1.5A Synchronous Buck DC/DC Converter

Description

The SC17A15 family of devices is high efficiency synchronous step-down dc-dc converters optimized for battery powered portable applications. The devices are ideal for portable applications powered by a single Li-Ion battery cell or by 3-cell NIMH/NICD batteries. With an output voltage range from 5.0 V down to 0.7 V, the devices support low voltage DSPS and processors in PDAS, pocket PCs, as well as notebooks computers. The SC17A15 operates at a fixed switching frequency of 1MHz.The SC17A15 supports up to 1.5A load current.

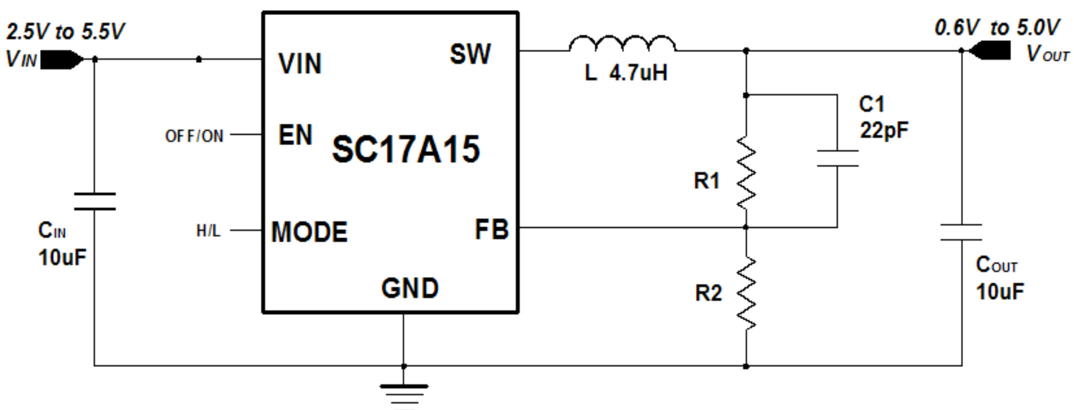
Features

- Input Voltage Range: 2.5V-5.5V
- Load Current Up to 1.5A
- Typical Quiescent Current: 40μA
- Conversion Efficiency Up to 92%
- Switching Frequency up to 1MHz
- Adjustable and Fixed Output Voltage
- 100% Duty Cycle for Lowest Dropout
- Internal Soft Start
- Thermal Shutdown
- Short-Circuit Protection
- SOT-23-6L Package

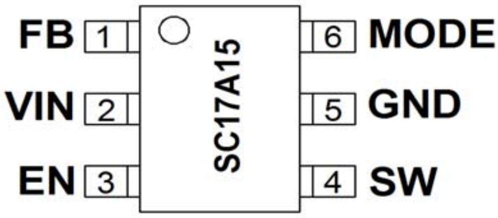
Applications

- PC Cards and Notebooks
- Standard 5V to 3.3V Conversion
- PDA, Pocket PC and Smart Phones
- USB Powered Modems
- CPUs and DSPS

Typical Application Circuit



Pin Configurations

Package Type	Pin Configurations
SC17A15 SOT-23-6L	

Pin Description

PIN	NAME	DESCRIPTION
1.	FB	Feedback Pin. Receive the feedback voltage from an external resistive divider which is connected to the output. In the adjustable version, the output voltage is set by a resistive divider according to the following formula. $V_{OUT} = 0.58 \times (1+R1/R2)$
2.	VIN	Supply voltage input.
3.	EN	En Control Input. Forcing this pin above 1.5V enables the part. Forcing this pin below 0.4V shuts down the device. In shutdown, all functions are disabled drawing <1uA supply current. Do not leave EN floating.
4.	SW	When MODE connects V_{IN}, high power consumption; When MODE connects GND, low power consumption.
5.	GND	Ground Pin.
6.	MODE	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}) ---------- –0.3V to 6V**
- **V_{SW}、V_{EN} ---------- – 0.3V to (V_{IN} + 0.3)V**
- **V_{FB} ---------- –0.3V to 6V**
- **I_{SW} ---------- 2.5A**
- **Maximum Junction Temperature ---------- 125℃**
- **Operating Ambient Temperature Range ---------- –40℃ to 85℃**
- **Storage Temperature Range ---------- –65℃ to 125℃**
- **Lead Temperature (Soldering, 10 sec) ---------- 300℃**

Electrical Characteristics

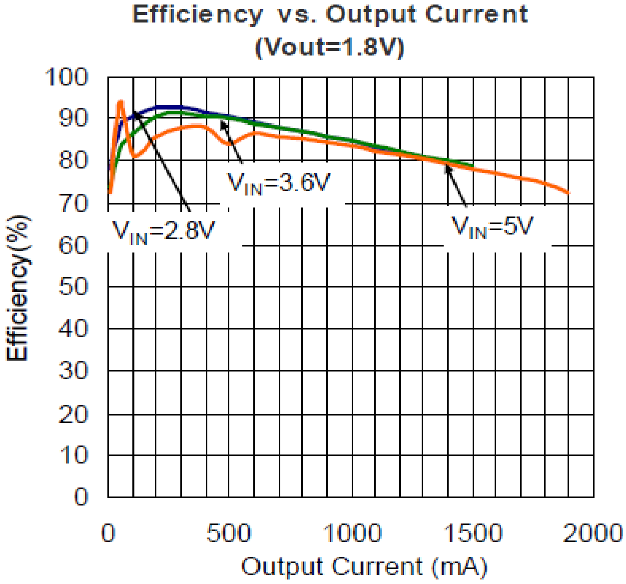
Operating Conditions: T_A=25 ℃,V_{IN}=3.6V unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	SC17A15			UNITS
			MIN	TYP	MAX	
V_{IN}	Input Supply Voltage		2.5		5.5	V
V_{OUT}	Output Voltage		0.7		5.0	V
V_{FB}	Regulated Voltage	T_A=25 ℃	0.56	0.58	0.60	V
I_{FB}	Feedback Current				±30	nA
ΔV_{FB}	V_{REF}	V_{IN}=2.5V to 5.5V		0.03	0.4	%/V
F_{OSC}	Oscillator Frequency	V_{FB} =0.58V or V_{OUT} =100%	0.8	1.0	1.2	MHz
I_Q	Quiescent Current	V_{FB} = 0.5V or V_{OUT} = 90%, I_{LOAD}=0A ,Mode=0V		40		μA
I_S	Shutdown Current	V_{EN} = 0V, V_{IN} = 4.2V		0.1	1	μA
I_{PK}	Peak Inductor Current	V_{IN} = 3.6V, V_{FB} = 0.5V or V_{OUT} =90%,		1.5		A
R_{PFET}	$R_{DS(ON)}$ of P-Channel FET	I_{SW} = 500mA		0.1		Ω
R_{NFET}	$R_{DS(ON)}$ of N-Channel FET	I_{SW} = -500mA		0.3		
EFFI	Efficiency	V_{IN}=EN=3.6V,I_{OUT}=100mA		92		%
ΔV_{OUT}	V_{OUT} Line Regulation	V_{IN}=2.5V~5.5V		0.04	0.3	%/V
$V_{LOADREG}$	V_{OUT} Load Regulation			0.33		%

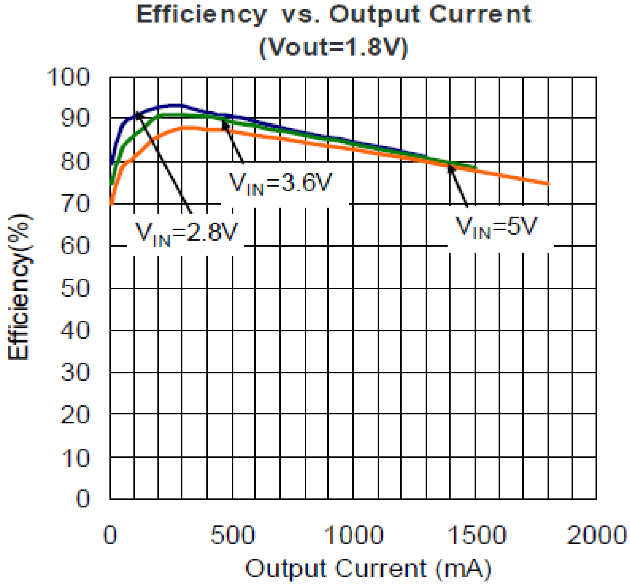
Typical Performance Characteristics

T_A=25℃, C_{IN} =10μF, C_{OUT} =10μF, L=4.7μH, R1=200K, R2=100KΩ, unless otherwise noted.

MODE Connect GND

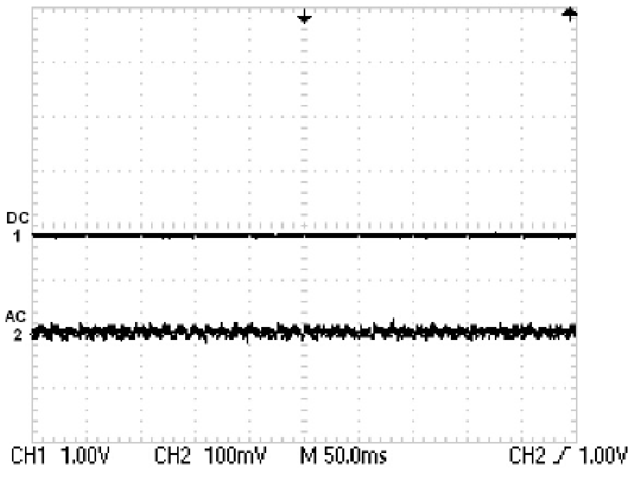


MODE Connect VIN



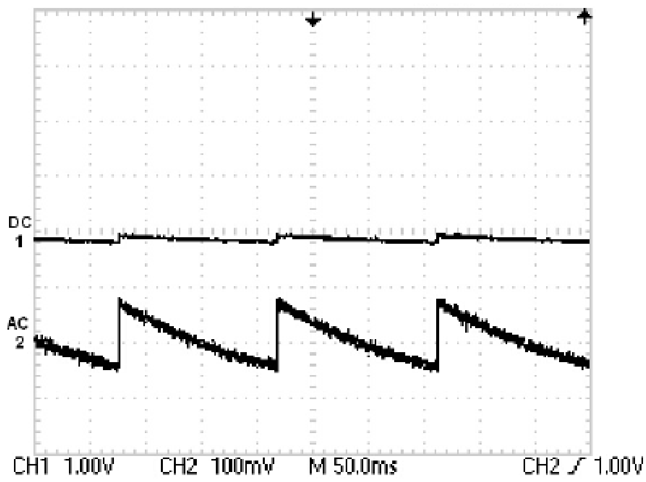
Output Noise

(VIN=5V, I_{LOAD} =0, MODE Connect VIN)



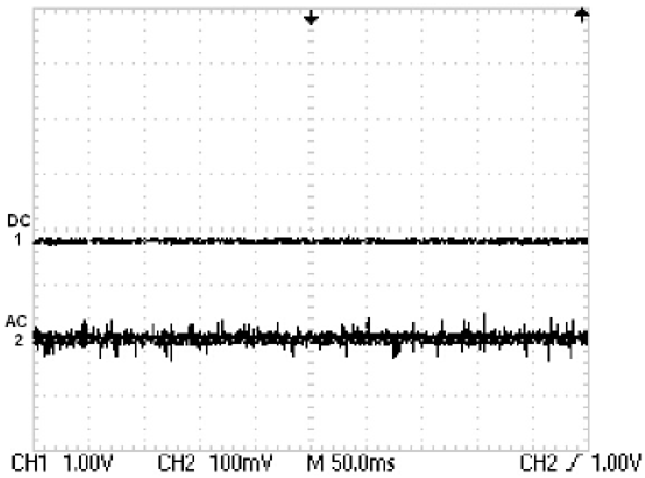
Output Noise

（VIN=5V, I_{LOAD} =0, MODE Connect GND）



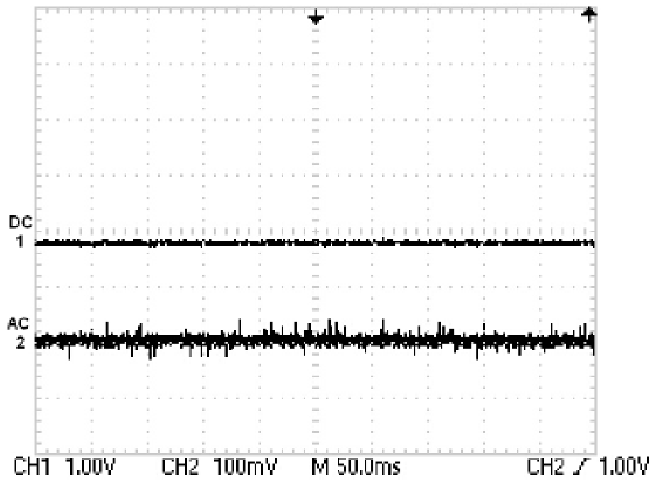
Output Noise

（VIN=5V, I_{LOAD} =1A, MODE Connect VIN）



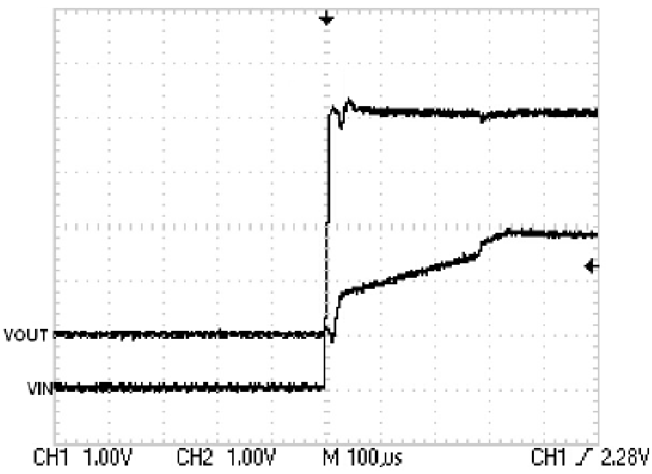
Output Noise

（VIN=5V, I_{LOAD} =1A, MODE Connect GND）



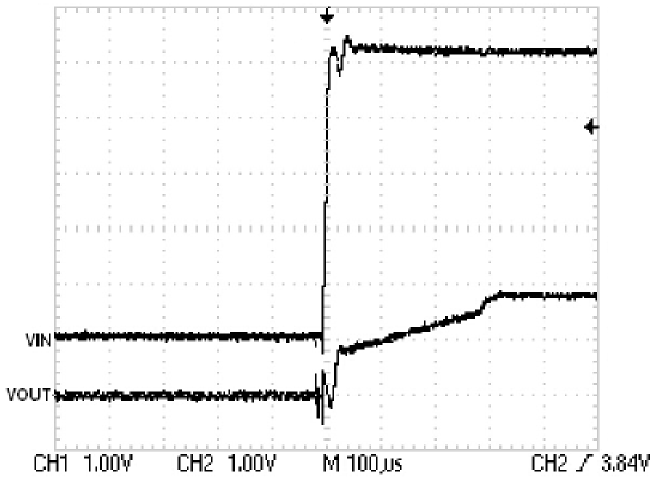
Start –up from power on

(V_{IN}=5V, I_{LOAD}=0A, MODE Connect GND)



Start –up from power on

(V_{IN}=5V, I_{LOAD}=0A, MODE Connect VIN)



Application Information

INDUCTOR SELECTION

For most applications, the value of the inductor will 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 $\triangle I_L$ = 240mA (40% of 600mA).

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

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 1.8A rated inductor should be enough for most applications (1.5A + 300mA). 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 with similar 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 SC17A15 requires to operate. Table 1 shows some typical surface mount inductors that work well in SC17A15 applications.

Part	L(μH)	Max DCR (mΩ)	Max DC Current (A)	Size W × L × H (mm^3)	Vendor
CDRH3D16	4.7	162	0.9	3.8 × 3.8 × 1.8	Sumida

Table1. Recommended Inductors

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:

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

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 IRIPPLE(P-P) requirement. The output ripple ΔVOUT 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 ΔIL 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.

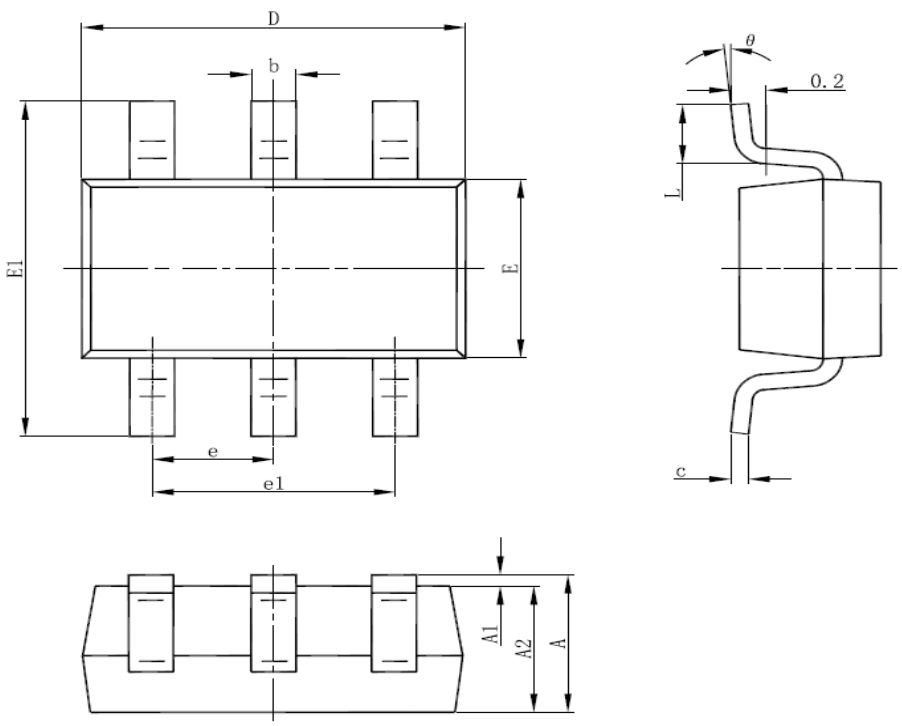
PCB LAYOUT GUIDELINES

When laying out the printed circuit board, the following checklist should be used to ensure proper operation of the SC17A15. 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 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.
3. Does the (+) plate of C_{IN} connects to VIN as closely as possible? This capacitor provides the AC current to the internal power MOSFETs.
4. Keep the switching node, SW, away from the sensitive VFB node.
5. Keep the (–) plates of C_{IN} and C_{OUT} as close as possible.

Packaging Information

SOT-23-5L 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°