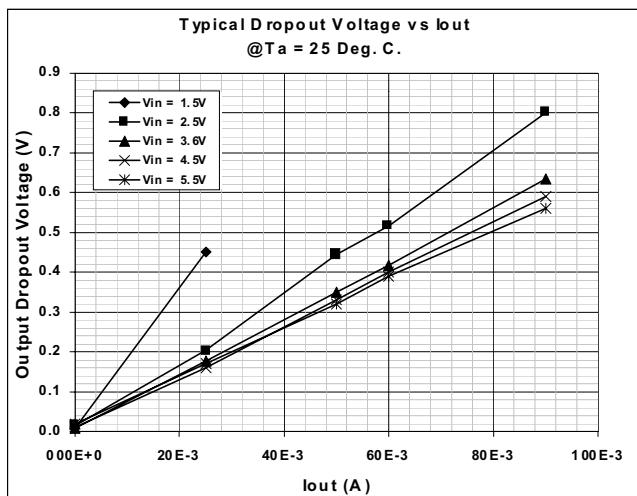


## POWER MANAGEMENT

### Description

The SC1462 is a versatile charge pump designed for use in battery operated power supply applications over the wide input range of 1.65 to 5.5 volts. A simple, low quiescent current charge pump doubler can be implemented without costly inductors or capacitors. Internal MOSFETs and control circuitry eliminate the need for costly board space and design time. The small 6 lead SOT-23 package helps minimize board space.

The SC1462 charge pump can be used for applications that require up to 80mA of output current with  $V_{IN} = 2.5V$  to 5.5V. Typical dropout voltage ( $2*V_{IN}$ )-Vout is shown below for several values of Vin.



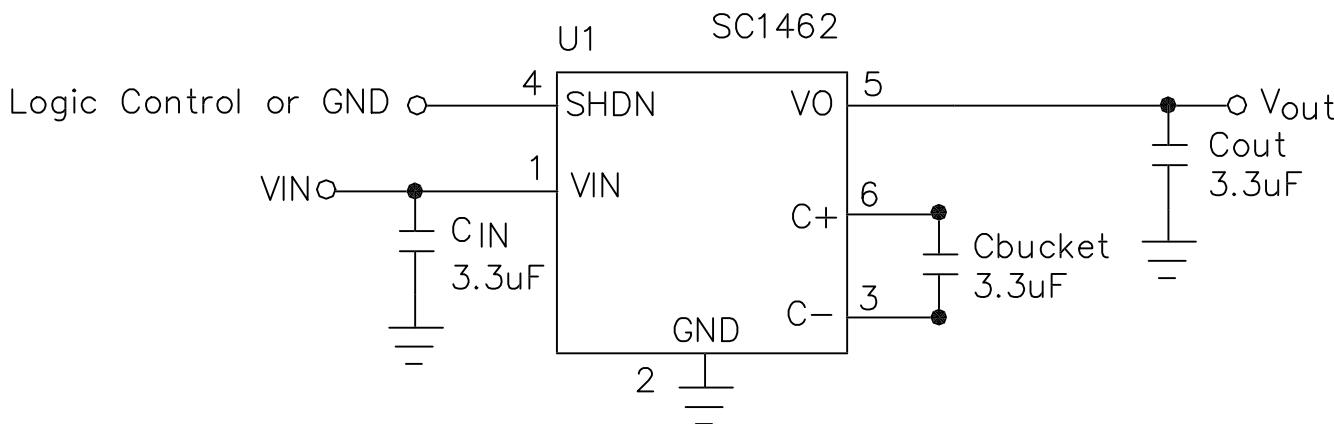
### Features

- ◆ Input supply voltage range of 1.65V to 5.5V
- ◆ Small size - 6 pin SOT-23 package
- ◆ Typical efficiency of :
  - 91% @ Vin = 2.5V, Iout = 45mA
  - 94% @ Vin = 3.6V, Iout = 55mA
- ◆ Short circuit and over-temperature protection
- ◆ 140 $\mu$ A typical input current @ no load
- ◆ Shutdown current <1 $\mu$ A
- ◆ Designed to work with ceramic or Tantalum capacitors
- ◆ Fixed frequency of 160kHz
- ◆ All specifications rated over full temperature range (-40°C to 85°C)

### Applications

- ◆ Cellular phones
- ◆ Handheld devices

### Typical Application Schematic



**POWER MANAGEMENT**
**Absolute Maximum Rating**

Parameter	Symbol	Maximum	Units
Supply Voltage	V <sub>IN</sub>	-0.3 to +6.0	V
Output Voltage	V <sub>O</sub>	-0.3 to +12	V
V <sub>OUT</sub> Short Circuit Duration	SC	Indefinite	
Thermal Resistance Junction to Ambient	θ <sub>JA</sub>	230	°C/W
Operating Ambient Temperature Range	T <sub>A</sub>	-40 to +85	°C
Junction Temperature Range	T <sub>J</sub>	-40 to +125	°C
Storage Temperature Range	T <sub>STG</sub>	-65 to +150	°C
Lead Temperature (Soldering) 10 seconds	T <sub>L</sub>	300	°C

**Electrical Characteristics**

Unless specified:

T<sub>A</sub> = -40°C to 85°C, SHDN = GND, 1.65V ≤ V<sub>IN</sub> ≤ 5.5V, Frequency = 160kHz, C<sub>IN</sub> = C<sub>OUT</sub> = C<sub>BUCKET</sub> = 3.3μF (ESR = 0.3Ω).

Parameter	Symbol	Conditions	MIN	TYP	MAX	Units
Input Supply Voltage	V <sub>IN</sub>		1.65		5.5	V
Input Supply Current	I <sub>IN</sub>	I <sub>O</sub> = 0, V <sub>IN</sub> = 2.5V		140	260	μA
		I <sub>O</sub> = 0, V <sub>IN</sub> = 3.6V		200	400	μA
		SHDN = V <sub>IN</sub>		0.1	1	μA
Output Resistance <sup>(5)</sup>	R <sub>OUT</sub>	V <sub>IN</sub> = 2.5V		9.5	13.5	Ω
Output Resistance <sup>(5)</sup>	R <sub>OUT</sub>	V <sub>IN</sub> = 3.6V		7.5	10.5	Ω
Total Switch Resistance <sup>(6)</sup>	R <sub>SW</sub>	V <sub>IN</sub> = 2.5V		3	4.5	Ω
Total Switch Resistance <sup>(6)</sup>	R <sub>SW</sub>	V <sub>IN</sub> = 3.6V		2	3	Ω
Output Current	I <sub>O</sub>	V <sub>IN</sub> = 2.5V			80	mA
		V <sub>IN</sub> = 3.6V			80	mA
Oscillator Frequency	OSC		100	160	200	KHz
Short Circuit Current	I <sub>SC</sub>	V <sub>OUT</sub> = 0V		200		mA
Output ripple (pk-pk) <sup>(1)(3)</sup>	V <sub>R</sub>	I <sub>O</sub> = 45mA, V <sub>IN</sub> = 2.5V		75		mV
Power Efficiency <sup>(1)</sup>	η	I <sub>O</sub> = 45mA, V <sub>IN</sub> = 2.5V	86			%
Maximum Output Voltage <sup>(3)</sup>	V <sub>out</sub>	I <sub>O</sub> = 0mA			2*V <sub>in</sub>	V

**NOTES:**

- (1) All electrical characteristics are for the application circuit on page 1.
- (2) Soft start functionality is performed along with short circuit protection. If V<sub>OUT</sub> is less than V<sub>IN</sub> - 200mV, then all switches are turned off and V<sub>OUT</sub> is charged with a 200mA current source from V<sub>IN</sub>. When V<sub>OUT</sub> reaches V<sub>IN</sub> - 200mV all switches are enabled.
- (3) Guaranteed by design.
- (4) This device is ESD sensitive. Use of standard ESD handling precautions is required.
- (5) The internal switch resistance, the capacitor ESR and the oscillator's switching frequency all contribute to R<sub>OUT</sub>. See the CAPACITOR SELECTION section for information on applying the R<sub>OUT</sub> specification.
- (6) The parameter R<sub>sw</sub> is equal to the total resistance of all 4 internal switches. See the CAPACITOR SELECTION section for information on applying the R<sub>sw</sub> specification. The parameter was calculated from actual output resistance and the equation on page 6 for R<sub>OUT</sub>.

**POWER MANAGEMENT**
**Electrical Characteristics (Cont.)**

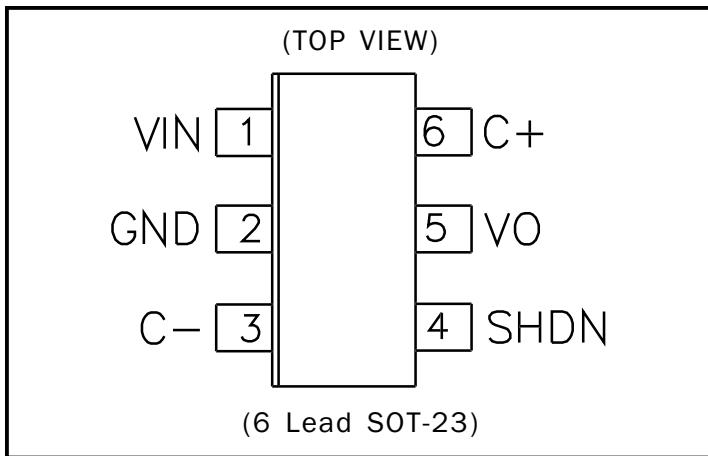
Unless specified:

$T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$ , SHDN = GND,  $1.65\text{V} \leq V_{\text{IN}} \leq 5.5\text{V}$ , Frequency = 160kHz,  $C_{\text{IN}} = C_{\text{OUT}} = C_{\text{BUCKET}} = 3.3\mu\text{F}$  (ESR =  $0.3\Omega$ ).

Parameter	Symbol	Conditions	MIN	TYP	MAX	Units
Time to Regulation at Turn on <sup>(2)</sup>	$t_{\text{ON}}$	$I_O = 0$ to 60mA, $V_{\text{IN}} = 3.6\text{V}$		500		us
Input High Threshold	VIH	SHDN pin, $2.5\text{V} \leq V_{\text{IN}} \leq 5.5\text{V}$	1.6			V
Input Low Threshold	VIL	SHDN pin, $2.5\text{V} \leq V_{\text{IN}} \leq 5.5\text{V}$			0.4	V
Over Temperature Protection <sup>(3)</sup>	O.T.			140		°C
Over Temperature Hysteresis <sup>(3)</sup>	O.T.H.			20		°C

**NOTES:**

- (1) All electrical characteristics are for the application circuit on page 1.
- (2) Soft start functionality is performed along with short circuit protection. If  $V_{\text{OUT}}$  is less than  $V_{\text{IN}} - 200\text{mV}$ , then all switches are turned off and  $V_{\text{OUT}}$  is charged with a 200mA current source from  $V_{\text{IN}}$ . When  $V_{\text{OUT}}$  reaches  $V_{\text{IN}} - 200\text{mV}$  all switches are enabled.
- (3) Guaranteed by design.
- (4) This device is ESD sensitive. Use of standard ESD handling precautions is required.
- (5) The internal switch resistance, the capacitor ESR and the oscillator's switching frequency all contribute to  $R_{\text{OUT}}$ . See the CAPACITOR SELECTION section for information on applying the  $R_{\text{OUT}}$  specification.
- (6) The parameter  $R_{\text{sw}}$  is equal to the total resistance of all 4 internal switches. See the CAPACITOR SELECTION section for information on applying the  $R_{\text{sw}}$  specification. The parameter was calculated from actual output resistance and the equation on page 6 for  $R_{\text{OUT}}$ .

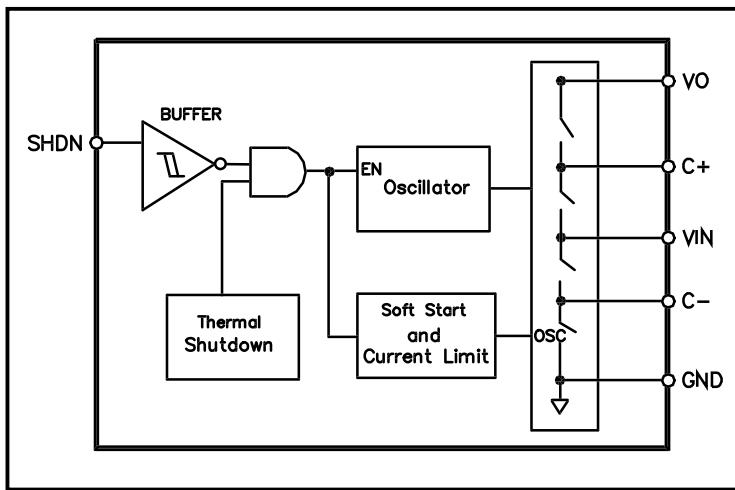
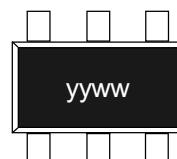
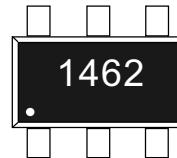
**POWER MANAGEMENT**
**Pin Configuration**

**Ordering Information**

Part Number <sup>(1)</sup>	Package
SC1462ISKTR	SOT-23-6

**Note: (1)** Only available in tape and reel packaging.  
A reel contains 3000 devices.

**Pin Descriptions**

Pin # SOT-23-6	Pin Name	Pin Function
1	VIN	Supply voltage input.
2	GND	Ground.
3	C-	This pin should be connected to the negative terminal of the external charging capacitor.
4	SHDN	Shutdown pin. When this pin is connected to VIN, the device enters sleep mode.
5	VO	Voltage output.
6	C+	This pin should be connected to the positive terminal of the external charging capacitor.

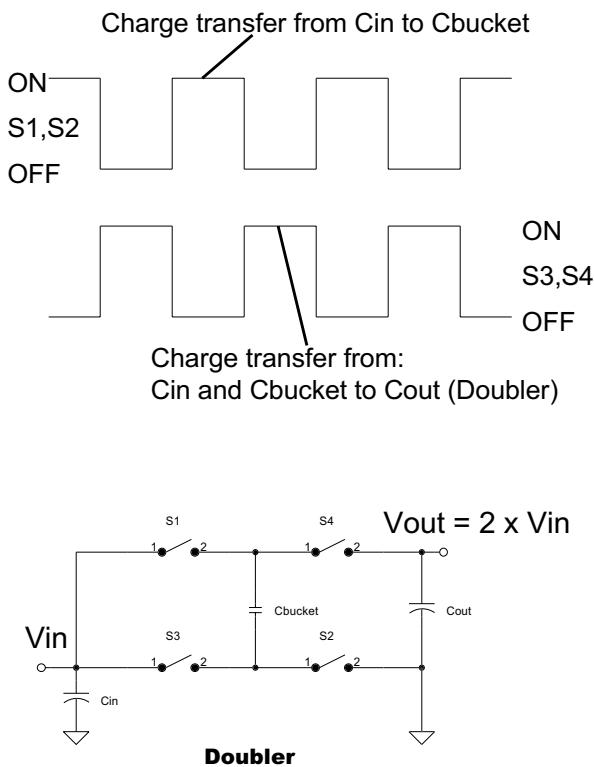
**Block Diagram**
**Marking Information**

**Top Mark**

**Bottom Mark**

yyww = Datecode (Example : 9908)

**POWER MANAGEMENT**
**Applications Information**
**THEORY OF OPERATION**

The SC1462 utilizes a switched capacitor charge pump, to generate an output voltage approximately  $2 \times V_{IN}$ .

An internal oscillator generates two out of phase fixed frequency clock signals which turn on and off internal MOSFET switches. During phase1 of clock, the flying charge pump capacitor is charged to  $V_{IN}$  through switches S1, and S2. During phase2 the flying charge pump capacitor is connected in series with the input voltage via S3, and S4, producing an output voltage.


**SHORT CIRCUIT / SOFT START**

An internal current limit and soft start circuit provides protection against output short circuit and limits large current spikes generated during the initial start up to charge output capacitor.

If  $V_{OUT}$  is less than  $V_{IN} - 200\text{mV}$ , then all switches are turned off and  $V_{OUT}$  is charged with a 200mA current source from  $V_{IN}$ . When  $V_{OUT}$  reaches  $V_{IN} - 200\text{mV}$ , the current source is disconnected from output and the charge pump circuitry is enabled again.

**OUTPUT CURRENT**

The dropout voltage for a charge pump doubler is defined as  $(2 \times V_{IN}) - V_{OUT}$ . The maximum output current is usually specified as that which will not cause the dropout voltage to exceed the requirements of the application. The calculation of the dropout voltage is given in the capacitor selection section on page 6. Typical dropout voltages versus  $I_{OUT}$  are graphed on page 8.

**THERMAL SHUTDOWN**

The thermal shutdown circuit provides added protection to the SC1462. During a  $V_{OUT}$  short circuit condition or if the load is excessive, the over temperature circuitry will shut down the charge pump if the junction temperature exceeds approximately  $140^{\circ}\text{C}$ . The charge pump is enabled only if the junction temperature drops to approximately  $120^{\circ}\text{C}$ . The SC1462 will cycle in and out of thermal shut down until the short circuit or the excessive load condition on  $V_{OUT}$  is removed, thereby improving device reliability. The junction temperature can be calculated from the following formula if the ambient temperature ( $T_a$ ) and the charge pump power dissipation ( $P_{diss}$ ) are known.

$$T_J = T_a + P_{diss} * \theta_{JA} \quad ; \quad \theta_{JA} = 230 \text{ }^{\circ}\text{C/W}$$

## POWER MANAGEMENT

### Applications Information (Cont.)

#### CAPACITOR SELECTION

Capacitor selection is based on both the maximum acceptable ripple voltage and the maximum tolerable drop at the output.

##### Ripple

The peak to peak output ripple voltage is dependent on the following factors:

- 1- Oscillator Frequency
- 2- ESR of  $C_{OUT}$
- 3- Capacitance value of  $C_{out}$

Item 1 is fixed and depend on the charge pump device used. Item 2, and 3 can be optimized for best performance and reduction of the output ripple.

The following formula could be used for an approximation for  $V_{out\_ripple}$ :

$$V_{out\_ripple} = \frac{I_{out}}{2 \times F_{osc} \times C_{out}} + 2 \times I_{out} \times ESR\_C_{out}$$

##### Vout Drop

The voltage drop at the output is specified with the following equation:

$$V_{out\_drop} = I_{out} \times R_{out}$$

$R_{out}$  is dependent on the following factors:

- 1- Oscillator Frequency
- 2- ESR of  $C_{OUT}$  &  $C_{bucket}$
- 3- Capacitance value of  $C_{OUT}$  &  $C_{bucket}$
- 4- Internal switch resistance ( $R_{sw}$  = Total of all 4 switch resistances).

A good approximation for calculating the output resistance is shown below.

$$R_{out} \approx \frac{1}{F_{osc} \times C_{bucket}} + 2 \times R_{sw} + 4 \times ESR\_C_{bucket} + ESR\_C_{out}$$

This equation can be used to calculate  $C_{bucket}$  for a specific  $V_{out}$  when  $V_{in}$  and  $I_{out}$  are known. The maximum value for the  $R_{sw}$  from the Electrical Characteristics section on page 2 should be used in order to find a worst case number.

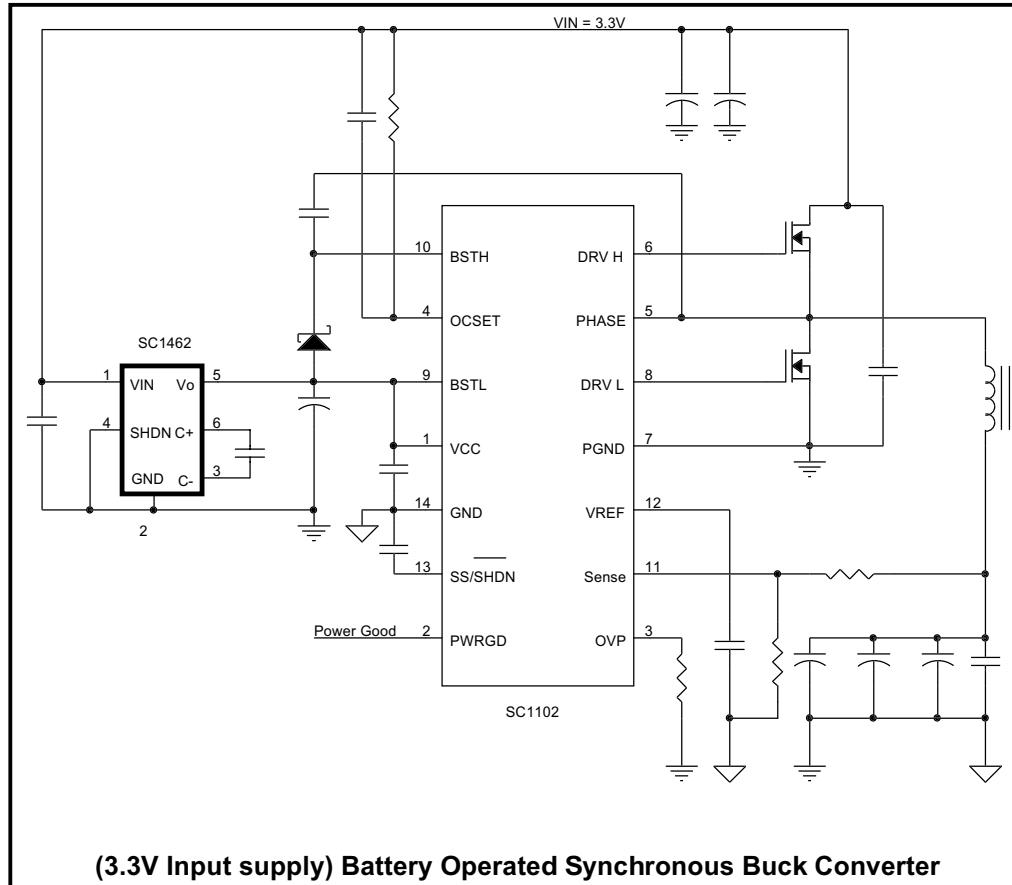
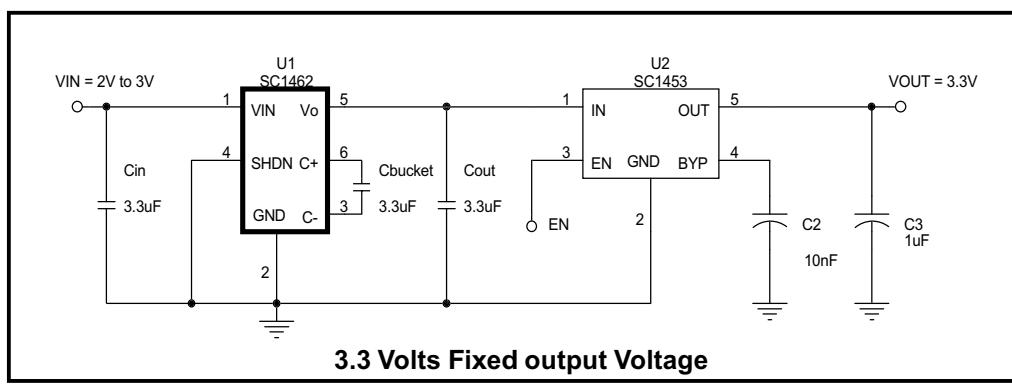
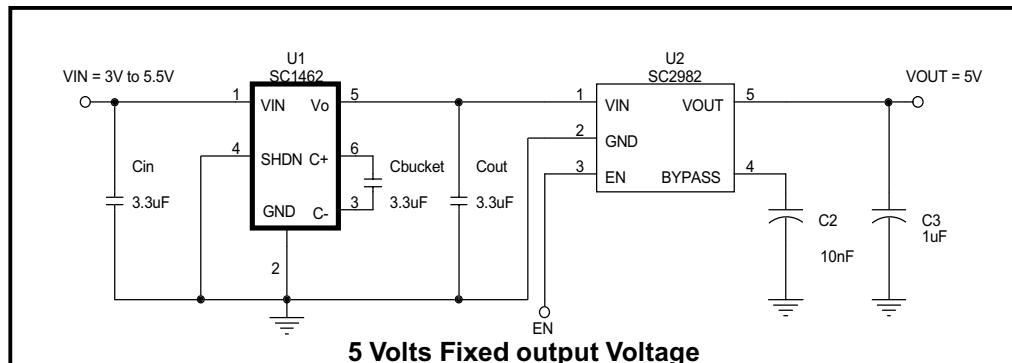
#### LAYOUT CONSIDERATION

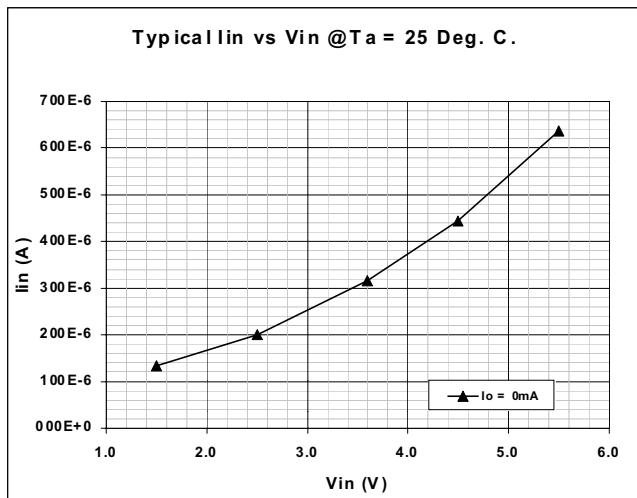
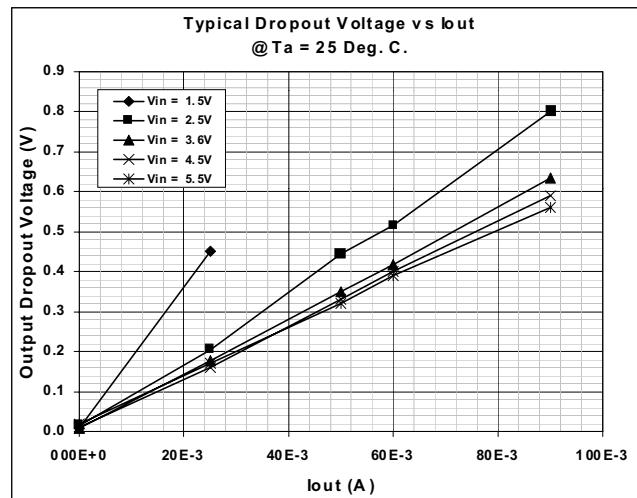
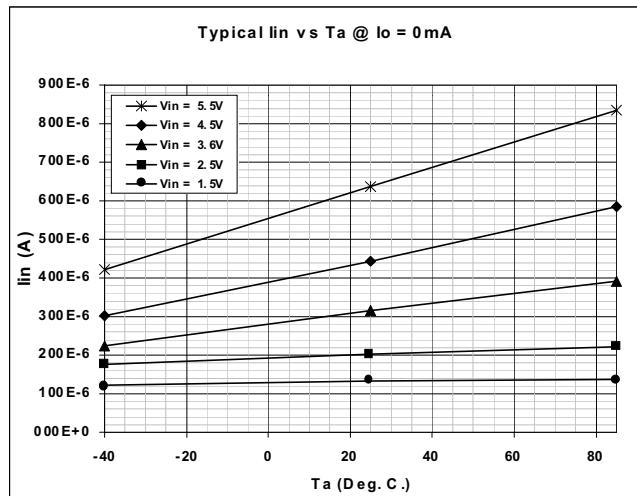
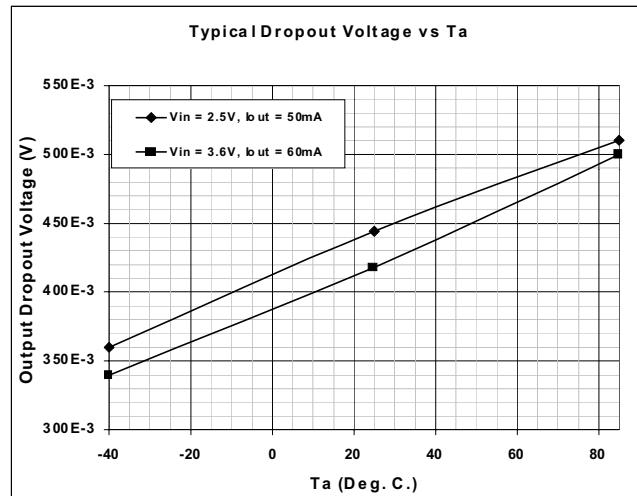
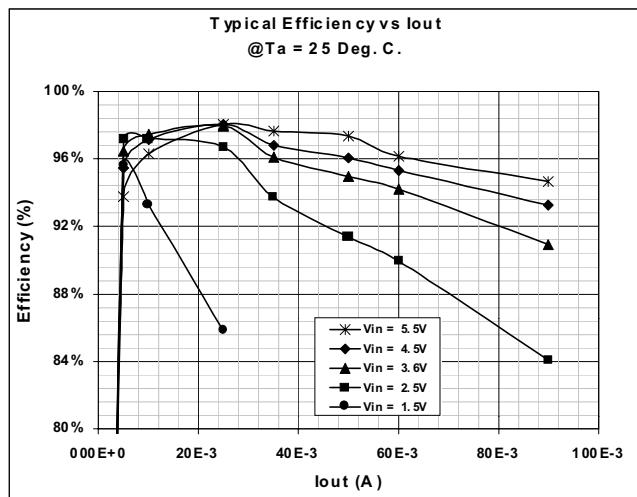
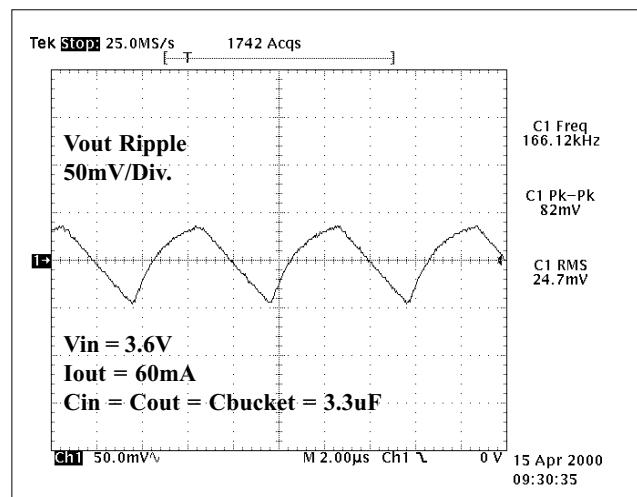
Standard power board layout should be followed to ensure proper operation. Any stray inductance should be minimized, this can be achieved by using large power planes or traces, and reducing the distances between input, output and the load. All components should be placed as close as possible to the SC1462.

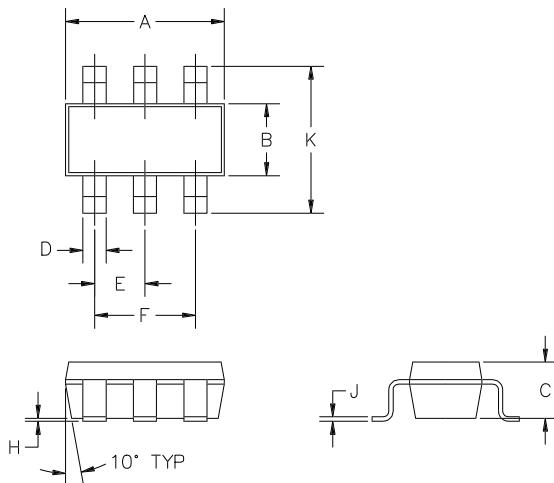
Following tables show typical capacitor characteristics, and capacitor manufacturers.

Component	ESR( $\Omega$ )	ESL(nH)
0.1uF Ceramic 0603 Package	0.050	1.60
1.0uF Ceramic 1206 Package	0.040	0.47
10uF Ceramic 1206 Package	0.075	0.50
47uF,16V Tantalum D case	0.100	0.60
330uF,6.3V "OSCON"	0.025	2.50
330uF,16V Al. Electrolytic	0.143	2.37
820uF,4V "OSCON"	0.012	2.50
1000uF,10V Al. Electrolytic	0.053	5.00

Capacitor Manufacturers	Phone
AVX Corp.	(803) 448-9411
VISHAY	(207) 324-4140
Nichicon Corp.	(708) 843-7500
muRata	(800) 831-9172
TOKIN	(408) 432-8020
Taiyo Yuden	(800) 348-2496
Sanyo	(619) 661-6835

**POWER MANAGEMENT**
**Applications Information (Cont.)**


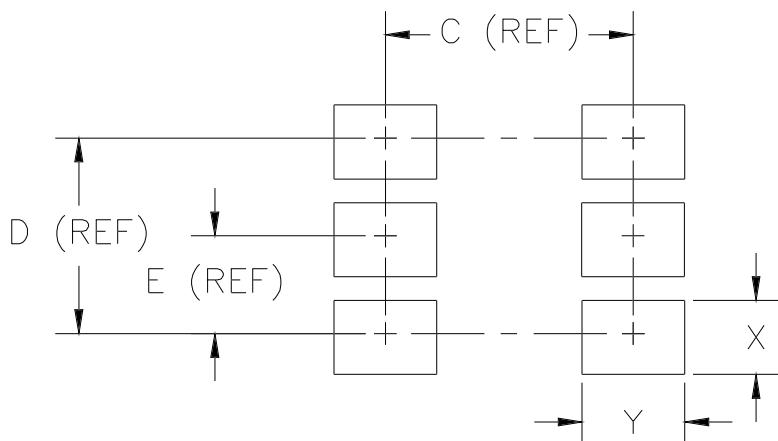
**POWER MANAGEMENT**
**Typical Characteristics**

**Typical  $I_{in}$  vs  $V_{in}$   $I_{out} = 0mA$** 

**Typical Dropout vs  $I_{out}$** 

**Typical  $I_{in}$  vs  $T_a$   $I_{out} = 0mA$** 

**Typical Dropout vs  $T_a$** 

**Typical Efficiency vs  $I_{out}$** 

**Typical Output Ripple**

**POWER MANAGEMENT**
**Outline Drawing - SOT-23-6L**


DIMENSIONS <sup>①</sup>				
DIM <sup>N</sup>	INCHES	MM	MIN	MAX
A	.110 .120	2.80 3.05	.110	.120
B	.059 .070	1.50 1.75	.059	.070
C	.036 .051	.90 1.30	.036	.051
D	.014 .020	.35 .50	.014	.020
E	.033 .040	.85 1.05	.033	.040
F	.067 .083	1.7 2.1	.067	.083
H	.0004 .006	.010 .150	.0004	.006
J	.0035 .008	.090 .20	.0035	.008
K	.102 .118	2.6 3.00	.102	.118

PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH AND METAL BURR.

CONTROLLING DIMENSIONS: MILLIMETERS.

**Land Pattern - SOT-23-6L**


DIMENSIONS			
DIM <sup>N</sup>	INCHES	MM	NOTE
C	.094	2.4	—
D	.074	1.9	—
E	.037	.95	—
X	.028	.7	—
Y	.039	1.0	—

**Contact Information**

**Semtech Corporation**  
**Power Management Products Division**  
**652 Mitchell Rd., Newbury Park, CA 91320**  
**Phone: (805)498-2111 FAX (805)498-3804**