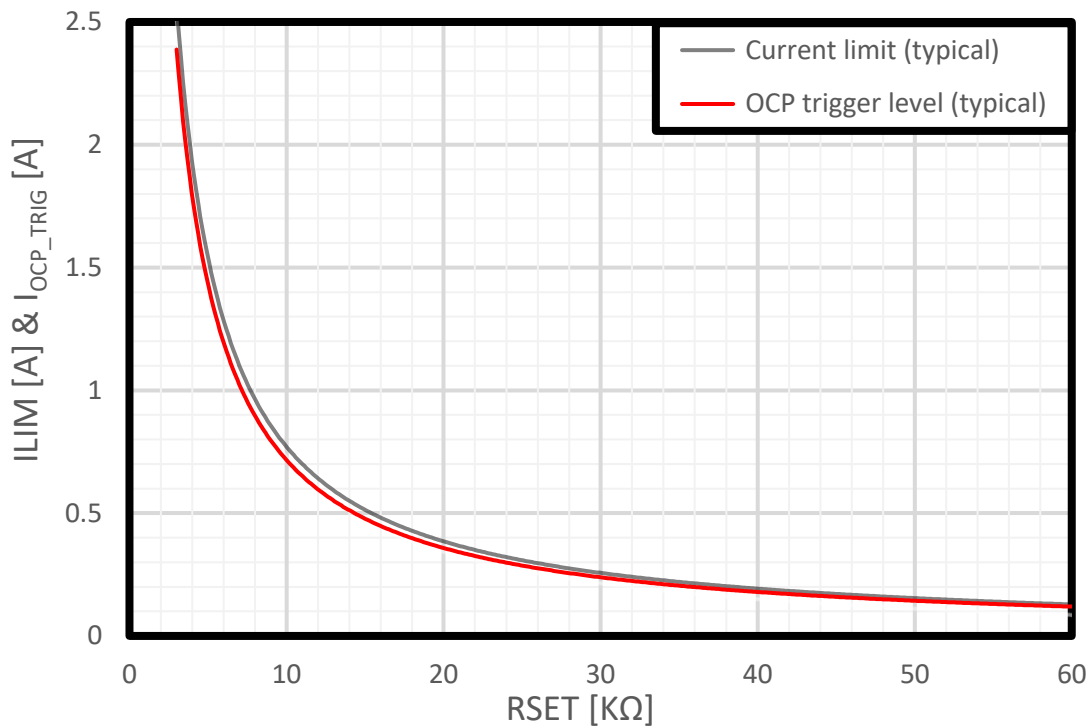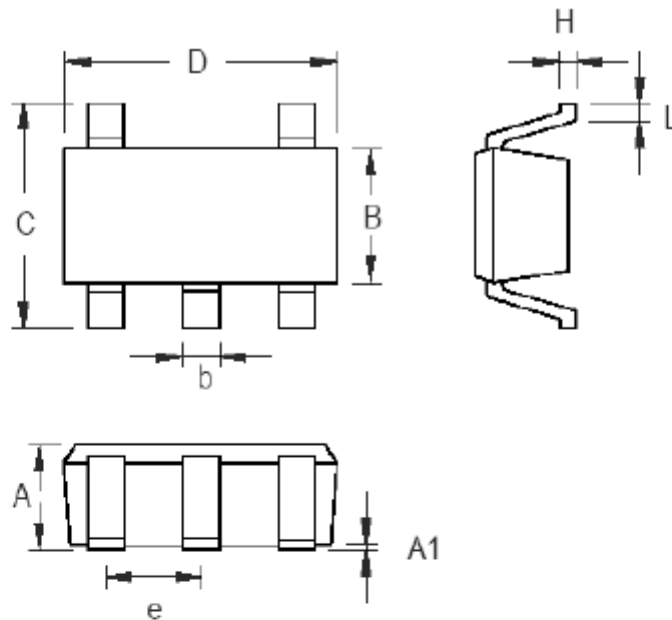

Figure 6. Current limit level and OCP trigger level

Package Information

SOT23-5

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.035	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.356	0.559	0.014	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024