3A, 20V, 600 kHz, Sync. Step-Down Converter

Features

3A Output Current
Wide 4.5V to 20V Operating Input Range
Up to 95% Efficiency
600kHz switching frequency
Internal soft-start
Input under-voltage lockout
Current run-away protection
Output short protection
Thermal protection
Available in SOT23-6 package

General Description

The FS9029 are monolithic buck switching regulators based on I2 architecture for fast transient response. Operating with an input range of 4.5V~20V,FS9029 deliver 3A of continuous output current with two integrated N-Channel MOSFETs. The internal synchronous power switches provide high efficiency without the use of an external Schottky diode. At light load, FS9029 operate in low frequency to maintain high efficiency.

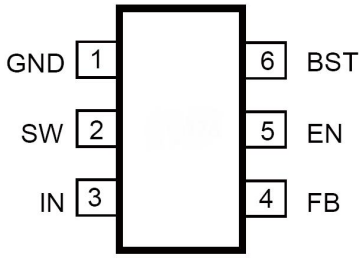
FS9029 guarantee robustness with output short protection, thermal protection, current run-away protection and input under voltage lockout.

FS9029 in SOT23-6 package, which provides a compact solution with minimal external components.

Applications

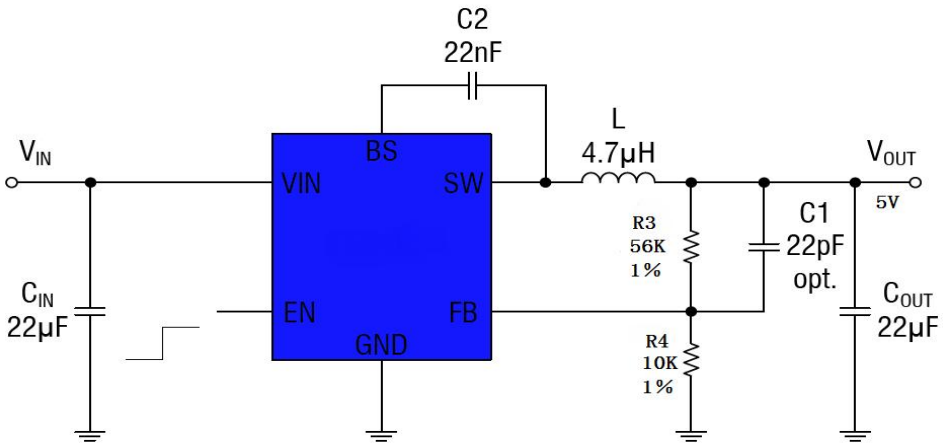
Distributed Power Systems
Networking Systems
FPGA, DSP, ASIC Power Supplies
Green Electronics/ Appliances
Notebook Computers

TOP VIEW



SOT23-6L

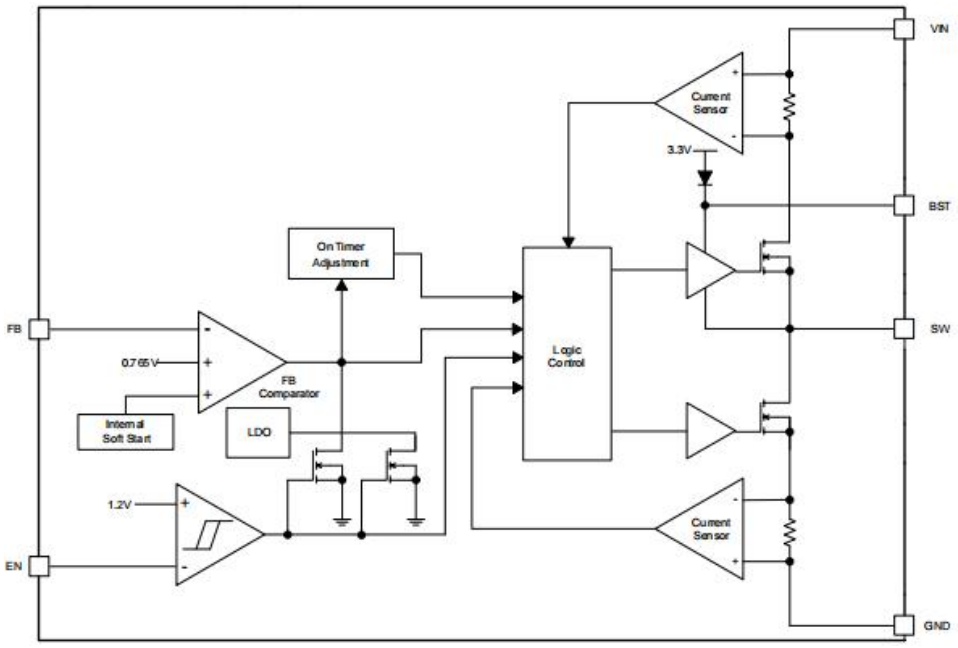
Typical Application



PIN DESCRIPTIONS

PIN	NAME	FUNCTION
1	GND	Ground
3	VIN	Power supply Pin
2	SW	Switching Pin
4	FB	Adjustable version feedback input. Connect FB to the center point of the externalresistor divider.
5	EN	Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable the ICand enter micro-power shutdown mode.
6	BST	Bootstrap. A capacitor connected between SW and BST pins is required to form afloating supply across the high-side switch driver.

Functional Block Diagram



Absolute Maximum Ratings @T_A=25℃ unless otherwise noted

VIN, EN Pin …… -0.3V to 20V
SW Pin …… -0.3V(-5V for 10ns) to 20V(22V for 10ns)
BST Pin ……SW-0.3V to SW+4V
All other Pins ……-0.3V to 4V
Junction Temperature[1]) ……150ºC
Lead Temperature ……260°C
Storage Temperature …… -65ºC to +150ºC

Note:

1) The FS9029 include thermal protection that is intended to protect the device in overload conditions. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.

- **Electrical Characteristics @T_A=25℃ unless otherwise noted**

VIN = 12V, TA = +25°C, unless otherwise noted.

Parameter	Conditions	Min	Typ	Max	Unit
VIN Under Voltage Lockout Threshold	V_{IN} rising	-	4.2	-	V
VIN Under Voltage Lockout Hysteresis		-	350	-	mV
Shutdown Supply Current	V_{EN}=0V	-	-	1	uA
Supply Current	V_{EN}=5V, V_{FB}=1V	-	150	-	uA
Feedback Voltage	T_J = 25°C		0.765		V
FB Leakage Current	V_{FB}=0.85			100	nA
Top Switch Resistance			80		m Ω
Bottom Switch Resistance			45		m Ω
Top Switch Leakage Current	V_{IN}=18V, V_{EN}=0V, V_{SW}=0V			1	uA
Bottom Switch Leakage Current	V_{IN}=18, V_{EN}=0V, V_{SW}=18V			1	uA
Bottom Switch Current Limit			3.5		A
Minimum On Time[2])			120		nS
Minimum Off Time	V_{FB}=0.4V		150		nS
Maximum On Time			4		uS
EN Rising Threshold	V_{EN} rising		1.2		V
EN Falling Threshold	V_{EN} falling		1.05		V
Soft-Start Period [2])[3])			1.3		ms
Frequency			600		kHz
Thermal Shutdown [2])			160		°C
Thermal Shutdown Hysteresis [2])			20		°C

Note：

2) Guaranteed by design.

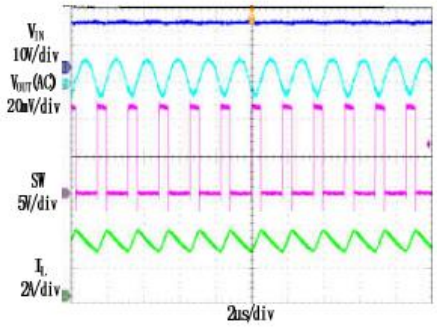
3) Soft-Start Period is tested from 10% to 90% of the steady state output voltage.

- **Typical Performance Characteristics**

VIN =12V, VOUT = 3.3V, L = 3.3μH, COUT = 22μF*2, TA = +25°C, unless otherwise noted

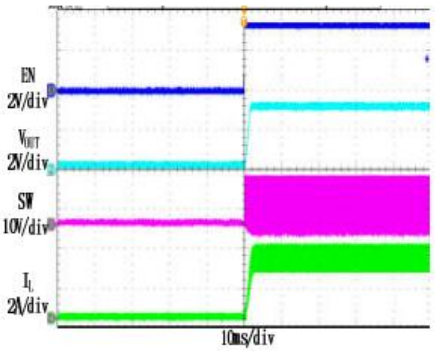
Steady State Test

V_{IN}=12V, V_{OUT}=3.3V
I_{OUT}=3A



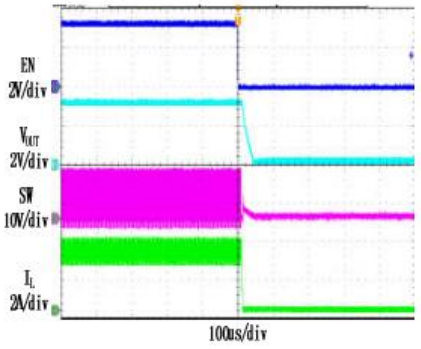
Startup through Enable

V_{IN}=12V, V_{OUT}=3.3V
I_{OUT}=3A (Resistive load)



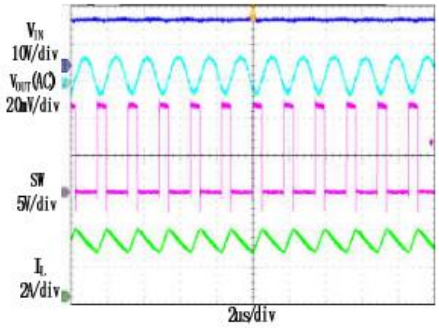
Shutdown through Enable

V_{IN}=12V, V_{OUT}=3.3V
I_{OUT}=3A (Resistive load)



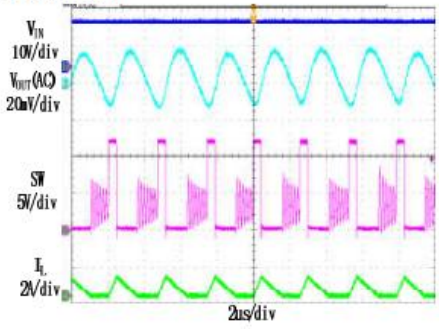
Heavy Load Operation

3A LOAD



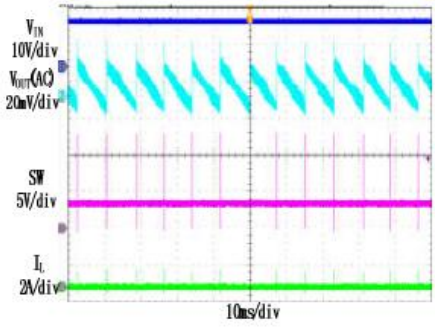
Medium Load Operation

0.3A LOAD



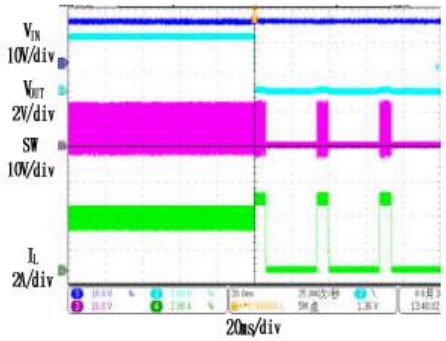
Light Load Operation

0 A LOAD



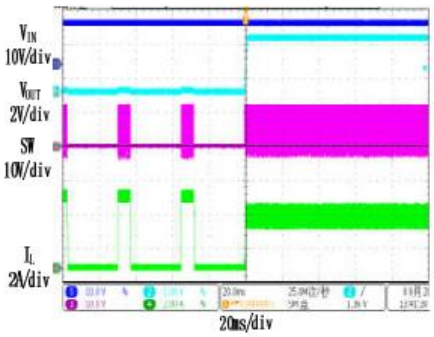
Short Circuit Protection

V_{IN}=12V, V_{OUT}=3.3V
I_{OUT}=3A- Short



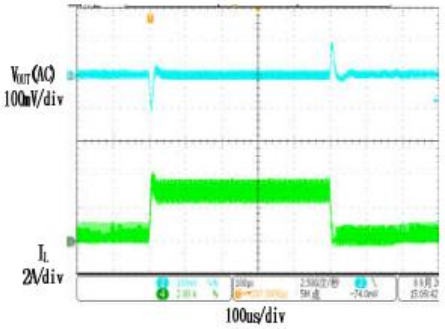
Short Circuit Recovery

V_{IN}=12V, V_{OUT}=3.3V
I_{OUT}= Short-3A



Load Transient

C5=51pF
0.3A LOAD → 3A LOAD → 0.3A LOAD



OPERATION

- **FUNCTIONAL DESCRIPTION**

FS9029 are synchronous step-down regulators based on I2 control architecture. It regulates input voltages from 4.5V to 18V down to an output voltage as low as 0.765V, and is capable of supplying up to 3A of load current.

Power Switch

N-Channel MOSFET switches are integrated on the FS9029 to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage great than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 3.3V rail when SW is low.

VIN Under-Voltage Protection

A resistive divider can be connected between VIN and ground, with the central tap connected to EN, so that when VIN drops to the pre-set value, EN drops below 1.05V to trigger input under voltage lockout protection.

Output Current Run-Away Protection

At start-up, due to the high voltage at input and low voltage at output, current inertia of the output inductor can be easily built up, resulting in a large start-up output current. A valley current limit is designed in FS9029 so that only when output current drops below the valley current limit can the top power switch be turned on. By such control mechanism, the output current at start-up is well controlled.

Shutdown Mode

The regulator shuts down when voltage at EN pin is driven below 0.4V. The entire regulator is off and the supply current consumed by the regulator drops below 1μA.

Output Short Protection

When the output is shorted to ground, the regulator is allowed to switch for 2048 cycles. If the short condition is cleared within this period, then the regulator resumes normal operation. If the short condition is still present after 2048 switching cycles, then no switching is allowed and the regulator enters hiccup mode for 6144 cycles. After the 6144 hiccup cycles, the regulator will try to start-up again. If the short condition still exists after 2048 cycles of switching, the regulator enters hiccup mode. This process of start-up and hiccup iterate itself until the short condition is removed.

Thermal Protection

When the temperature of the regulator rises above 160°C, it is forced into thermal shut-down. Only when core temperature drops below 140°C can the regulator become active again.

APPLICATION INFORMATION

Output Voltage Set

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage ratio is:

$$V_{FB} = V_{OUT} \cdot \frac{R_4}{R_4 + R_3}$$

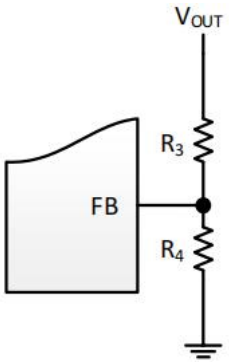
where VFB is the feedback voltage and VOUT is the output voltage.

Choose R4 around 10kΩ, and then R3 can be calculated by:

$$R_3 = R_4 \cdot \left(\frac{V_{OUT}}{0.765} - 1 \right)$$

The following table lists the recommended values.

Vout(V)	R4（kΩ）	R3（kΩ）
2.5	10（1%）	23（1%）
3.3	10（1%）	33（1%）
5	10（1%）	56（1%）



PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to follow the guidelines as below.

1. Place the input decoupling capacitor as close to FS9029 (VIN pin and PGND) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
2. Put the feedback trace as far away from the inductor and noisy power traces as possible.
3. The ground plane on the PCB should be as large as possible for better heat dissipation.