200mΩ Power Distribution Switches

Description

The SC91S15 is an integrated 200mΩ Power switch for self-powered and bus-powered Universal Series Bus (USB) applications. A built-in charge pump is used to drive the MOSFET that is free of parasitic body diode to eliminate any reversed current flow across the switch when it is powered off. Its low quiescent supply current (50μA) and small package (SOT-23-5) is particularly suitable in battery-powered portable equipment.

Several protection functions include soft start to limit inrush current during plug-in, current limiting at 1.5A to meet USB power requirement, and thermal shutdown to protect damage under over current condition.

The SC91S15 converters are available in the industry standard SOT-23-5L packages.

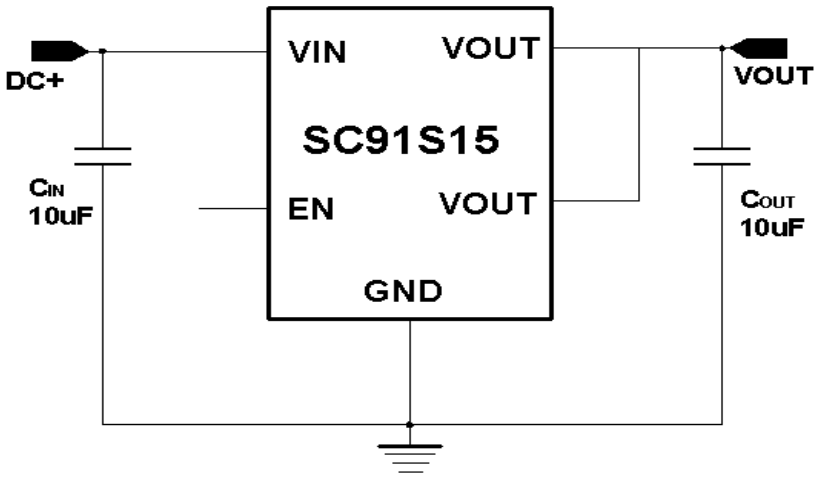
Features

- 200mΩ Typ. High-Side MOSFET
- Guaranteed 1A Continuous Current
- 1.5A Current Limit
- Soft Start
- Thermal Protection
- Low 50μA Supply Current
- Small SOT-23-5 Package Minimizes Board Space

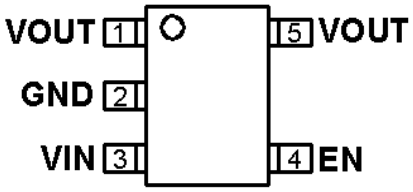
Applications

- Battery-Powered Equipment
- Motherboard USB Power Switch
- USB Device Power Switch
- Hot-Plug Power Supplies
- Battery-Charger Circuits

Typical Application Circuit



Pin Configurations

Package Type	Pin Configurations
SC91S15 SOT-23-5L	

Pin Description

PIN SOT-23-5L	NAME	DESCRIPTION
1、5	VOUT	MOSFET Drain. Bypass V_{OUT} with ESR capacitor. However stability improves with higher ESRs.
2	GND	Power and Signal Ground for the IC.
3	VIN	MOSFET Source. When operating SC91S15 as a switch it must be bypassed with a low ESR ceramic capacitor.
4	EN	Status Condition Indicator. This pin indicates the conducting status of the SC91S15. If the part is forward biased (V_{IN}>V_{OUT}+V_{FWD}) this pin will be Hi-Z. If the part is reverse biased (V_{OUT}>V_{IN}+V_{RTO}), then this pin will pull down 10mA through an open-drain. When terminated to a high voltage through a 470k resistor, a high voltage indicates diode conducting. May be left floating or grounded when not in use.

Absolute Maximum Ratings

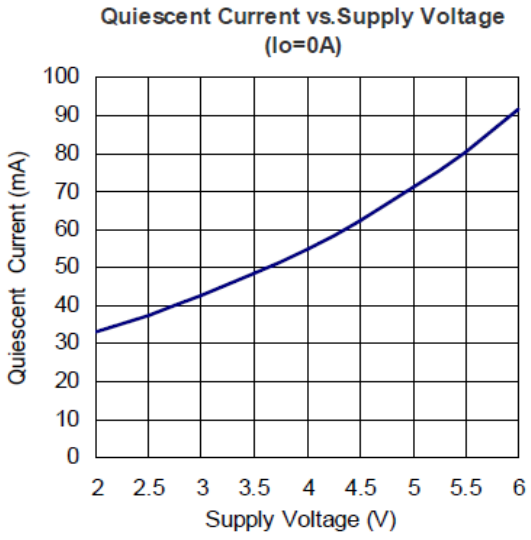
- Input Supply Voltage (Vcc) ---------- –0.3V to 7V
- Chip Enable ---------- –0.3V to 7V
- Power Dissipation, PD @ TA = 25°C ---------- 0.25W
- Maximum Junction Temperature ---------- 125℃
- Operating Ambient Temperature Range ---------- –20℃ to 85℃
- Storage Temperature Range ---------- –65℃ to 125℃
- Package Thermal Resistance SOT-23-5 ---------- 289°C /W
- VOUT ESD Level HBM (Human Body Mode---------- 4KV
- MM (Machine Mode) ---------- 400V

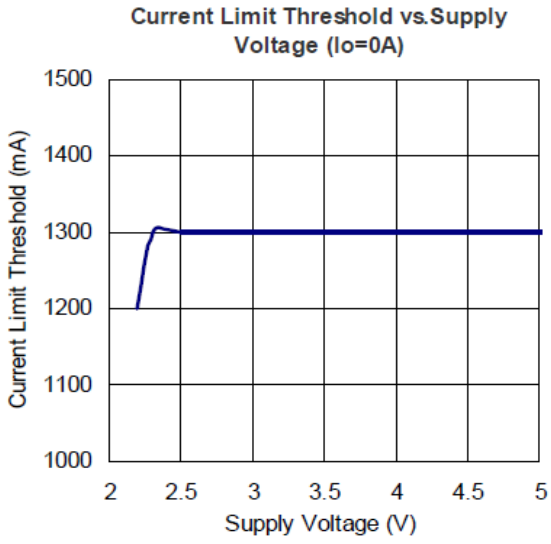
Electrical Characteristics

V_{IN} = 5V, C_{IN} =10μF, C_{OUT} = 1μF, T_A = 25°C, unless otherwise specified.

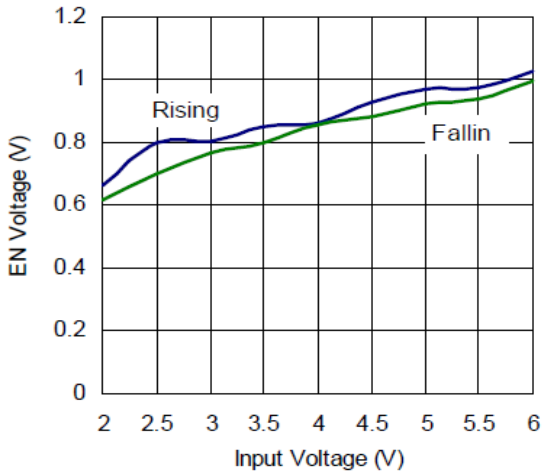
SYMBOL	PARAMETER	CONDITIONS	SC91S15			UNITS
			MIN	TYP	MAX	
V_{IN}	Input Voltage Range		1.9		5.5	V
$R_{DS(ON)}$	Output NMOFET RDS(ON))	VIN=5V, ILOAD=500 mA		200		mΩ
I_{IN}	Supply Current	VIN=3V		40	45	μA
		VIN=5V		60	80	
T_R	Output Turn-On Rising Time	RL=10Ω,90%Settling		30		us
I_{LIMIT}	Current Limit Threshold	RL=3Ω	1	1.38	1.5	A
I_{OS}	Short-circuit Fold Back Current	VOUT = 0V		200		mA
	EN Input High Threshold		1.2	0.86		V
	EN Input Low Threshold		0.6	0.86		
I_{OFF}	Shutdown Supply Current	EN=0		0.1	1	μA
$I_{LEAKAGE}$	Output Leakage Current	EN=0, VOUT=0V		0.1	1	μA
U_{VLO}	V_{IN} Under Voltage Lockout			1.8		V
	V_{IN} Under Voltage Hysterics			100		mV
T_{SD}	Thermal Limit			130		°C
T_{SD}	Thermal Limit Hysterics			20		°C

Typical Operating Characteristics

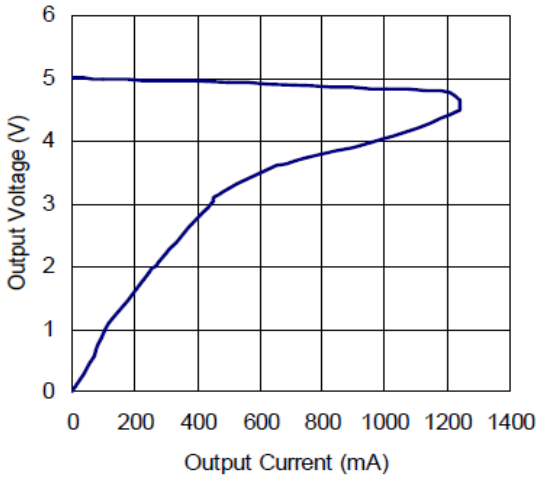




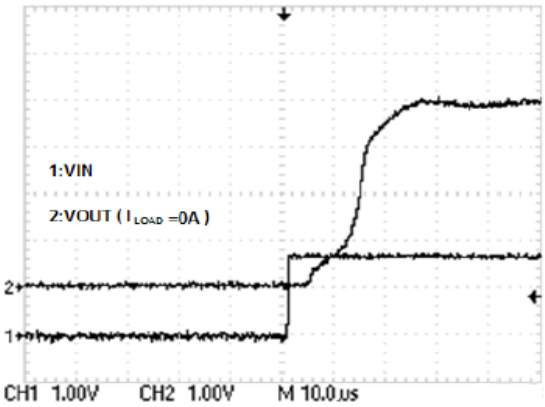
EN Threshold vs.Input Voltage



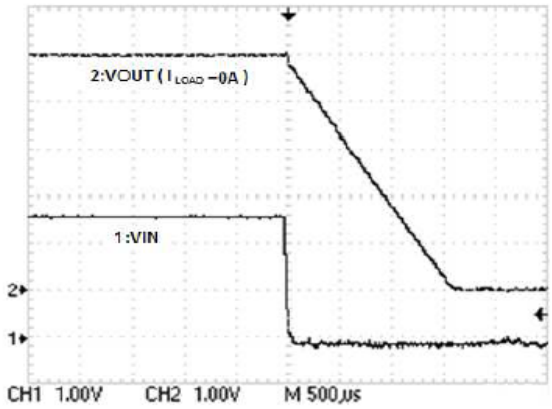
Output Voltage vs.Output Current



Turn-On Response



Turn-OFF Response



Functional Description

The SC91S15 is a high-side single switch with active-high enable input.

Soft Start

In order to eliminate the upstream voltage droop caused by the large inrush current during hot-plug events, the "soft-start" feature effectively isolates power supplies from such highly capacitive loads.

Thermal Shutdown

Thermal shutdown shuts off the output MOSFET if the die temperature exceeds 130°C and 20°C ofhysterics forces the switch turning off until the die temperature drops to 110°C.

Input and Output

VIN (input) is the power supply connection to the circuitry and the drain of the output MOSFET. VOUT (output) is the source of the output MOSFET. In a typical circuit, current flows through the switch from VIN to VOUT

toward the load. Both V_{OUT} pins must be short on the board and connected to the load and so do both V_{IN} pins but connected to the power source.

Under-voltage Lockout

U_{VLO} prevents the MOSFET switch from turning on until input voltage exceeds 1.7V (typical). If input voltage drops below 1.7V (typical), U_{VLO} shuts off the MOSFET switch.

Current Limiting and Short Protection

The current limit circuit is designed to protect the system supply, the MOSFET switch and the load from damage caused by excessive currents. The current limit threshold is set internally to allow a minimum of 550mA through the MOSFET but limits the output current to approximately 500mA typical. When the output is short to ground, it will limit to a constant current 30mA until thermal shutdown or short condition removed.

Filtering

To limit the input voltage drop during hot-plug events connect a 10μF ceramic capacitor from V_{IN} to GND. However, higher capacitor values will further reduce the voltage drop at the input. Connect a sufficient capacitor from V_{OUT} to GND. This capacitor helps to prevent inductive parasitics from pulling V_{OUT} negative during turn-off or EMI damage to other components during the hot detachment. It is also necessary for meeting the USB specification during hot plug-in operation. If SC91S15 is implanted in device end application, minimum 1μF capacitor from V_{OUT} to GND is recommended and higher capacitor values are also preferred.

In choosing these capacitors, special attention must be paid to the Effective Series Resistance, ESR, of the capacitors to minimize the IR drop across the capacitor's ESR. A lower ESR on this capacitor can get a lower IR drop during the operation. Ferrite beads in series with all power and ground lines are recommended to eliminate or significantly reduce EMI. In selecting a ferrite bead, the DC resistance of the wire used must be kept to a minimum to reduce the voltage drop.

Reverse current preventing

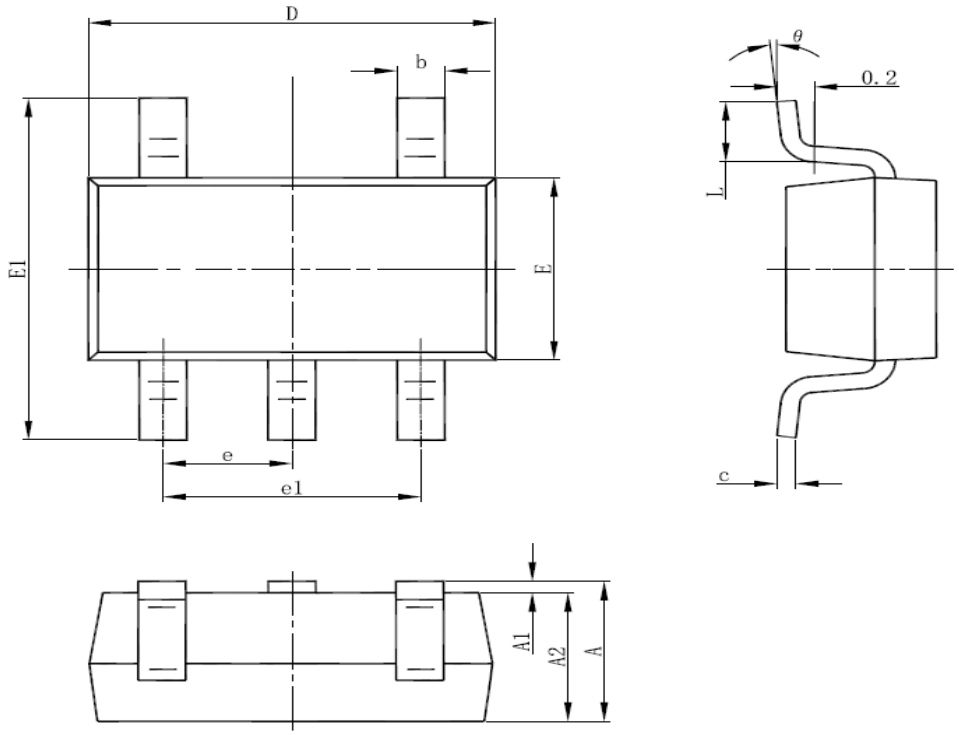
The output MOSFET and driver circuitry are also designed to allow the MOSFET source to be externally forced to a higher voltage than the drain ($V_{OUT}>V_{IN}\geq 0$). To prevent reverse current from such condition, SC91S15 will automatically shut off the MOSFET.

Layout and Thermal Dissipation

- Place the switch as close to the USB connector as possible. Keep all traces as short as possible to reduce the effect of undesirable parasitic Inductance.
- Place the output capacitor and ferrite beads as close to the USB connector as possible. If ferrite beads are used, use wires with minimum resistance and large solder pads to minimize connection resistance.
- If the package is with dual V_{OUT} or V_{IN} pins, short both the same function pins to reduce the internal turn-on resistance. If the output power will be delivered to two individual ports, it is especially necessary to short both V_{OUT} pin at the switch output side in order to protect the switch when each port is plug-in separately.
- Under normal operating conditions, the package can dissipate the channel heat away. Wide power bus planes connected to V_{IN} and V_{OUT} and a ground plane in contact with the device will help dissipate additional heat.

Packaging Information

SOT-23-5L Package Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°