Description

The LP25P21T5 is current limited P-channel MOSFET power switch designed for high-side load switching applications. This switch operates with inputs ranging from 2.5V to 5.5V, 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 LP25P21T5 is also protected from thermal overload which limits power dissipation and junction temperatures. It can be used to control loads that require from 0.4A to 2A. Current limit threshold is programmed with a resistor from SET to ground. The quiescent supply current in active mode is only 25μA. In shutdown mode, the supply current decreases to less than 1μA.

The LP25P21T5 is available in Pb-free packages and is specified over the -40°C to +85°C ambient temperature range.

Features

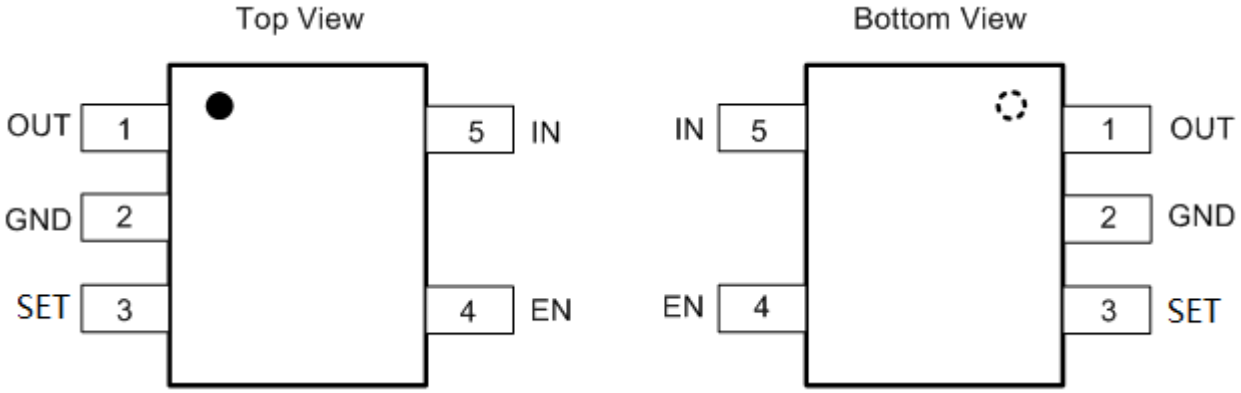
- Input Voltage Range: 2.5V to 5.5V
- Programmable Current Limit
- Reverse Current Blocking
- Short-Circuit Response: 2μs
- Very Low Quiescent Current: 25μA (Typ)
- 1μA Max Shutdown Supply Current
- Under-Voltage Lockout
- Thermal Shutdown
- 4kV ESD Rating
- Package: SOT23-5
- Ambient Temperature Range: -40ºC to +85ºC

Applications

- Laptop/Desktop Computers and Netbooks
- 3G Wireless Cards
- Smart Phones and PDAs
- LCD TVs and Monitors
- Set-Top-Boxes
- MP3/MP4
- Printers
- Portable Game Players
- Portable Media Players and MIDs
- USB Keyboards
- USB Hard Disk Drives
- USB Memory Drives
- USB Hubs

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Pin Configuration



Pin Function

Pin Number	Pin Name	Pin Function
1	OUT	Power output.
2	GND	Ground pin.
3	SET	Current limit programming pin, with a resistor from ISET to ground.
4	EN	Enable input, High enable.
5	IN	Power supply input.

Absolute Maximum Ratings

Parameter	Rating	Unit
IN, EN Voltage	-0.3 to 6	V
OUT Voltage	-0.3 to VIN + 0.3	V
OUT Current	Internal Limited	A
Power Dissipation	300	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)	300	°C

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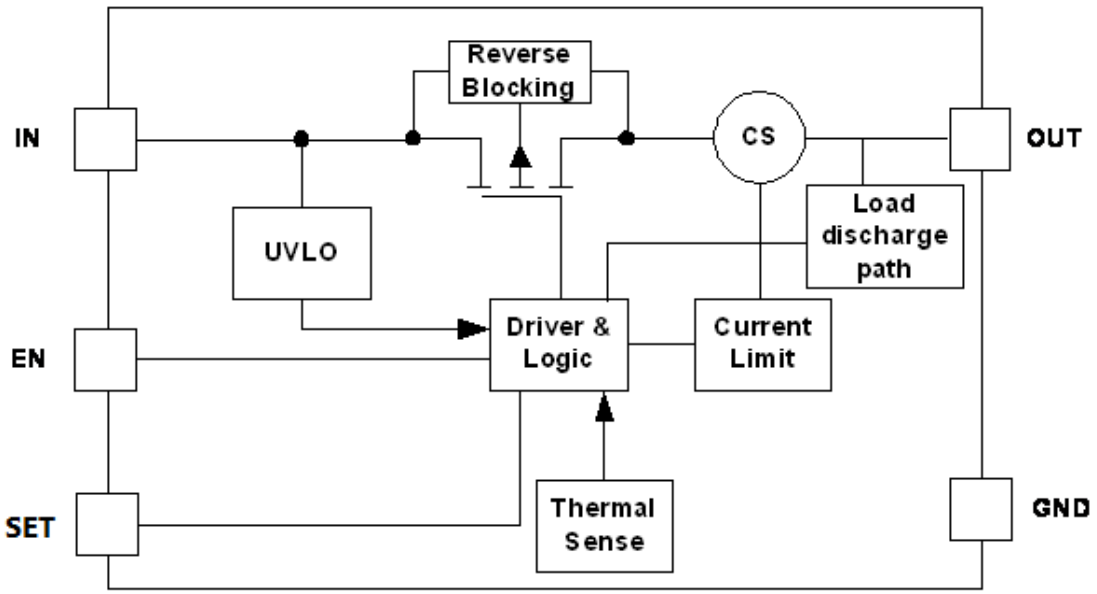
Electrical Characteristics

(V_{IN}=+5.0V, T_A=-40ºC to 85ºC, typical values at T_A=25ºC, unless otherwise stated)

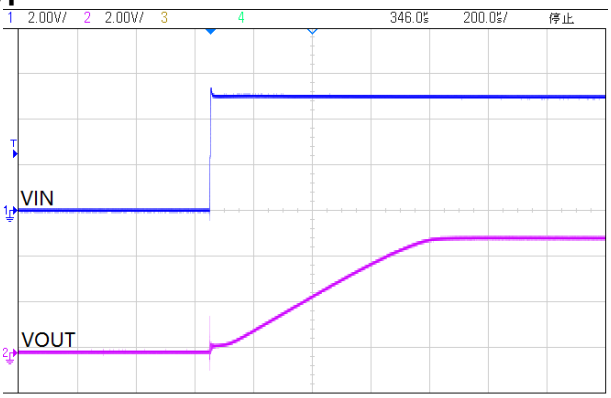
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
V_{IN}	Input Voltage Range		2.5		5.5	V
V_{UVLO}	Input UVLO		1.4	1.8	2.2	V
$V_{UVLOHys}$	UVLO Hysteresis			0.1		V
I_{SHDN}	Input Shutdown Quiescent Current	Disabled, OUT floating or shorted to ground		0.1	1	μA
I_Q	Input Quiescent Current/Channel	Enabled, I_{OUT}= 0		25	60	μA
$R_{DS(ON)}$	Switch on-resistance	V_{IN}=5V, I_{OUT}=0.6A		70	120	mΩ
I_{LMT}	Current Limit	V_{IN}=5V, V_{OUT}=4.5V, R_{SET}=6.8kΩ	0.75	1	1.25	A
$I_{LMT(min)}$				0.4		A
V_{IL}	EN Input Logic Low Voltage				0.8	V
V_{IH}	EN Input Logic High Voltage		2			V
I_{SINK}	EN Input leakage	V_{EN} = 5V		0.01	1	μA
T_{ON}	Output Turn-on Delay Time	V_{IN} =5V, C_L=1μF, R_{LOAD}=100Ω	0.2	0.6	1	ms
T_R	Output Turn-on Rise Time	V_{IN} =5V, C_L=1μF, R_{LOAD}=100Ω	0.2	0.5	0.8	ms
T_{OFF}	Output Turn-off Delay Time	V_{IN} =5V, C_L=1μF, R_{LOAD}=100Ω	0.1	0.3	0.5	ms
T_F	Output Turn-off Fall Time	V_{IN} =5V, C_L=1μF, R_{LOAD}=100Ω	50	120	200	μs
$R_{discharge}$	Output discharge FET R_{dson}	Disabled, V_{IN} = 5V, V_{OUT}=5V	200	400	800	Ω
I_{REV}	Rverse leakage current	V_{OUT}= 5V , V_{IN}=0V measure I_{VOUT}		0.2	2	μA
T_{SHDN}	Thermal shutdown threshold	V_{IN} = 5V	120	135	155	ºC
T_{HYS}	Thermal shutdown hysteresis	V_{IN} = 5V		15		ºC

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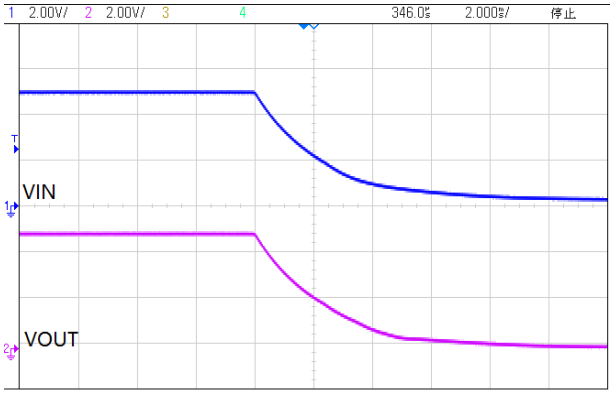
Block Diagram



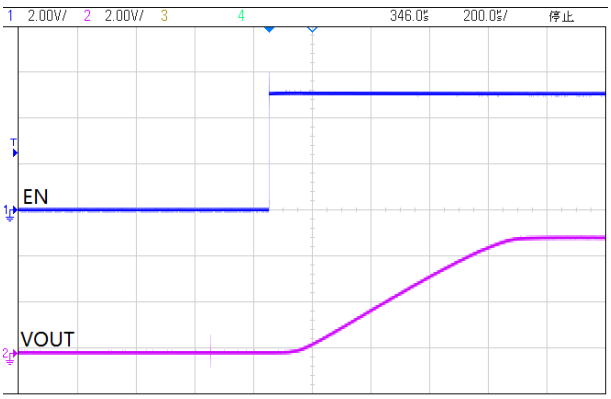
Typical Performance Characteristics



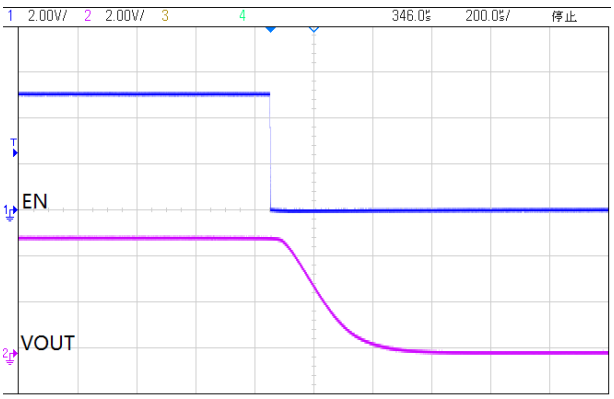
UVOL at Rising



UVOL at Falling

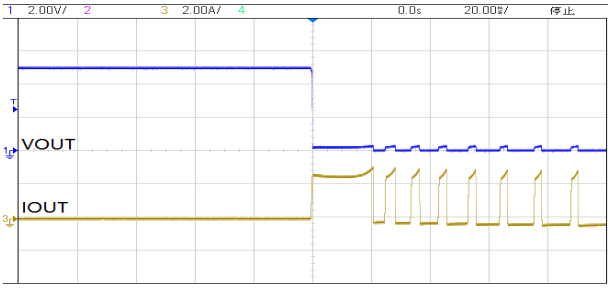


Turn on delay

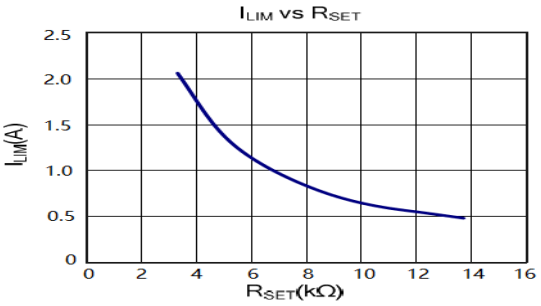


Turn off delay

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Short circuit response and Thermal shut down



Operation

LP25P21T5 is an integrated power switch with a low $R_{DS(ON)}$ P-channel MOSFET, internal gate drive circuit, programmable current limiting. When the LP25P21T5 turns on, it can deliver up to 2A continuous current to load. When the device is active, if there is no load, the device only consumes 25μA supply current, which makes the device suitable for battery powered applications.

Power Supply Considerations

A 0.01μF to 0.1μF ceramic bypass capacitor between IN and GND, close to the device, is recommended. Placing a high-value electrolytic capacitor on the output pin(s) is recommended when the output load is heavy. This precaution reduces power-supply transients that may cause ringing on the input and minimize the input voltage droops. Additionally, bypassing the output with a 0.01μF to 0.1μF ceramic capacitor improves the immunity of the device to short-circuit transients.

Power Dissipation and Junction Temperature

The low on-resistance on the P-channel MOSFET allows the small surface-mount packages to pass large currents. It is good design practice to check power dissipation and junction temperature for each application. Begin by determining the $R_{DS(ON)}$ of the P-channel MOSFET relative to the input voltage and operating temperature. Using the highest operating ambient temperature of interest and $R_{DS(ON)}$, the power dissipation per switch can be calculated by:

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

Finally, calculate the junction temperature:

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

Where:

T_A= Ambient temperature

$R_{\theta JA}$ = Thermal resistance

P_D = Total power dissipation

Compare the calculated junction temperature with the maximum junction temperature which is 125°C. If they are within degrees, either the maximum load current needs to be reduced or another package option will be required.

Over Current

A sense FET is employed to check for overcurrent conditions. When an overcurrent condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. LP25P2 1T5 will limit the current until the overload condition is removed or the device begins to thermal cycle.

Three possible overload conditions can occur. In the first condition, the output has been shorted before the device is

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enabled or before VI(IN) has been applied. The LP25P21 T5 senses the short and immediately switches into a constant-current output.

In the second condition, a short or an overload occurs while the device is enabled. At the instant the overload occurs, high currents may flow for a short period of time before the current-limit circuit can react .

After the current-limit circuit reached the overcurrent trip threshold, the device switches into constant-current mode.

In the third condition, the load has been gradually increased beyond the recommended operating current. The current is permitted to rise until the current-limit threshold is reached or until the thermal limit of the device is exceeded. The LP25P21 T5 is capable of delivering current up to the current-limit threshold without damaging the device. Once the threshold has been reached, the device switches into its constant-current mode.

Thermal Protection

Thermal protection prevents damage to the IC when heavy-overload or short-circuit faults are present for extended periods of time. The LP25P21 T5 implements a thermal sensing to monitor the operating junction temperature of the power distribution switch. In an overcurrent or short-circuit condition, the junction temperature rises due to excessive power dissipation. Once the die temperature rises to approximately 135°C due to overcurrent conditions, the internal thermal sense circuitry turns the power switch off, thus preventing the power switch from damage. Hysteresis is built into the thermal sense circuit, and after the device has cooled approximately 15°C, the switch turns back on. The switch continues to cycle in this manner until the load fault or input power is removed.

Current Limiting Setting

Current limit is programmable to protect the power source from over current and short circuit conditions. Connect a resistor RSET from SET pin to GND to program the current limit:

$$I_{LIM}\,(A) = 6800 / R_{SET}\,(\Omega)$$

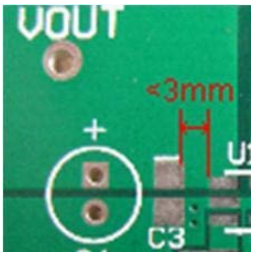
The minimum current limit is 0.4A. Current limit beyond 2A is not recommended.

PCB Layout Guide

PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout for optimum performance. If change is necessary, please follow these guidelines for reference.

1) Keep the path of current short and minimize the loop area formed by Input and output capacitor.

2) Output capacitor and IC must be on the same side. The distance of out pin and output capacitor <3mm is recommended.



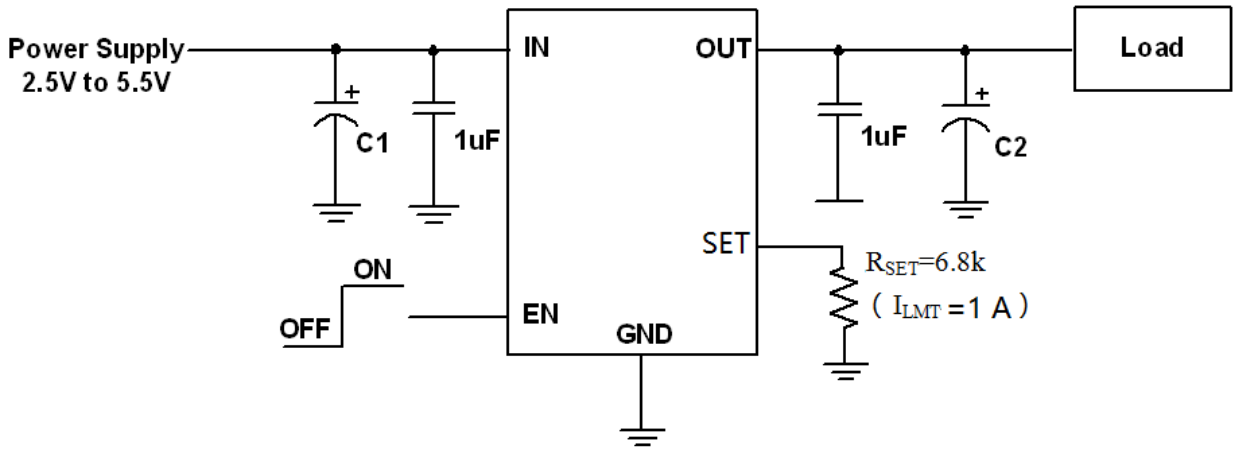
3) Bypass ceramic capacitors are suggested to be put close to the Vin Pin.

4) Connect IN, OUT, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.

5) A 2-layer PCB layout is recommended.

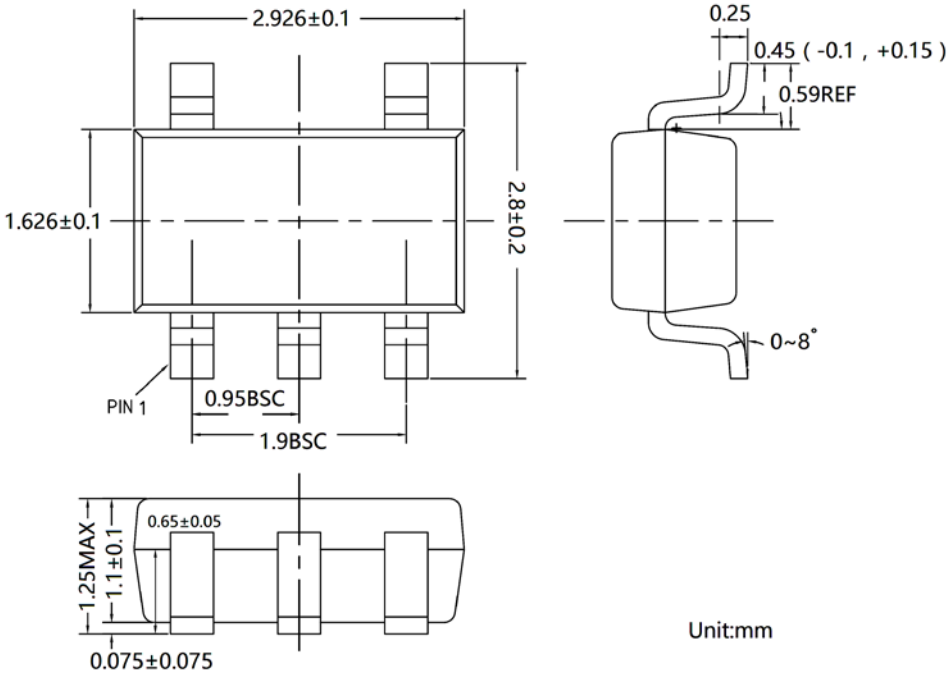
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Application Circuits



Note: Tantalum or Aluminum Electrolytic capacitors (C1 and C2) may be required for USB applications

Package



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