0.8A，Synchronous Step Down Converter

GENERAL DESCRIPTION

The FS2405/FS2405B is a constant frequency, current mode step-down converter. The device integrates a main switch and a synchronous rectifier for high efficiency without an external Schottky diode. It is ideal for powering portable equipment that runs from a single cell Lithium-Ion (Li+) battery. The output voltage can be regulated as low as 0.6V. The FS2405/FS2405B can also run at 100% duty cycle for low dropout operation, extending battery life in portable system. This device offers two operation modes, PWM control and PFM Mode switching control, which allows a high efficiency over the wider range of the load.

FEATURES

- High Efficiency: Up to 96%
- 1.5MHz Constant Frequency Operation
- 800mA Output Current
- No Schottky Diode Required
- 2V to 6V Input Voltage Range
- Output Voltage as Low as 0.6V
- PFM Mode for High Efficiency in Light Load
- 100% Duty Cycle in Dropout Operation
- Low Quiescent Current: 20µA

- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response
- Short Circuit Protection
- Thermal Fault Protection
- Inrush Current Limit and Soft Start
- <1µA Shutdown Current
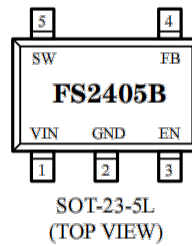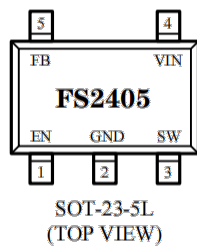- SOT23-5 package

APPLICATIONS

- Cellular and Smart Phones
- Wireless and DSL Modems
- PDAs
- Portable Instruments
- Digital Still and Video Cameras
- DTV

TYPICAL APPLICATION CIRCUIT
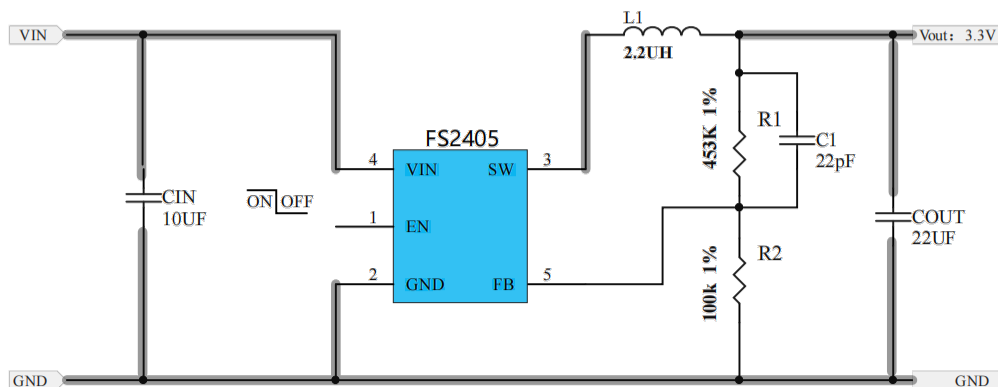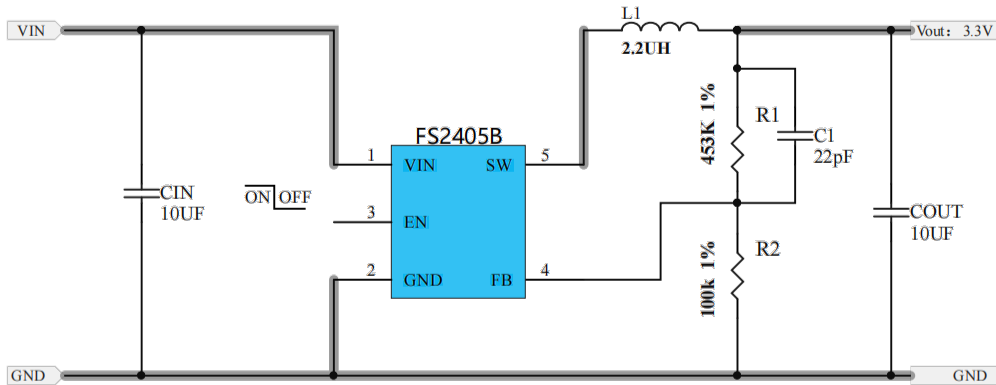
PIN ASSIGNMENT/DESCRIPTION

FS2405
SOT-23-5L
(TOP VIEW)

FS2405B
SOT-23-5L
(TOP VIEW)

Pin Name	Function
EN	Chip Enable Pin. Drive EN above 1.5V to turn on the part. Drive EN below 0.3V to turn it off. Do not leave EN floating.
GND	IC Ground
SW	Power Switch Output. It is the switch node connection to Inductor. This pin connects to the drains of the internal P-ch and N-ch MOSFET switches.
VIN	Power Supply Input.Must be closely decoupled to GND with a 4.7µF or greater ceramic capacitor.
FB	Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage.

Function Block Diagram
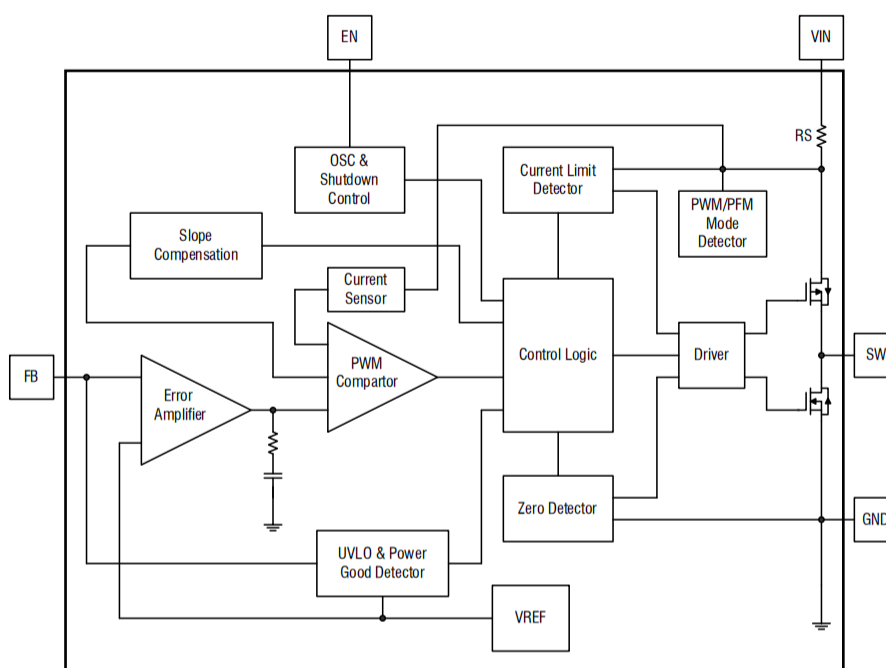
Absolute Maximum Ratings (note1)

Item		VALUE	Unit
Input Supply Voltage		-0.3 to 6.5	V
EN,FB Voltages		-0.3 to (VIN+0.3)	V
SW Voltages		-0.3 to (VIN+0.3)	V
Power Dissipation		0.4	W
Thermal Resistance θ_{JC}		130	°C /W
Thermal Resistance θ_{JA}		250	°C /W
Junction Temperature(Note2)	FS2405	150	°C
	FS2405B	125	
Operating Temperature Range		-40 to 85	°C
Lead Temperature(Soldering,10s)		300	°C
Storage Temperature Range		-65 to 150	°C
ESD HBM(Human Body Mode)		2000	V
ESD MM(Machine Mode)		200	V

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: TJ is calculated from the ambient temperature TA and power dissipation PD according to the

following formula: TJ = TA + (PD) x (250°C/W).

PCB Layout Recommendations

When laying out the printed circuit board, the following checking should be used to ensure proper operation of the FS2405/FS2405B . Check the following in your layout:

1. The power traces, consisting of the GND trace, the SW trace and the Vin trace should be kept short, direct and wide.
2. Does the (+) plates of C$_{IN}$ connect to VIN as closely as possible. This capacitor provides the AC current to the internal power MOSFETs.
3. Keep the switching node, SW, away from the sensitive VOUT node.
4. Keep the (-) plates of CIN and COUT as close as possible

pcb布局设计注意事项实际应用中PCBlayout中要注意的事项：

1）输入电容尽量靠近Vin引脚，减少寄生电感的存在，因为输入电流不连续，寄生电感引起的噪声对芯片的耐压以及逻辑单元造成不良影响 。输出滤波电容尽量靠近Vout引脚；

2）功率回路尽可能的短粗，保持较小的环路面积，较少噪声辐射。SW是噪声源，保证电流的同时保持尽量小的面积，远离敏感的易受干扰的位置。如，电感靠近SW引脚，远离反馈线。输出电容靠近电感，地端增加地过孔；

3）加粗地线宽度或者接地铜皮面积，如果不同层，要多打地孔；

4）反馈电阻尽量靠近FB引脚，从RFB到FB引脚的连线尽量短，因为这段线极易受到干扰，对输出特性影响较大；大电流负载的FB在负载远端取，反馈电容走线要就近取。

5）电感尽量选取屏蔽类型的，电感正下方所在区域不要有地线，电感量辐射容易影响地平面电平，电感下方的Bottom Layer布线影响不大。

6）芯片散热要按设计要求，尽量在底下增加过孔散热。
RFB到FB引脚的连线尽量短，因为这段线极易受到干扰，对输出特性影响较大；大电流负载的FB在负载远端取，反馈电容走线要就近取。

ELECTRICAL CHARACTERISTICS(note1)

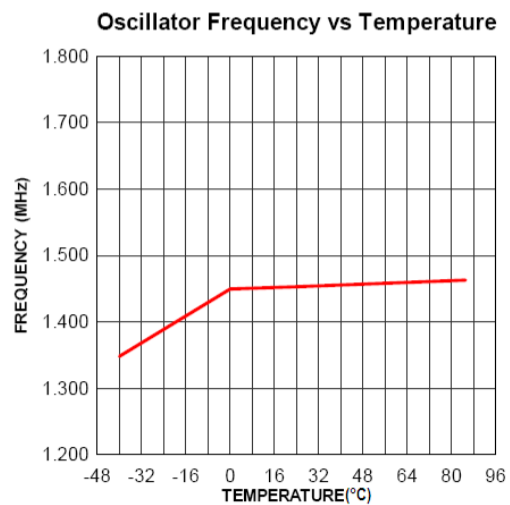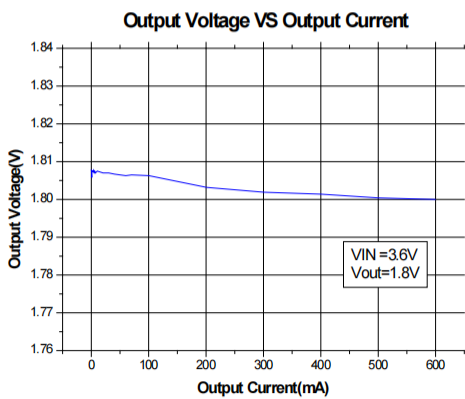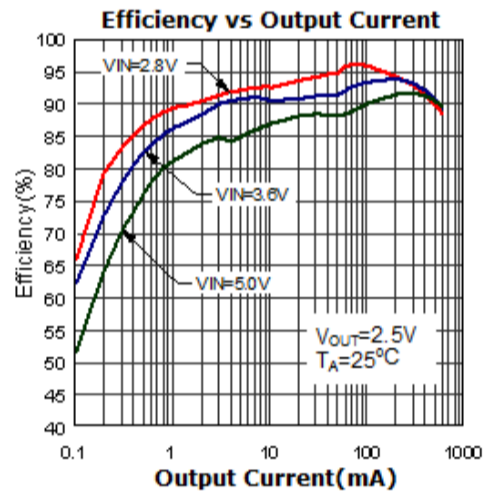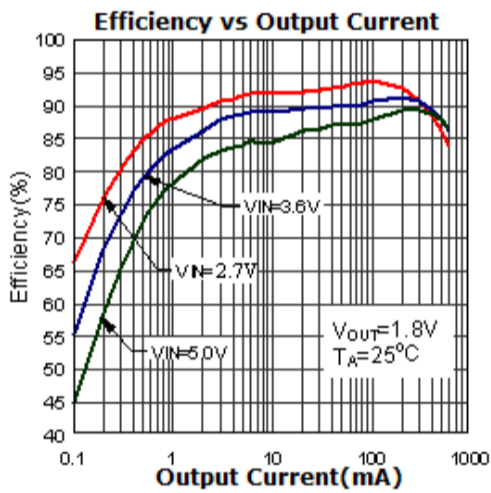(V_{IN}=V_{EN}=3.6V, VOUT=1.8V, TA = 25°C, unless otherwise noted.)

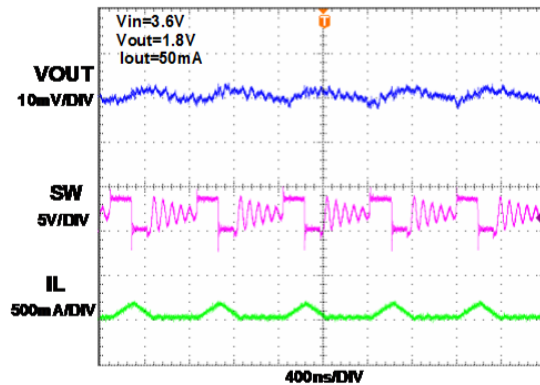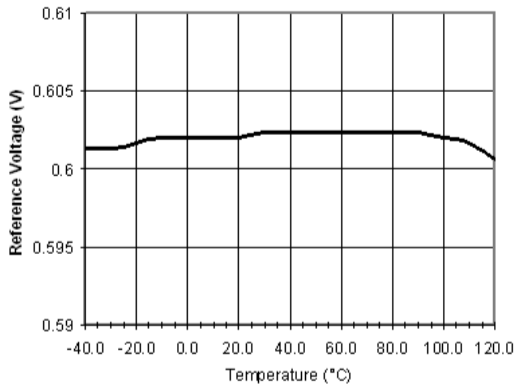| PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range		2		6	V
UVLO Threshold	FS2405B	1.7	1.9	2.1	V
Input DC Supply Current	(Note 2)				μA
PWM Mode	V_{OUT} = 90%, I_{LOAD}=0mA		140	300	μA
PFM Mode	V_{OUT} = 105%, I_{LOAD} =0mA		20	35	μA
Shutdown Mode	V_{EN} = 0V, V_{IN}=4.2V		0.1	1.0	μA
Regulated Feedback Voltage V_{FB}	T_A = 25°C	0.588	0.600	0.612	V
Reference Voltage Line Regulation	V_{IN} =2.7V to 5.5V		0.04	0.40	%/V
Output Voltage Line Regulation	V_{IN} =2.7V to 5.5V		0.04	0.40	%
Output Voltage Load Regulation			0.5		%
Oscillation Frequency	V_{OUT} =100%		1.5		MHz
	V_{OUT} =0V		300		kHz
On Resistance of PMOS	I_{SW}=100 mA		350	450	mΩ
On Resistance of NMOS	I_{SW}=-100 mA		300	450	mΩ
Peak Current Limit	V_{IN}= 3V, V_{OUT} =90%		1.5		A
FS2405/FS2405B					
EN High-Level Input Voltage	V_{ENH}	1.5			V
EN Low-Level Input Voltage	V_{ENL}			0.4	V
FS2405B					
EN Threshold		0.3	1.0	1.5	V
EN Leakage Current			±0.01	±1.0	μA
SW Leakage Current	V_{EN}=0V,V_{IN}=V_{SW}=5V		±0.01	±1.0	μA

Note 1: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

Note 2: Dynamic supply current is higher due to the gate charge being delivered at the switching frequency.
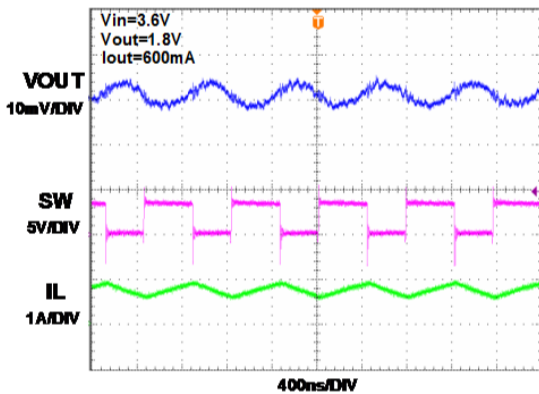
TYPICAL OPERATING CHARACTERISTICS

Efficiency vs Output Current

Efficiency vs Output Current

Efficiency vs Output Current

Efficiency vs Output Current

Output Voltage VS Output Current

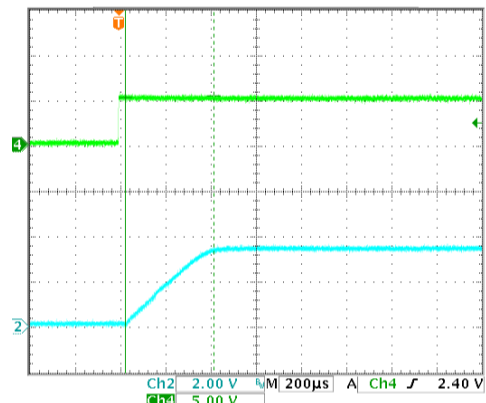

Oscillator Frequency vs Temperature
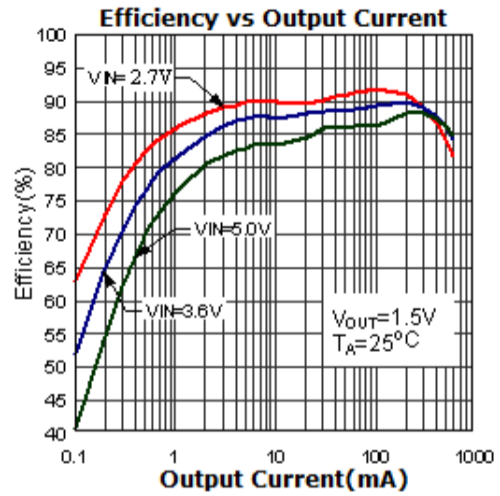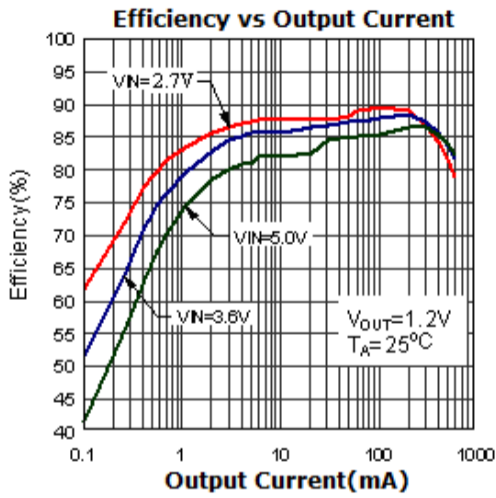
PFM MODE

PWM MODE

START UP RESPONSE

Function Description

The FS2405/FS2405B is a high performance, 800mA, 1.5MHz monolithic step-down converter. The FS2405/FS2405B requires only three external power components (CIN, COUT and L). The adjustable version can be programmed with external feedback to any voltage, ranging from 0.6V to the input voltage.

At dropout operation, the converter duty cycle increases to 100% and the output voltage tracks the input voltage minus the RDS(ON) drop of the high-side MOSFET.

The internal error amplifier and compensation provides excellent transient response, load, and line regulation. Soft start function prevents input inrush current and output overshoot during start up.

Application Information

Setting the Output Voltage

The internal reference V_{REF} is 0.6V (Typical). The output voltage is divided by a resistor divider,R1 and R2 to the FB pin. The output voltage is given by

$$\left(1+\frac{R1}{R2}\right)*0.6V = Vout$$

Inductor Selection

For most designs, the FS2405/FS2405B operates with inductors of 1μH to 4.7μH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔI_L is inductor Ripple Current. Large value inductors result in lower ripple current and small value inductors result in high ripple current. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range.

Capacitor Selection

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency should be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 4.7uf ceramic capacitor for most applications is sufficient. A large value may be used for improved input voltage filtering.

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current ratings. The output ripple ΔV_{OUT} is determined by:（A 10μF ceramic can satisfy most applications.）

$$\Delta V_{OUT} \leq \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left(ESR + \frac{1}{8 \times f_{OSC} \times C_{OUT}}\right)$$

PACKAGE DESCRIPTION

SOT23-5L
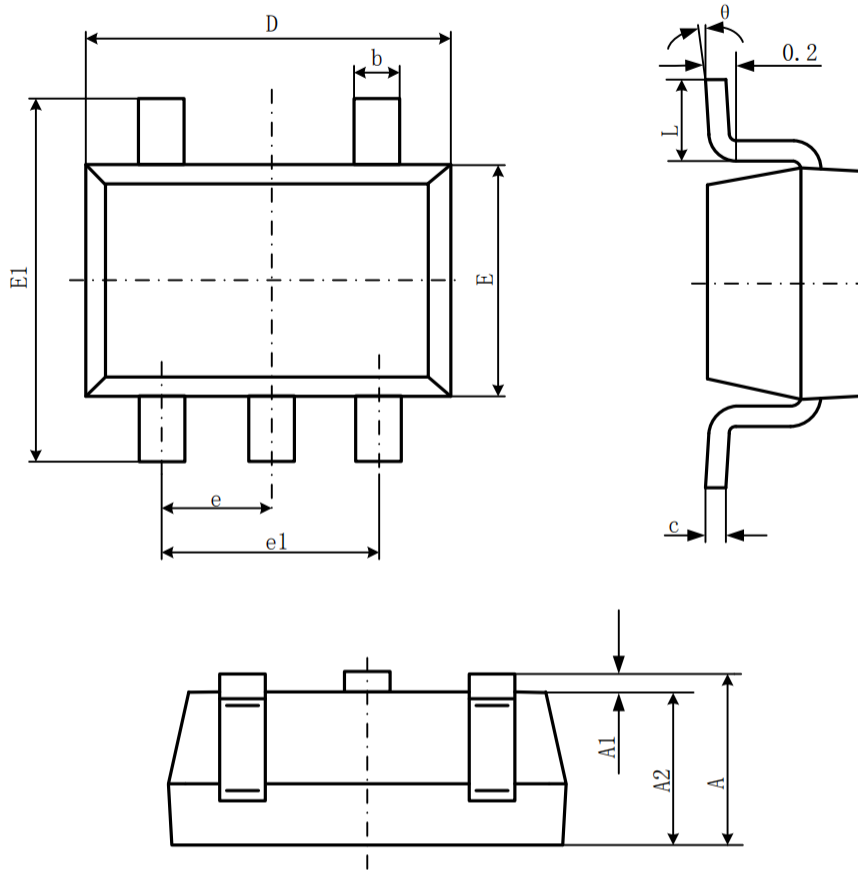
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°