FOR SEMI FS9001R

150mΩ ,Adjustable, Fast Response Current Limited Power Switches

● Features

Input Voltage Range: 2.4V to 5.5V

Programmable Over-Current Threshold

Fast Transient Response:

— 400ns Response to Short Circuit

Low Quiescent Current

— 9μA Typical

— 1μA Max with Switch Off

150m Typical $R_{DS(ON)}$

Only 2.5V Needed for ON/OFF Control

Under-Voltage Lockout

Thermal Shutdown

4kV ESD Rating

5-Pin SOT23

Temperature Range: -40°C to +85°C

● Applications

Hot Swap Supplies

Notebook Computers

Peripheral Ports

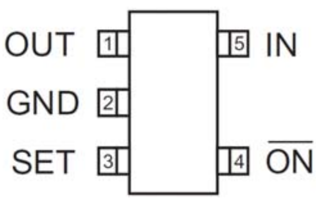
Personal Communication Devices

● General Description

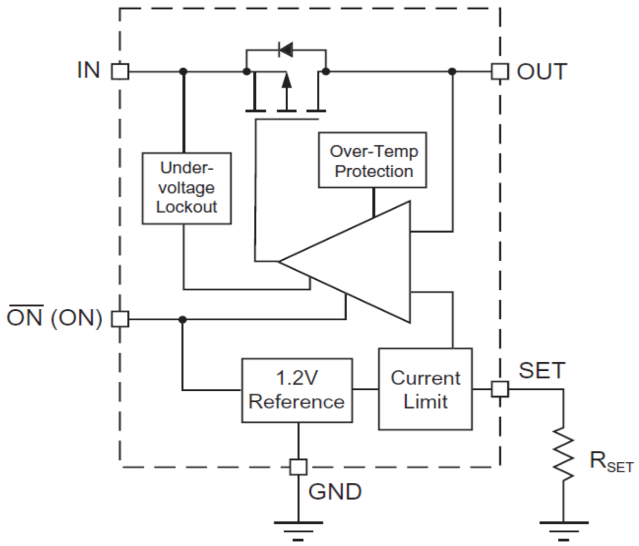
The FS9001R Smart Switch is a current limited P-channel MOSFET power switch designed for high-side load switching applications. This switch operates with inputs ranging from 2.4V to 5.5V, making it ideal for both 3V and 5V systems. An integrated current-limiting circuit protects the input supply against large currents which may cause the supply to fall out of regulation. The FS9001R is also protected from thermal overload which limits power dissipation and junction temperatures. It can be used to control loads that require up to 1A. Current limit threshold is programmed with a resistor from SET to ground. The quiescent supply current is typically a low 9μA. In shutdown mode, the supply current decreases to less than 1μA.

The FS9001R is available in a Pb-free 5-pin SOT23 package and is specified over the -40°C to +85°C temperature range.

● Package Information & Functional Block Diagram



SOT23-5



Absolute Maximum Ratings

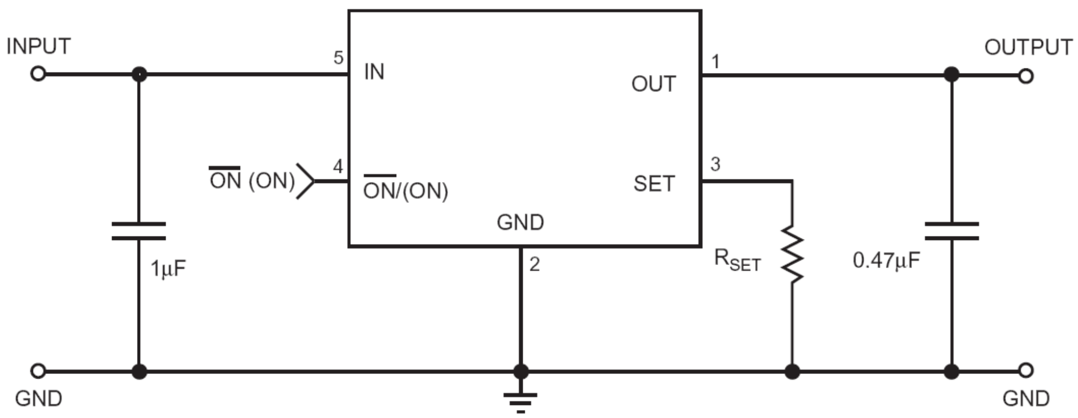
Parameter	Rating	Unit
IN Voltage	-0.3 to 7	V
EN、SET、OUTVoltage	-0.3 to V_{IN} + 0.3	V
Maxim Continuous Switch Current	3	A
Junction to Ambient Thermal Resistance (θ_{JA})	125	°C/W
Operating Junction Temperature	-40 to 85	°C
Storage Temperature	-65 to 150	°C
Lead Temperature (Soldering, 10 sec)	300	°C
ESD	4000	V

Electrical Characteristics

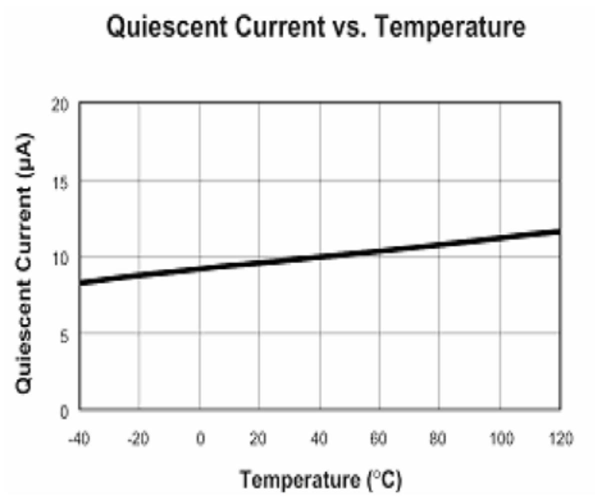
V_{IN} = 5V, T_a = 25°C, unless otherwise specified

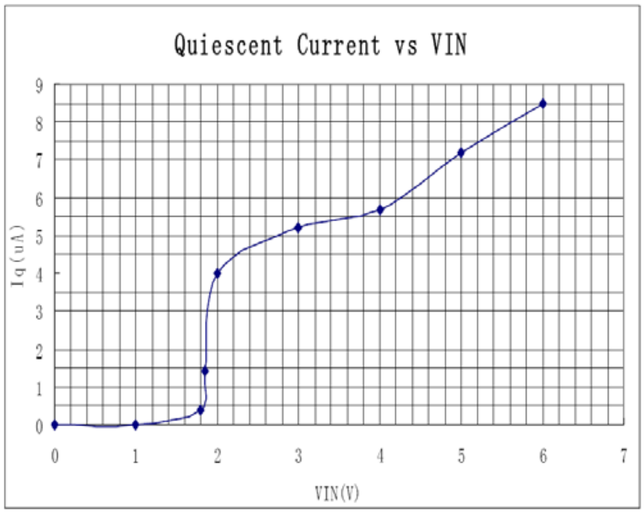
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
V_{IN}	Input Voltage Range		2.4		5.5	V
V_{UVLO}	Input U_{VLO}		1.8		2.4	V
I_{SHDN}	Input Shutdown Quiescent Current	Disabled, V_{EN}=0V, OUT floating or shorted to ground		0.01	1	uA
I_Q	Input Quiescent Current	Enabled, V_{EN}=V_{IN}, I_{OUT}= 0		7	25	uA
$R_{DS(ON)}$	Switch on-resistance	V_{IN} = 5V, T_A=25°C		150		mΩ
		V_{IN} = 3V , T_A=25°C		200		mΩ
I_{LMT}	Current Limit	R_{SET}=7.2kΩ	0.75	1	1.25	A
V_{IL}	EN Input Logic Low Voltage				0.8	V
V_{IH}	EN Input Logic High Voltage		2.0			V
I_{LEAK}	Output Leakage Current	EN=Inactive,R_{LOAD}= 0		0.5	10	uA
T_{RESP}	Current Limit Response Time	V_{IN}=5V		50		uS
T_{SD}	Thermal Shutdown Protection			125		°C
T_{SD}	Thermal Shutdown Hysteresis			10		°C

Typical Performance Characteristics

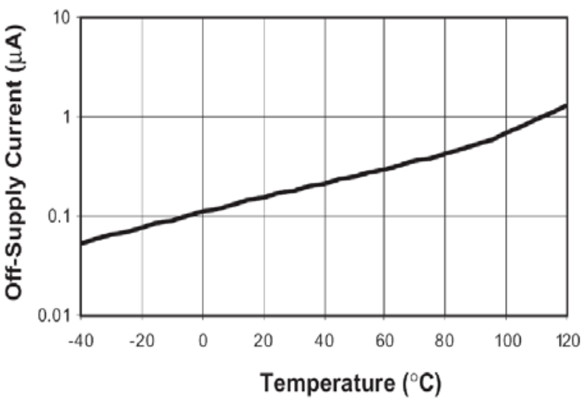


- **Typical Performance Characteristics**

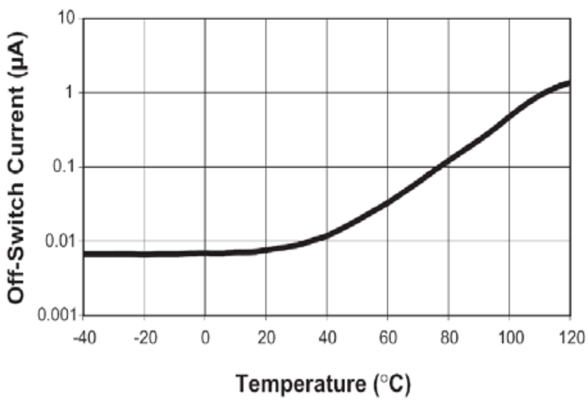




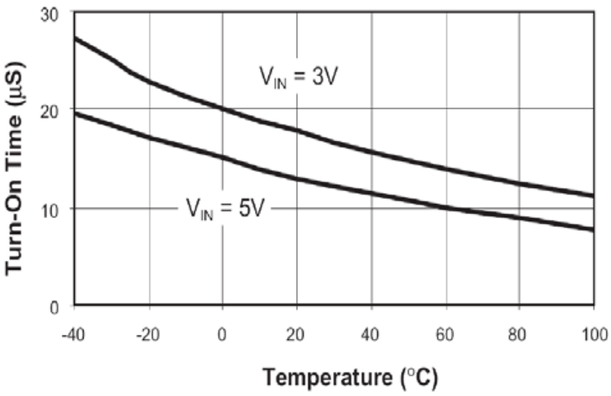
Off-Supply Current vs. Temperature



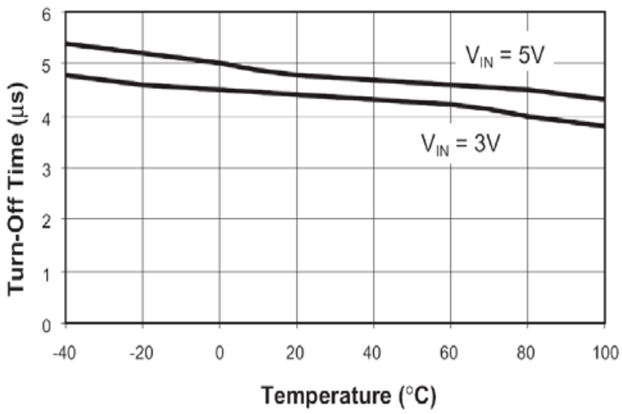
Off-Switch Current vs. Temperature



Turn-On vs. Temperature
(R_{LOAD} = 10Ω; C_{LOAD} = 0.47μF)

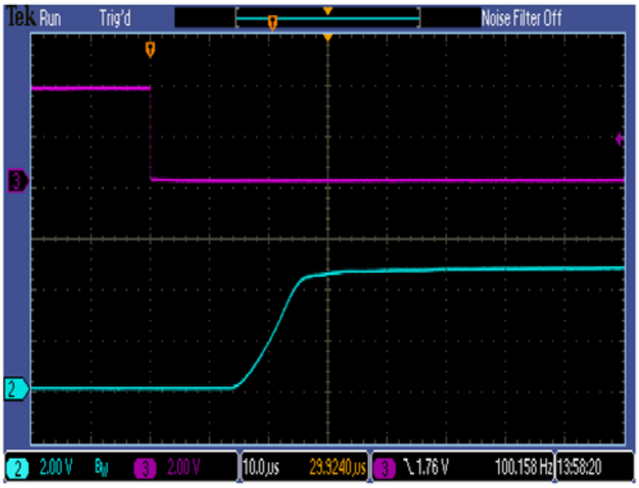


Turn-Off vs. Temperature
(R_{LOAD} = 10Ω; C_{LOAD} = 0.47μF)

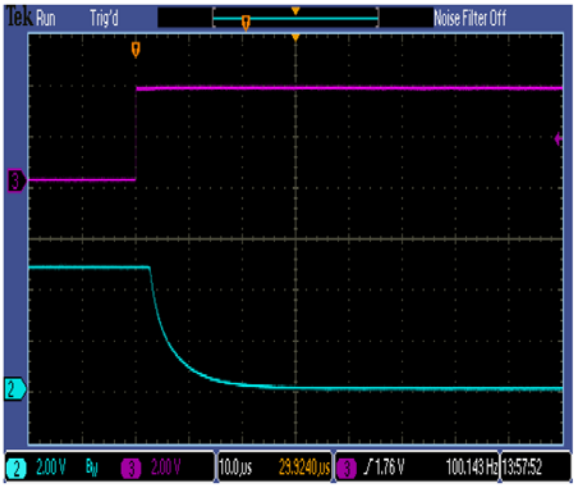


VIN=5V, RL=10Ω, COUT=0.47uF (Channel3=VEN, Channel2=VO)

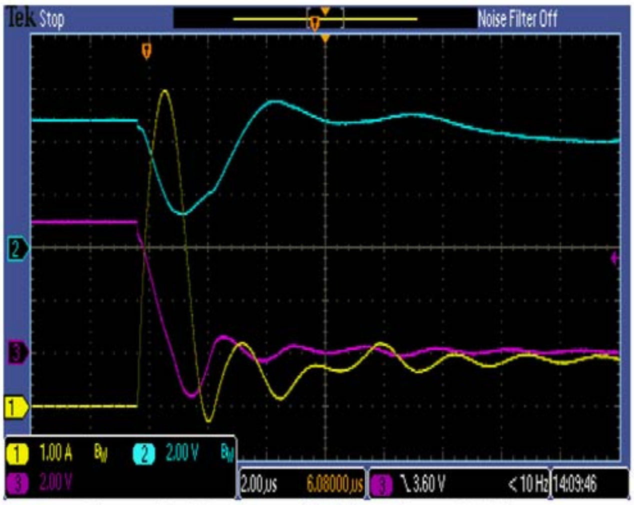
Turn on



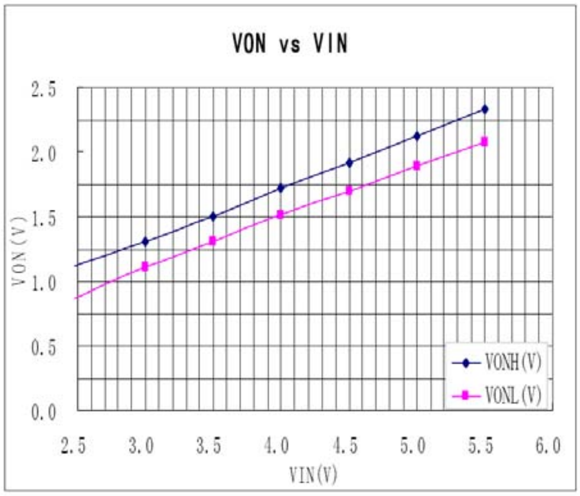
Turn off

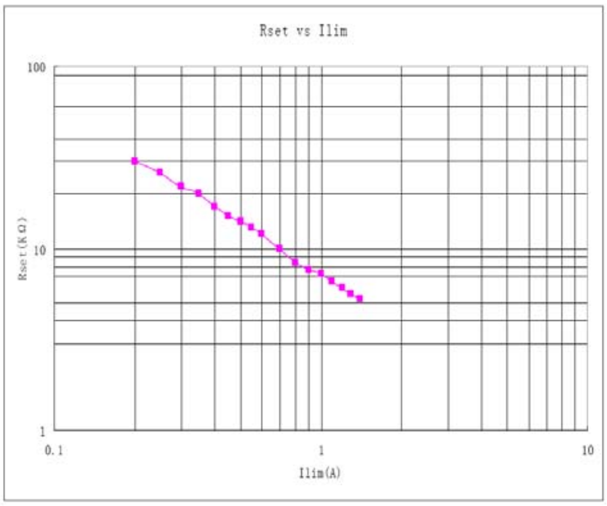


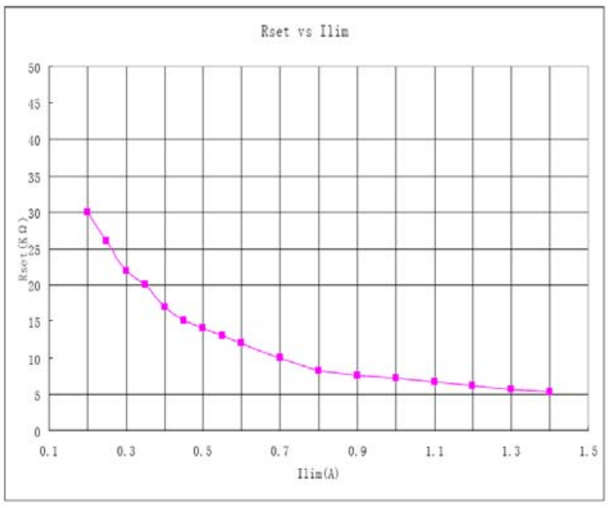
Short circuit to GND



Channel1=IO,Channel2=Vin,Channel3=Vo







Setting Current Limit

In most applications, the variation in I_{LIM} must be taken into account when determining $R_{SET.}$ The I_{LIM} variation is due to processing variations from part to part, as well as variations in the voltages at IN and OUT, plus the operating temperature. These three factors add up to a ±25% tolerance Figure 1 illustrates a cold device with a statistically higher current limit and a hot device with a statistically lower current limit, both with R_{SET} equal to 10kΩ. While the chart, "R_{SET} vs. I_{LIM}" indicates an I_{LIM} of 0.7A with an R_{SET} of 10kΩ, this figure shows that the actual current limit will be at least 0.525A and no greater than 0.880A.

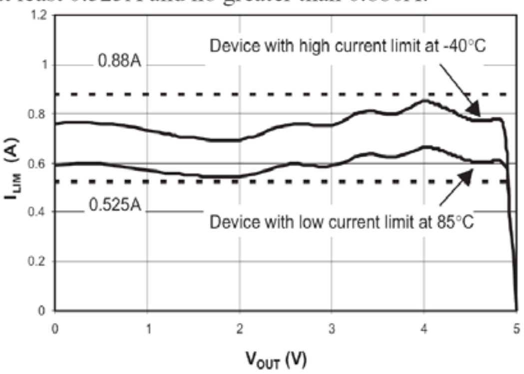


Figure 1: Current Limit Using 10kΩ.

To determine $R_{SET,}$ start with the maximum current drawn by the load and multiply it by 1.33 (typical I_{LIM} = minimum I_{LIM} / 0.75). This is the typical current limit value. Next, refer to "R_{SET} vs. I_{LIM}" and find the R_{SET} that corresponds to the typical current limit value. Choose the largest resistor available that is less than or equal to it. For greater precision, the value of R_{SET} may also be calculated using the I_{LIM} R_{SET} product found in the chart "R_{SET} Coefficient vs. I_{LIM}." The maximum current is derived by multiplying the typical current for the chosen R_{SET} in the chart by 1.25. A few standard resistor values are listed in the table "Current Limit R_{SET} Values."

Current Limit R_{SET} Values

RSET (kΩ)	Current Limit Typ (mA)	Device Will Not Current Limit Below (mA)	Device Always Current Limits Below (mA)
30	200	150	250
26	250	188	313
22	300	225	375
20	350	263	438
17	400	300	500
15	450	338	563
14	500	375	625
13	550	413	688
12	600	450	750
10	700	525	875
8.3	800	600	1000
7.8	900	675	1125
7.2	1000	750	1250
6.6	1100	825	1375
6.1	1200	900	1500
5.6	1300	975	1625
5.3	1400	1050	1750

Example: A USB port requires 0.5A. 0.5A multiplied by 1.33 is 0.665A. From the chart named "R_{SET} vs. I_{LIM}," R_{SET} should be less than 12kΩ. 10kΩ is a standard value that is a little less than 12kΩ but very close. The chart reads approximately 0.700A as a typical I_{LIM} value for 10kΩ. Multiplying 0.700A by 0.75 and 1.25 shows that the FS9001R will limit the load current to greater than 0.525A but less than 0.875A.

Operation in Current Limit

When a heavy load is applied to the output of the FS9001R, the load current is limited to the value of I_{LIM} determined by R_{SET}. See Figure 2, "Overload Operation." Since the load is demanding more current than I_{LIM}, the voltage at the output drops. This causes the FS9001R to dissipate a larger than nor-mal quantity of power, and its die temperature to increase. When the die temperature exceeds an over-temperature limit, the FS9001R will shut down until is has cooled sufficiently, at which point it will startup again. The FS9001R will continue to cycle on and off until the load is removed, power is removed, or until a logic high level is applied to ON.

Enable Input

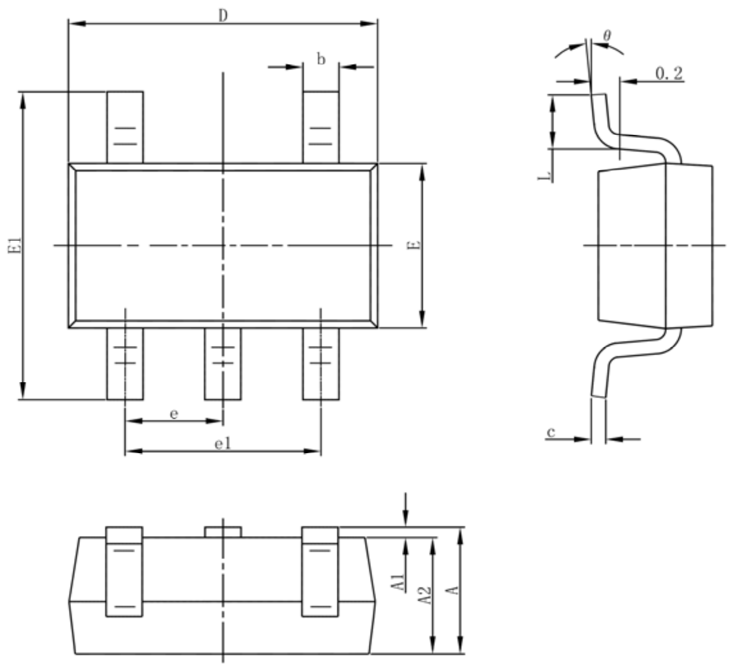
In many systems, power planes are controlled by integrated circuits which run at lower voltages than the power plane itself. The enable input ON of the FS9001R has low and high threshold voltages that accommodate this condition. The threshold voltages are compatible with 5V TTL and 2.5V to 5V CMOS.

Reverse Voltage

The FS9001R is designed to control current flowing from IN to OUT. If a voltage is applied to OUT which is greater than the voltage on IN, large currents may flow. This could cause damage to the FS9001R

- **Package Information**

SOT-23-5L PACKAGE OUTLINE DIMENSIONS



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°