



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

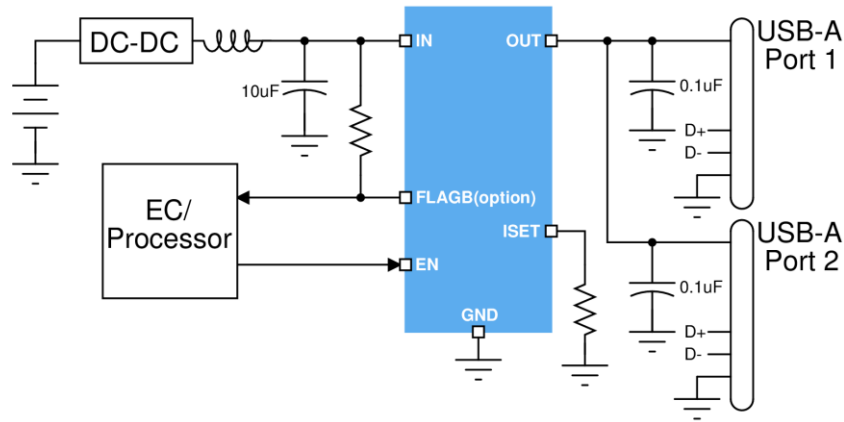
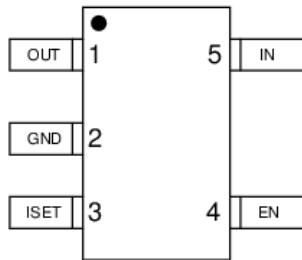
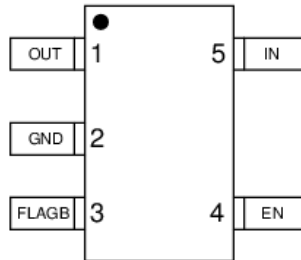


Figure 1. Typical Application Circuitry

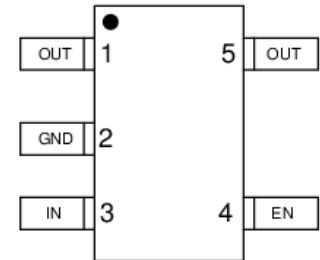
Pin Configuration



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

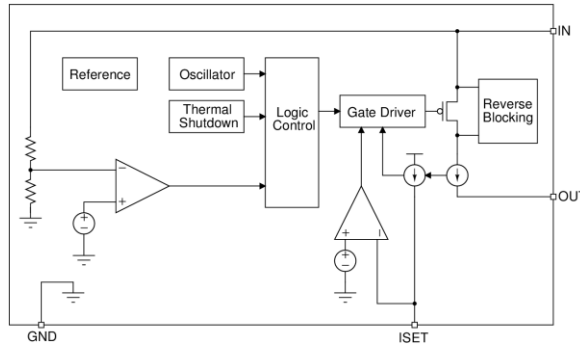


Figure 2. Internal Block Diagram (LPW5202A)

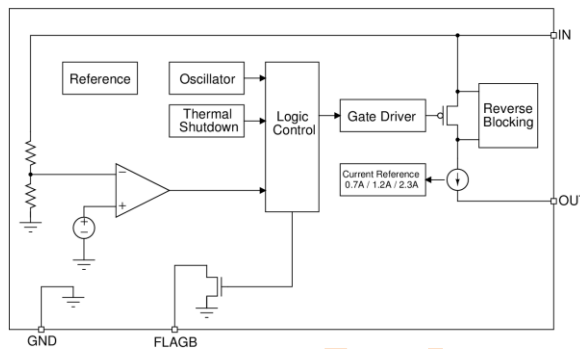


Figure 3. Internal Block Diagram (LPW5202F)

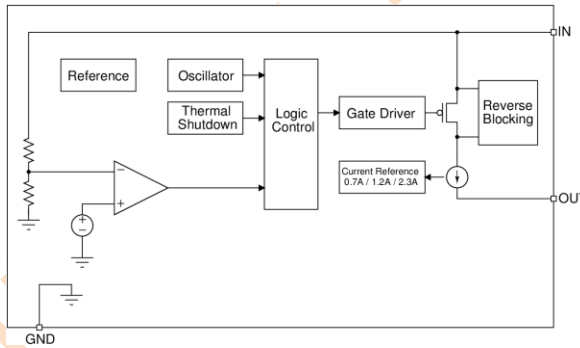


Figure 4. Internal Block Diagram (LPW5202S)

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 , $T_A \leq 25^\circ\text{C}$) ----- 0.6W
- Thermal Resistance (θ_{JA}) (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 $V_{IN} = 5V$, $T_A = -40^\circ\text{C}$ to 85°C unless otherwise noted, $T_A = 25^\circ\text{C}$ for typical value.

| Parameters | | Symbol | Test conditions | Min | Typ | Max | Unit |
|--------------------------------|--------------|---------------|---------------------------------------------------------------------|-----|------|-----|------|
| On-resistance | | $R_{DS(ON)}$ | $V_{IN} = 5V$, $I_{OUT} = 200\text{mA}$, $T_A = 25^\circ\text{C}$ | | 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 | | $V_{IN} = 5V$, $T_A = 25^\circ\text{C}$ | | 2.14 | | |
| | LPW5202xxx11 | | $V_{IN} = 5V$, $T_A = 25^\circ\text{C}$ | | 1.12 | | |
| | LPW5202xxx06 | | $V_{IN} = 5V$, $T_A = 25^\circ\text{C}$ | | 0.65 | | |
| Current limit level | LPW5202Axxx | I_{LIM} | Refer to Figure 6 and Equation (1) | | | | A |
| | LPW5202xxx21 | | $V_{IN} = 5V$, $V_{OUT} = 4.5V$, $T_A = 25^\circ\text{C}$ | | 2.3 | | |
| | LPW5202xxx11 | | $V_{IN} = 5V$, $V_{OUT} = 4.5V$, $T_A = 25^\circ\text{C}$ | | 1.2 | | |
| | LPW5202xxx06 | | $V_{IN} = 5V$, $V_{OUT} = 4.5V$, $T_A = 25^\circ\text{C}$ | | 0.7 | | |
| Short circuit protection level | | I_{SHORT} | $V_{IN} = 5V$, $T_A = 25^\circ\text{C}$ | | 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

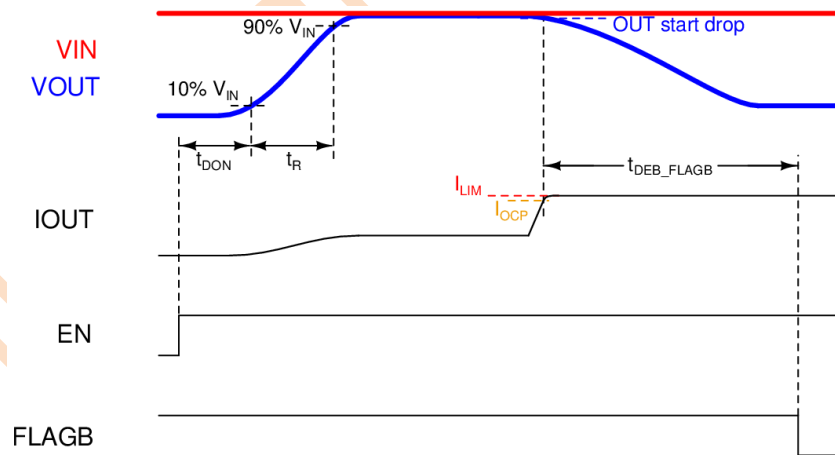


Figure 5. Start-up and over current protection

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:

$$R_{SET} = \frac{7700}{I_{LIM}} \quad (1)$$

Where, R_{SET} , united as $k\Omega$, 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:

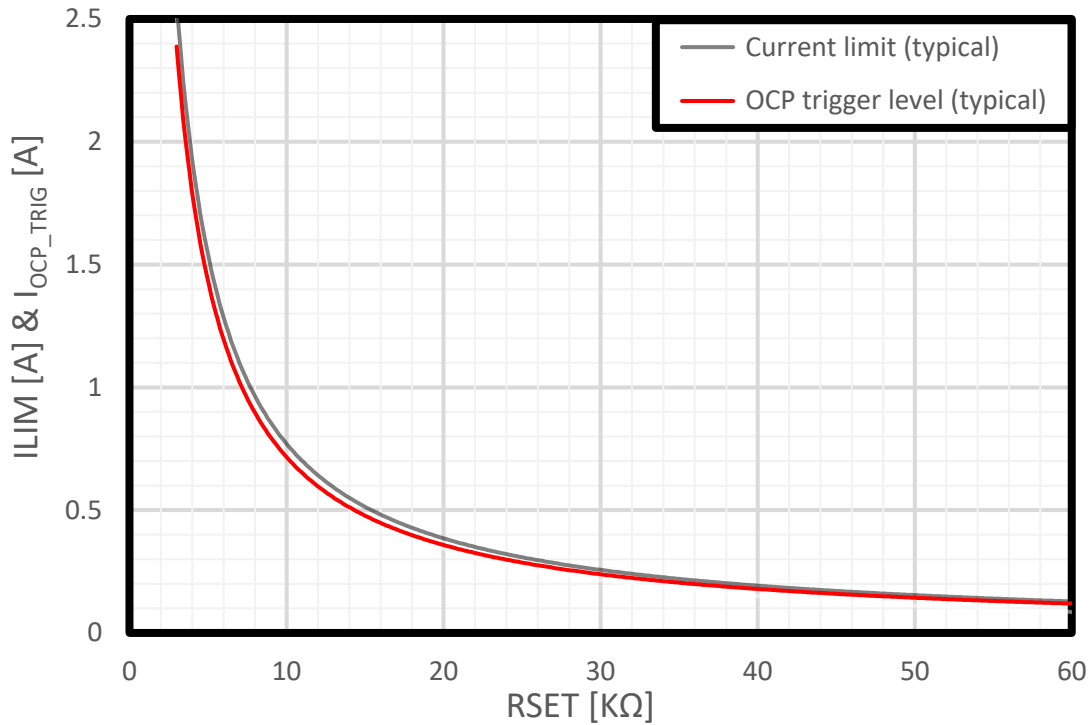
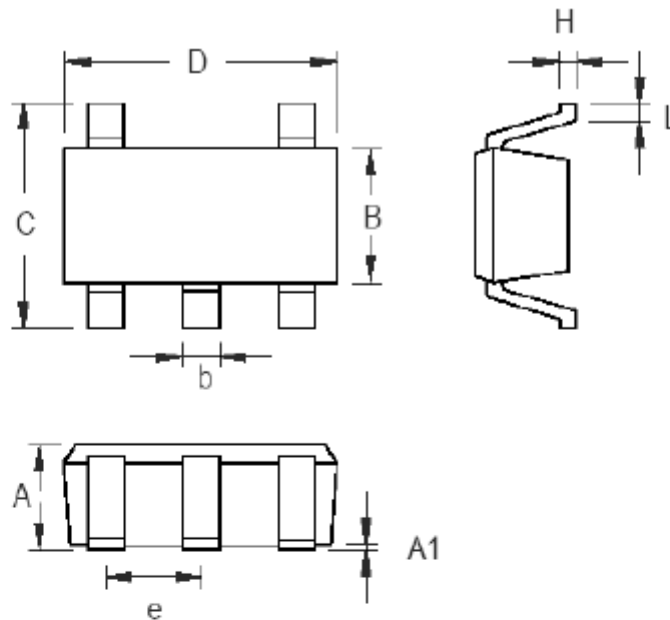


Figure 6. Current limit level and OCP trigger level



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 |

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