1000mA Synchronous Step-Down Converter

Description

The SC12A10 is high efficiency synchronous, PWM step-down DC/DC converters working under an input voltage range from 2.5V to 5.5V. This feature makes the SC12A10 suitable for single Li-Lon battery-powered applications. 100% duty cycle capability extends battery life in portable devices, while the quiescent current is 120µA with no load, and drops to < 1µA in shutdown

The internal synchronous switch is desired to increase efficiency without an external Schottky diode. The 1.2MHz fixed switching frequency allows the using of tiny, low profile inductors and ceramic capacitors, which minimized overall solution footprint.

The SC12A10 converters are available in the industry standard SOT-23-5 power packages (or upon request).

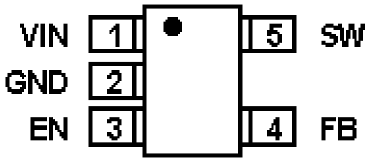
Features

- Up to 93% Efficiency
- Current Mode Operation for Excellent Line and Load Transient Response
- Low Quiescent Current: 160µA
- Low Switch on Resistance RDS(ON), Internal Switch: 0.35Ω
- Output Voltage: 0.6V ~ 5.5V
- No Schottky Diode Required
- 1.0Hz Fixed Frequency Switching
- Short-Circuit Protection
- Shutdown Quiescent Current: < 1µA
- Low Profile SOT-23-5 Package (lead-freepackaging is now available)

Applications

- Digital cameras and MP3
- Palmtop computers / PDAs
- Cellular phones
- Wireless handsets and DSL modems
- PC cards
- Portable media players

Pin Configurations

Package Type	**Pin Configurations**
SC12A10 **SOT-23-5**	

Typical Application Circuit

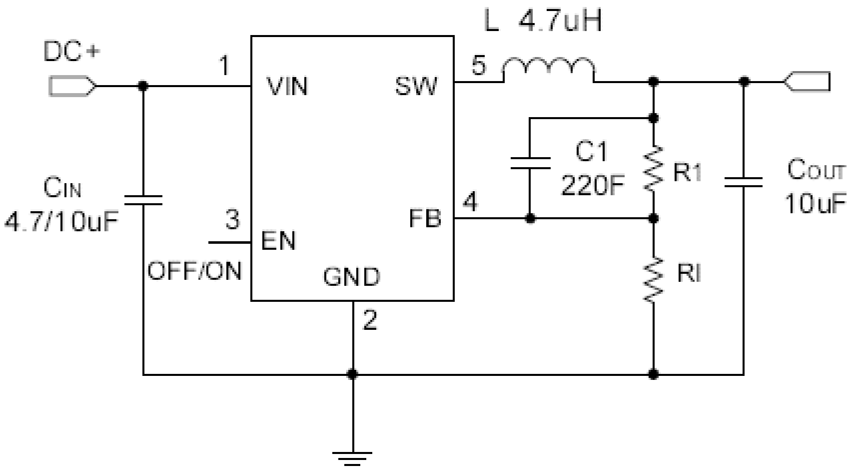


Figure 1 : Adjustable Output Voltage
$V_{OUT} = 0.6V \bullet [1 + (R1/R2)]$

Pin Description

PIN SOT-23-5	NAME	DESCRIPTION
1.	VIN	Main Supply Pin. It must be closely decoupled to GND, Pin 2, with a 10µF or greater ceramic capacitor.
2.	GND	Ground.
3.	EN	En Control Input. Forcing this pin above 1.5V enables the part. Forcing this pin below 0.3V can shuts down the device. In shutdown, all functions are disabled drawing <1mA supply current. Do not leave EN floating.
4.	FB	Feedback Pin. Receive the feedback voltage from an external resistive divider across the output. In the adjustable version, the output voltage is set by a resistive divider according to the following formula: $V_{OUT} = 0.6V \cdot [1 + (R1/R2)]$.
5.	SW	Switch Node Connection to Inductor. This pin connects to the drains of the internal main and synchronous power MOSFET switches.

Absolute Maximum Ratings

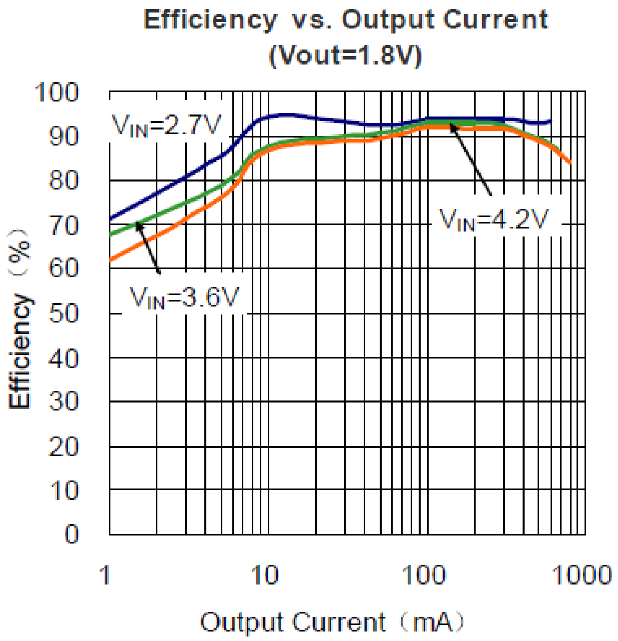
- **Input Supply Voltage (V_{IN}) ,V_{FB} -- –0.3V to 6V**
- **$V_{ON/OFF}$, V_{SW}. -- – 0.3V to V_{IN} + 0.3V**
- **I_{SW} -- 1.3A**
- **Operating Ambient Temperature Range --- –40℃ to 85℃**
- **Storage Temperature Range --- –65℃ to 125℃**
- **Lead Temperature (Soldering, 10 sec) --- 300℃**
- **Junction Temperature --- 125℃**

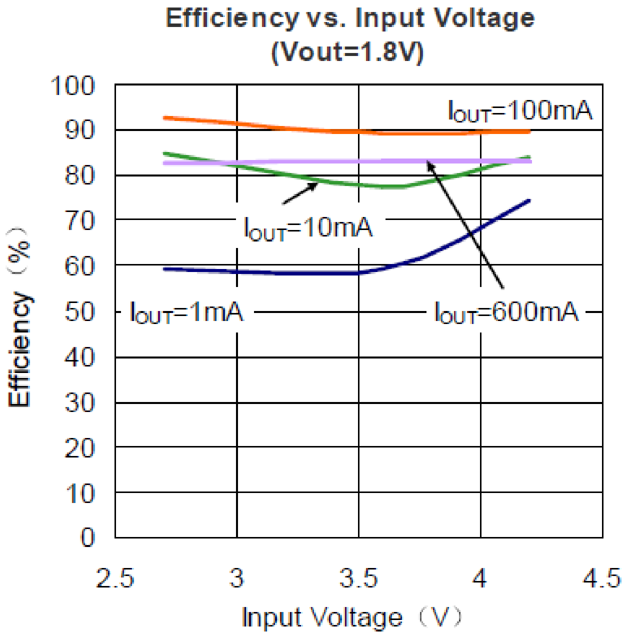
Electrical Characteristics

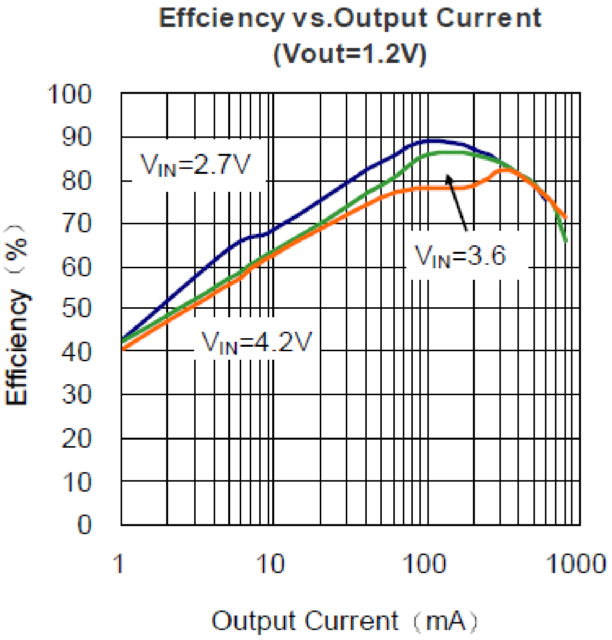
Operating Conditions: TA=25℃,VIN=3.6Vunless otherwise specified.

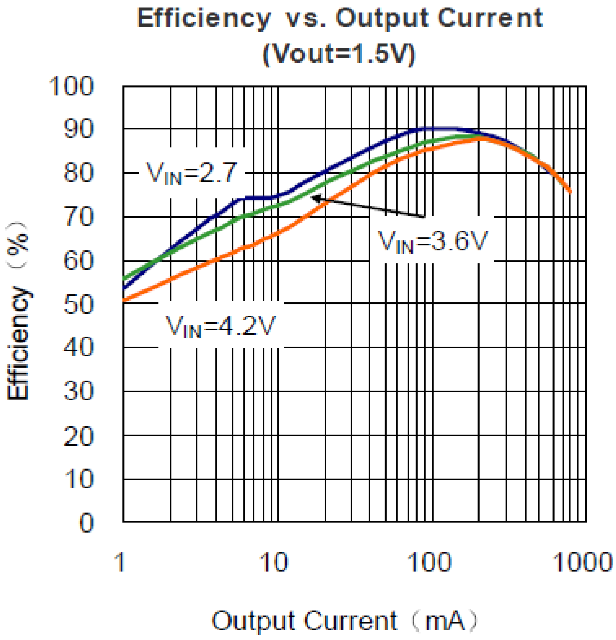
SYMBOL	PARAMETER	CONDITIONS	SC12A10			UNITS
			MIN	TYP	MAX	
VOUT	Output Voltage	IOUT = 100mA, R1/R2=2	1.75	1.8	1.85	V
VIN	Input Voltage Range		2.5		5.5	V
VFB	Regulated Voltage	TA = 25℃	0.588	0.6	0.612	V
IFB	Feedback Current				±30%	nA
ΔVFB	VREF	VIN=2.5V~5.5V		0.03	0.4	%/V
FOSC	Oscillator Frequency	VFB = 0.6V or VOUT = 100%	1	1.2	1.4	MHz
IQ	Quiescent Current	VFB = 0.5V or VOUT = 90%, ILOAD = 0A		120		μA
IS	Shutdown Current	VEN = 0V, VIN = 4.2V		0.1	1	μA
IPK	Peak Inductor Current	VIN = 3V, VFB = 0.5V or VOUT = 90%, Duty Cycle < 35%	0.95	1		A
RPFET	RDS(ON) of P-Channel FET	ISW = 100mA		0.3		Ω
RNFET	RDS(ON) of N-Channel FET	ISW = -100mA		0.39		Ω
EFFI	Efficiency	When connected to ext. components VIN=EN=3.6V, IOUT=100mA		93		%
ΔVOUT	VOUT line Regulation	VIN=2.5V~5.5V		0.03	0.3	%/V
VLOADREG	VOUT load Regulation			0.33		%

Typical Performance Characteristics

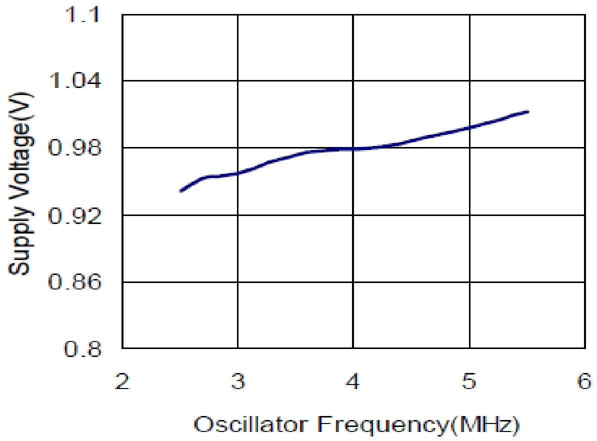

Efficiency vs. Output Current (Vout=1.8V)


Efficiency vs. Input Voltage (Vout=1.8V)

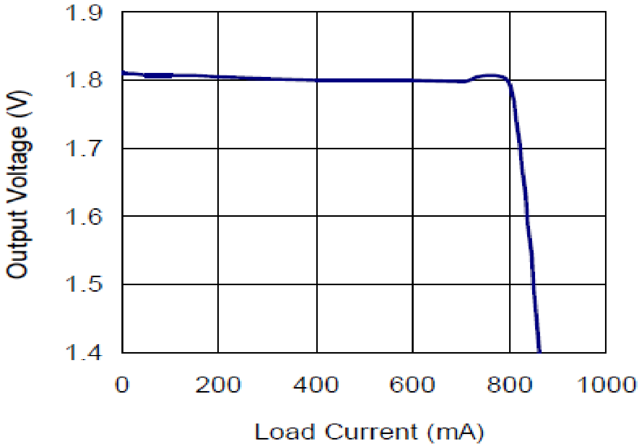

Effciency vs.Output Current (Vout=1.2V)


Efficiency vs. Output Current (Vout=1.5V)

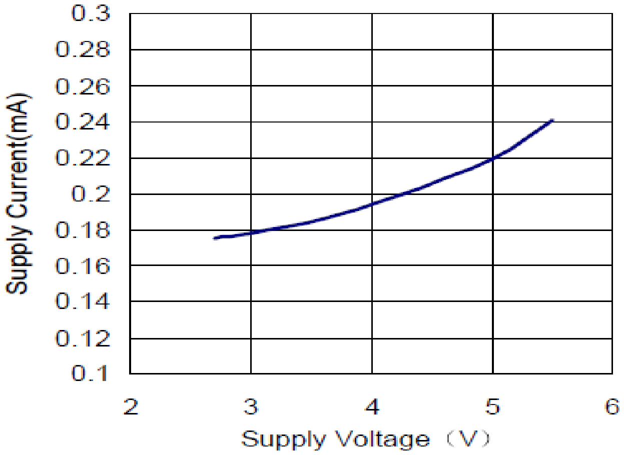
Oscillator Frequency vs. Supply Voltage(Vout=1.8V Io=100mA)



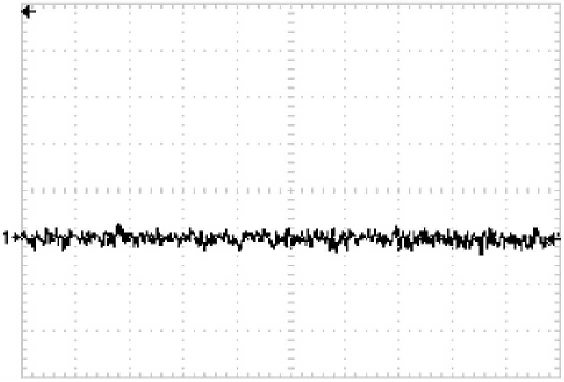
Output Voltage vs. Load Current(Vin=3.6V)



Supply Current vs Supply Voltage (Vout=1.8V Io=0A)

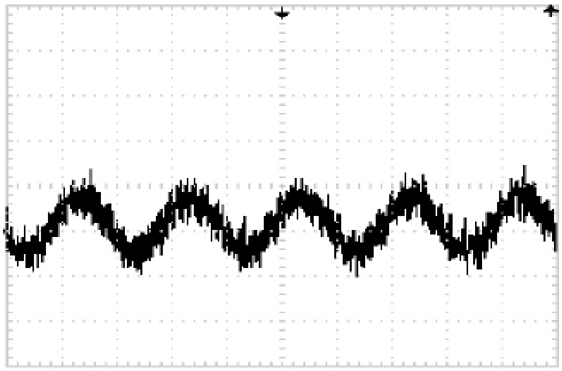


Output Noise（100mV/DIV 2ms/DIV AC COUPLED）



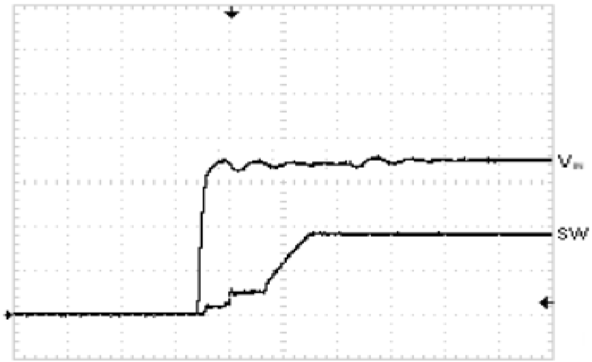
V_{IN}=3.6V V_{OUT}=1.8V I_{LOAD}=0mA

Output Noise（20mV/DIV 10ms/DIV AC COUPLED）



V_{IN}=3.6V V_{OUT}=1.8V I_{LOAD}=200mA

Start –up from Shutdown Input and Output Noise（1V/DIV 100ns/DIV）



Application Information

The basic SC12A10 application circuit is shown in Typical Application Circuit. External component selection is determined by the maximum load current and begins with the selection of the inductor value and operating frequency followed by C_{IN} and C_{OUT}.

Inductor Selection

For most applications, the value of the inductorwill fall in the range of 1mH to 4.7mH. Its value is chosen based on the desired ripple current.Large value inductors lower ripple current and small value inductors result in higher ripple currents. Higher V_{IN} or V_{OUT} also increases the ripple current as shown in equation 1. A reasonable starting point for setting ripple current is ΔI_L=360mA (40% of 900mA).

$$\Delta I_L = \frac{1}{(f)(L)} V_{OUT}\left(1-\frac{V_{OUT}}{V_{IN}}\right)$$

The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation. Thus, a 1.08A rated inductor should be enough for most applications (900mA + 180mA). For better efficiency, choose a low DC-resistance inductor.

Different core materials and shapes will change the size/current and price/current relationship of an inductor. Toroid or shielded pot cores in ferrite or perm alloy materials are small and don't radiate much energy, but generally cost more than powdered iron core inductors withsimilar electrical characteristics. The choice of which style inductor to use often depends more on the price vs. size requirements and any radiated field/EMI requirements than on what the SC12A10 requires to operate.

Output and Input Capacitor Selection

In continuous mode, the source current of the top MOSFET is a square wave of duty cycle V_{OUT}/V_{IN}.To prevent large voltage transients, a low ESR input capacitor sized for the maximum RMS current must be used. The maximum RMS capacitor current is given by:

$$C_{IN} \text{ required } I_{RMS} \cong I_{OMAX}\frac{\left[V_{OUT}\left(V_{IN}-V_{OUT}\right)\right]^{1/2}}{V_{IN}}$$

This formula has a maximum at V_{IN}= $2V_{OUT}$, where $I_{RMS}=I_{OUT}/2$. This simple worst-case condition is commonly used for design because even significant deviations do not offer much relief. Note that the capacitor manufacturer's ripple current ratings are often based on 2000 hours of life. This makes it advisable to further derate the capacitor, or choose a capacitor rated at a higher temperature than required. Always consult the manufacturer if there is any question. The selection of C_{OUT} is driven by the required effective series resistance (ESR). Typically, once the ESR requirement for C_{OUT} has been met, the RMS current rating generally far exceeds the $I_{RIPPLE(P-P)}$ requirement. The output ripple ΔV_{OUT} is determined by:

$$\Delta V_{OUT} \cong \Delta I_L\left(ESR + \frac{1}{8fC_{OUT}}\right)$$

Where f=operating frequency, C_{OUT}=output capacitance and ΔI_L=ripple current in the inductor. For a fixed output voltage, the output ripple is highest at maximum input voltage since ΔI_L increases with input voltage.

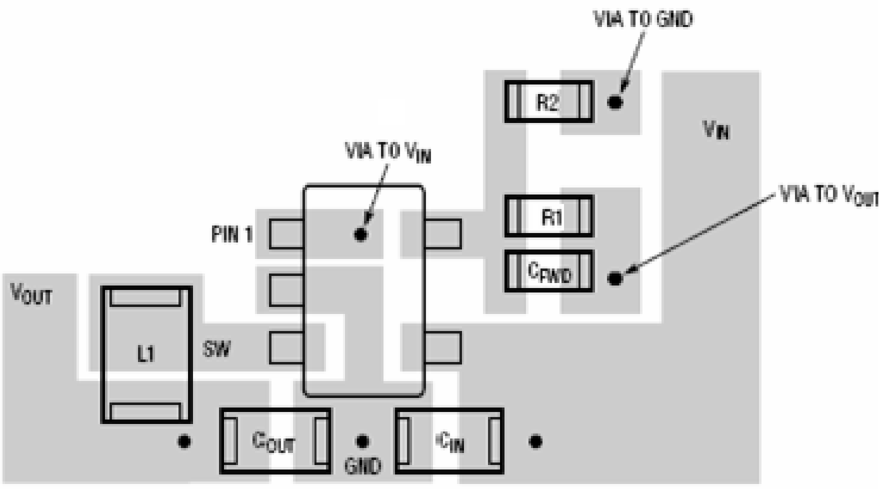
Aluminum electrolytic and dry tantalum capacitors are both available in surface mount configurations. In the case of tantalum, it is critical that the capacitors are surge tested for use in switching power supplies. An excellent choice is the AVX TPS series of surface mount tantalum. These are specially constructed and tested for low ESR so they give the lowest ESR for a given volume. Other capacitor types include Sanyo POSCAP, Kemet T510 and T495 series, and Sprague 593D and 595D series. Consult the manufacturer for other specific recommendations.

PCB Layout Guidelines

When laying out the printed circuit board, the following checklist should be used to ensure proper operation of the SC12A10. These items are also illustrated graphically in Figure 1. Check the following in your layout:

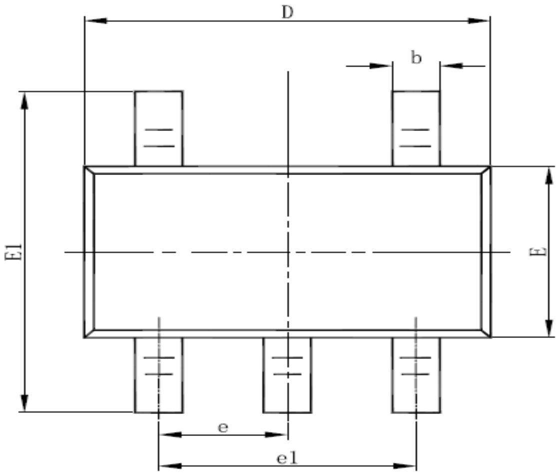
- The power traces, consisting of the GND trace, the SW trace and the VIN trace should be kept short, direct and wide.
- Does the V_{FB} pin connect directly to the feedback resistors? The resistive divider R1/R2 must be connected between the (+) plate of C_{OUT} and ground.
- Does the (+) plate of C_{IN} connects to V_{IN} as closely as possible? This capacitor providesthe AC current to the internal power MOSFETs.
- Keep the switching node, SW, away from the sensitive V_{FB} node.
- Keep the (–) plates of C_{IN} and C_{OUT} as close as possible.

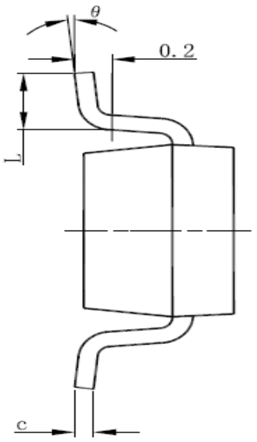
PCB Layout Recommend

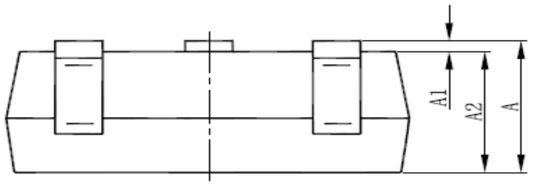


Packaging Information

SPT-23-5 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°