90mΩ Adjustable Current Limited Power Switches

Features

- Input Voltage Range: 2.5V to 5.5V
- Programmable Current Limit
- Reverse Current Blocking
- Short-Circuit Response: 350ns
- Very Low Quiescent Current: 25μA (Typ)
- 1μA Max Shutdown Supply Current
- Under-Voltage Lockout
- Thermal Shutdown
- 4kV ESD Rating
- SOT23-5 Packages
- Ambient Temperature Range: -40°C to +85°C

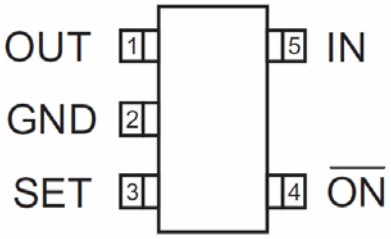
- Smart Phones and PDAs
- LCD TVs and Monitors
- Set-Top-Boxes
- MP3/MP4
- Printers
- Portable Game Players
- Portable Media Players and MIDs
- USB Keyboards
- USB Hard Disk Drives
- USB Memory Drives
- USB Hubs

General Description

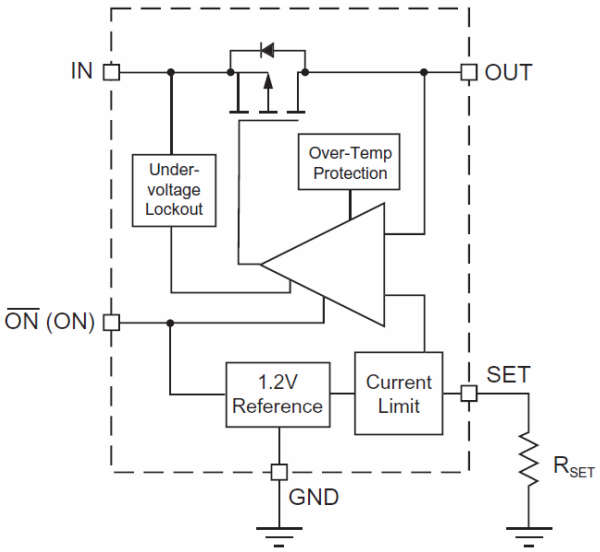
The FS9001 are current limited P-channel MOSFET power switch designed for high-side load switching applications. This switch operates with inputs ranging from 2.5V to 5.5V, making it ideal for both 3.3V and 5V systems. An integrated current-limiting circuit protects the input supply against large currents which may cause the supply to fall out of regulation. The FS9001 is also protected from thermal overload which limits power dissipation and junction temperatures. It can be used to control loads that require up to 1.7A. 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 FS9001 is available in Pb-free SOT23-5 packages and is specified over the -40°C to +85°C ambient temperature range.

Package Information & Functional Block Diagram



SOT23-5



Ordering Information

PART NUMBER	TEMPERATURE RANGE	MAXIMUM CURRENT	PACKAGE	TAPE&REEL
FS9001	-40 C to 85 C	1.7A	SOT23-5	-T

Absolute Maximum Ratings

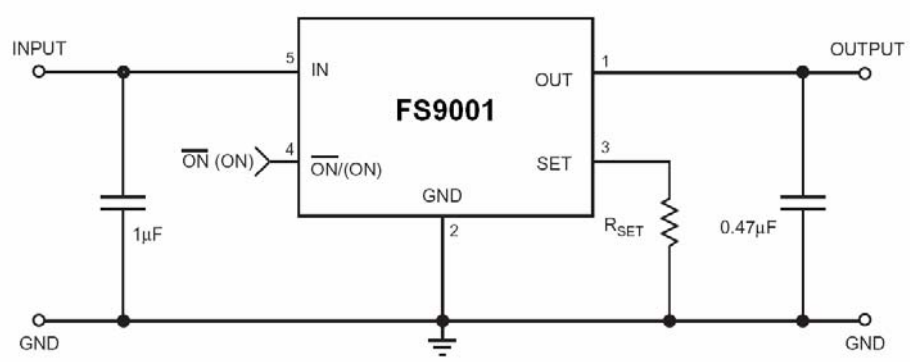
Parameter	Rating	Unit
IN, EN, SETVoltage	-0.3 to 6	V
OUTVoltage	-0.3 to VIN + 0.3	V
OUTCurrent	Internal Limited	A
Junction to Ambient Thermal Resistance (θJA)	150	°C/W
Operating Junction Temperature	-40 to 125	°C
Storage Temperature	-55 to 150	°C
Lead Temperature (Soldering, 10 sec)	300	°C

Electrical Characteristics

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

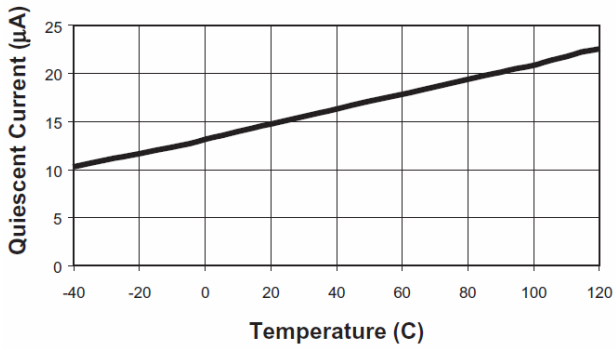
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
VIN	Input Voltage Range		2.7		5.5	V
VUVLO	Input UVLO		1.8		2.5	V
ISHDN	Input Shutdown Quiescent Current	Disabled, VEN=0V, OUT floating or shorted to ground		0.1	1	A
IQ	Input Quiescent Current	Enabled, VEN=VIN, IOUT= 0		25	40	A
RDS(ON)	Switch on-resistance	VIN = 5V, IOUT= 0.6A, TA=25oC		90	120	mΩ
		VIN = 3.3V, IOUT= 0.6A, TA=25oC		110	140	mΩ
ILMT	Minimum Current Limit	SET pin open (floating)		0.13		A
ILMT	Current Limit Set by RSET	SET pin open (floating)		0.13		A
		RSET=40.2kΩ	0.184	0.2	0.216	A
		RSET=19.6kΩ	0.368	0.4	0.432	A
		RSET=8.87kΩ	0.736	0.8	0.864	A
		RSET=6.8kΩ	0.92	1.0	1.08	A
		RSET=4.64kΩ	1.288	1.4	1.512	A
VIL	EN Input Logic Low Voltage				0.8	V
VIH	EN Input Logic High Voltage		2.0			V
ISINK	EN Input leakage	VEN = 5V		0.01	1	A
TD(ON)	Output Turn-on Delay Time	VIN =5V, CL=1uF, Rload=10		10		s
TR	Output Turn-on Rise Time	VIN =5V, CL=1uF, Rload=10		800		s
TD(OFF)	Output Turn-off Delay Time	VIN =5V, CL=1uF, Rload=10		60		s
TF	Output Turn-off Fall Time	VIN =5V, CL=1uF, Rload=10		20	200	s
Rdischrg	Output discharge FET Rdson	VIN = 5V, EN=0V, VOUT=5V		100	200	Ω
TSHDN	Thermal shutdown threshold	VIN = 5V		135		°C
THYS	Thermal shutdown hysteresis	VIN = 5V		15		°C

- **Typical Performance Characteristics**

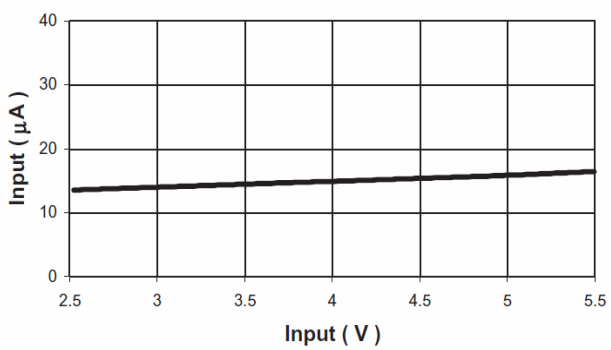


- **Typical Performance Characteristics**

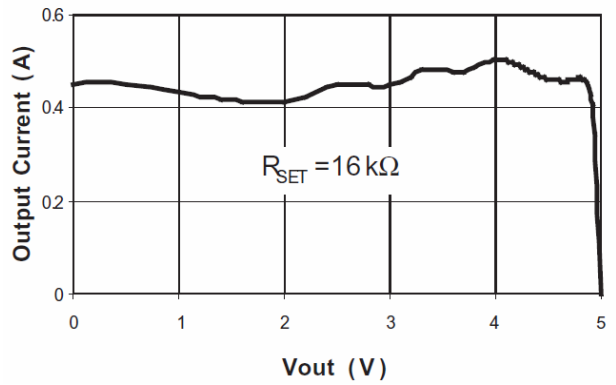
Quiescent Current vs. Temperature



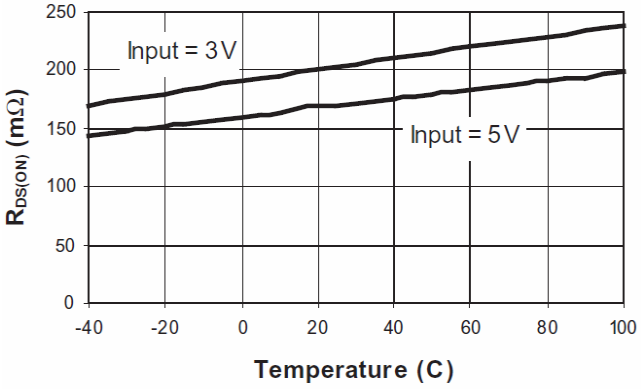
Quiescent Current



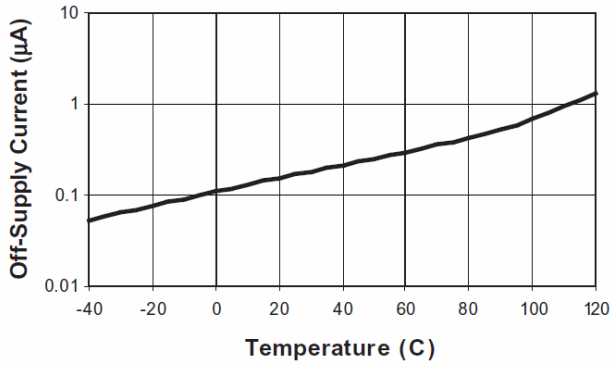
Output Current vs V_{OUT}



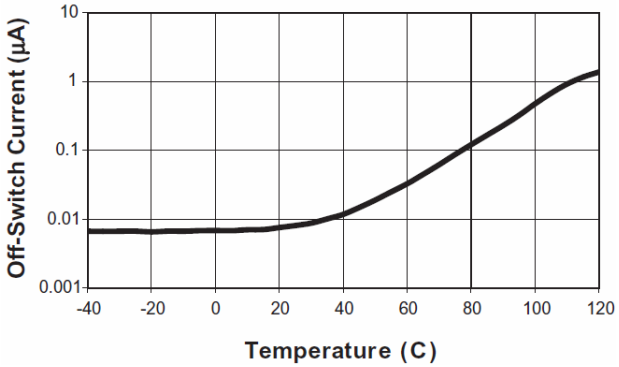
$R_{DS(ON)}$ vs. Temperature



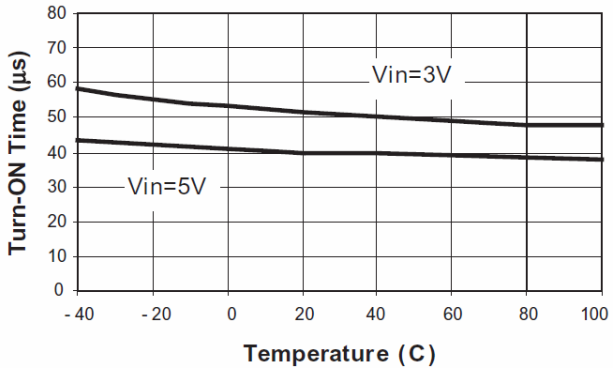
Off-Supply Current vs. Temperature



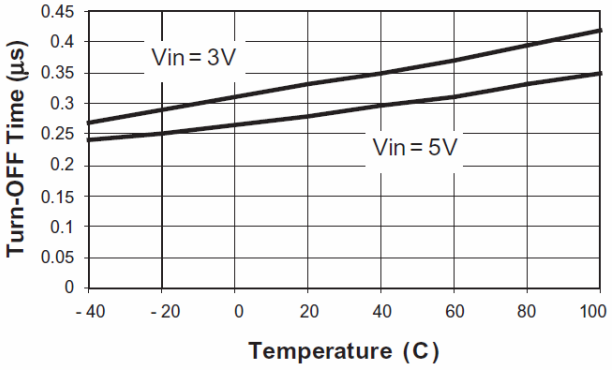
Off-Switch Current vs. Temperature



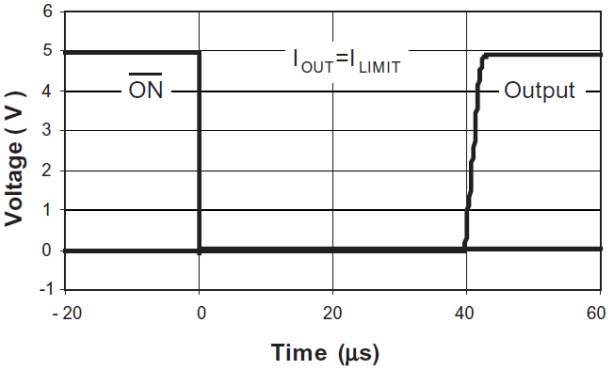
Turn-ON vs. Temperature



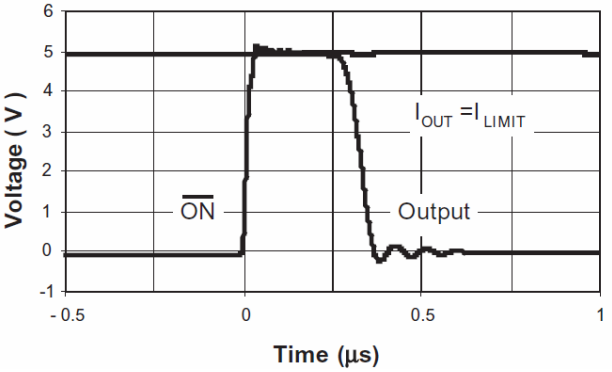
Turn-OFF vs. Temperature



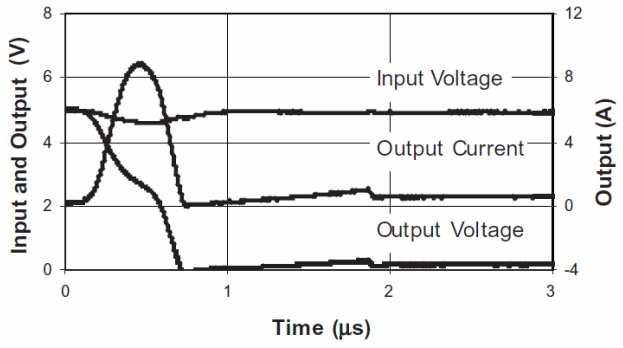
Turn-On
R_L = 10Ω, C_L = 0.47µF



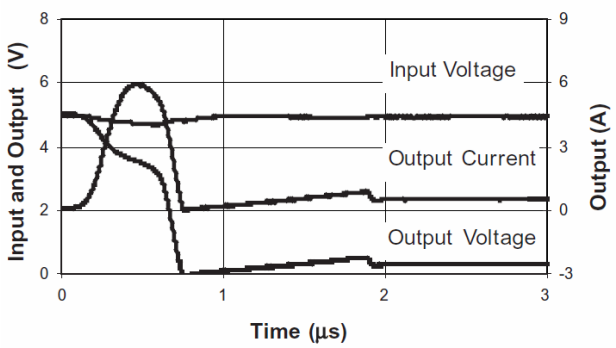
Turn-Off
R_L = 10Ω



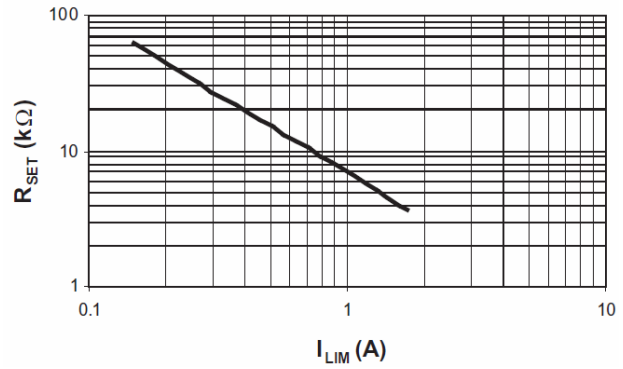
Short Circuit through 0.3Ω



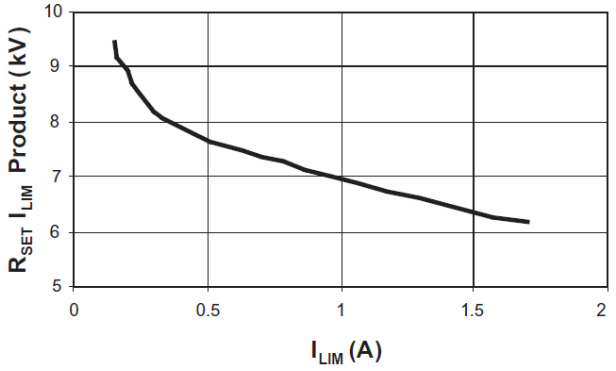
Short Circuit through 0.6Ω



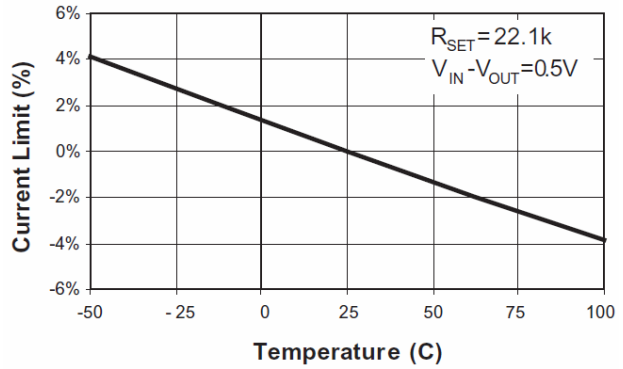
R_{SET} vs I_{LIM}



R_{SET} coefficent vs I_{LIM}



Current Limit v. Temperature



Operation

FS9001 is an integrated power switch with a low Rdson P-channel MOSFET, internal gate rive circuit, programmable current limiting, and thermal protection. When the FS9001 turns on, it can deliver up to 1.7A continuous current to load. When the device is active, if there is no load, the device only consumes 25uA supply current, which makes the device suitable for battery powered applications.

Power Supply Considerations

A 0.01-µF to 0.1-µF 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 0.01-μF to 0.1-μF ceramic capacitor improves the immunity of the device to short-circuit transients.

Programmable Current Limiting

A sense FET is employed to check for overcurrent conditions. Unlike current-sense resistors, sense FETs do not increase the series resistance of the current path. When an overcurrent condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. The current limit threshold is set by an external resistor on SET pin. Check the characteristic curve or the electrical characteristic table to find out an appropriate SET resistor value for a specific application.

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:

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

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.

Thermal Protection

Thermal protection prevents damage to the IC when heavy-overload or short-circuit faults are present for extended periods of time. The FS9001 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.