

### GENERAL DESCRIPTION

The PT1102 is a CMOS-based fixed frequency step-down DC/DC converter with a built-in internal power MOSFET. It achieves 1A continuous output current over a wide input supply range with excellent load and line regulation. It requires a minimum number of readily available external components to complete a 1A step down DC to DC converter solution with low ripple and high efficiency. The output voltage can be adjusted with external resistors.

With the enhanced voltage mode operation, the PT1102 achieves good loop stability with wide operating range. Under light load conditions, the PT1102 automatically switches to a VFM mode to improve efficiency. Fault condition protection includes current limiting and thermal shutdown. Furthermore, the PT1102 has a built-in UVLO function that prevents the output from being unstable when the input voltage becomes too low.

The PT1102 is available in SOP8 packages.

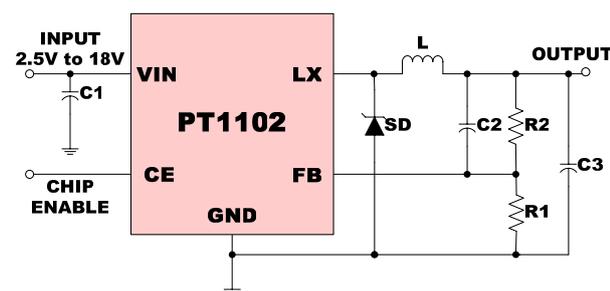
### FEATURES

- Wide Range Of Input Voltage: 2.5V~18V
- Oscillation Frequency: 500kHz
- Standby Current: Typical 0.1 $\mu$ A
- High Efficiency: Typical 88%
- Low Temp. Coefficient of Feedback Voltage:  
Typical  $\pm 100$ ppm/ $^{\circ}$ C
- Built-in Soft-start and UVLO
- Thermal Shutdown
- Package: SOP-8

### APPLICATIONS

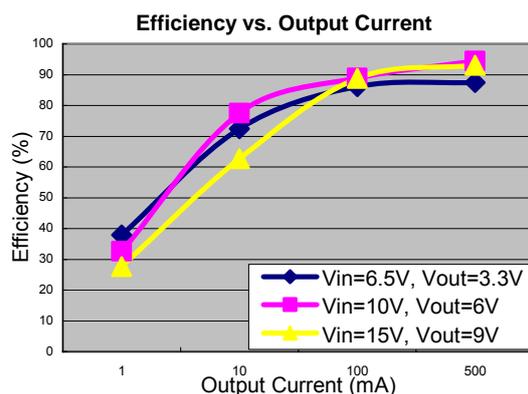
- Distributed Power Systems
- Battery Chargers
- Pre-regulator for linear Regulators

### TYPICAL APPLICATION CIRCUIT



L: CR105-270MC (Sumida, 27 $\mu$ H) or Equivalent  
 SD: RB063L-30(Rohm) or Equivalent  
 C1: 4.7 $\mu$ F, Ceramic Type  
 R1: 10k $\Omega$   
 R2: 40k $\Omega$  (For 5V Output)  
 C2: 1nF, Ceramic Type  
 C3: 47 $\mu$ F, Tantalum Type

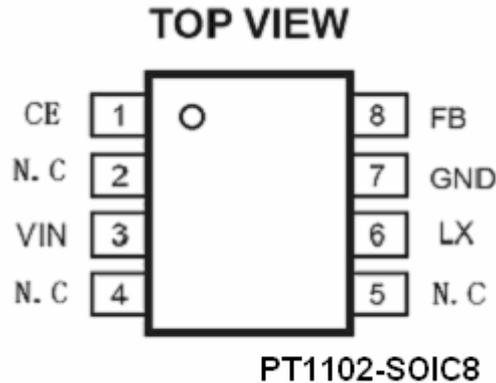
### KEY PERFORMANCE CHART



### ORDERING INFORMATION

Package	Temperature	Part Number	Transport Media
SOP8	-40 $^{\circ}$ C to 85 $^{\circ}$ C	PT1102ESOH	Tape and Reel

### PACKAGES



### PIN DESCRIPTIONS

Names	Pin No.	Description
CE	1	Chip Enable. Active with "H"
$V_{IN}$	3	Power Supply
LX	6	Output of Internal Power Switch
GND	7	Ground
FB	8	Feedback Voltage
N.C	2, 4, 5	Not Connected

### ABSOLUTE MAXIMUM RATINGS

(Note 1)

Symbol	Parameter	Value
$V_{IN}$	$V_{IN}$ Supply Voltage	20V
$V_{LX}$	LX Pin Output Voltage	-0.3~ $V_{IN}$ +0.3V
$V_{CE}$	CE Pin Input Voltage	-0.3~ $V_{IN}$ +0.3V
$V_{FB}$	$V_{FB}$ PIN Input Voltage	-0.3~6V
$I_{LX}$	LX Pin Output Current	1.5A
$T_{OPT}$	Operation Temperature Range	-40~85°C
$T_{STG}$	Storage Temperature Range	-55~125°C

### RECOMMENDED

### OPERATING

RANGE (Note 2)

Symbol	Parameter	Value
$V_{IN}$	$V_{IN}$ Supply Voltage	5~18V
$V_{LX}$	LX Pin Output Voltage	-0.3~ $V_{IN}$ +0.3V
$V_{CE}$	CE Pin Input Voltage	-0.3~ $V_{IN}$ +0.3V
$V_{FB}$	$V_{FB}$ PIN Input Voltage	-0.3~5.5V
$I_{LX}$	LX Pin Output Current	≤1.5A

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.

**Note 2:** Recommended operating Range indicates conditions for which the device is functional, but does not guarantee specific performance limits.

### ELECTRICAL CHARACTERISTICS (Note 3,4,5)

( $T_{OPT}=25^{\circ}\text{C}$ , Unless Otherwise Noted.)

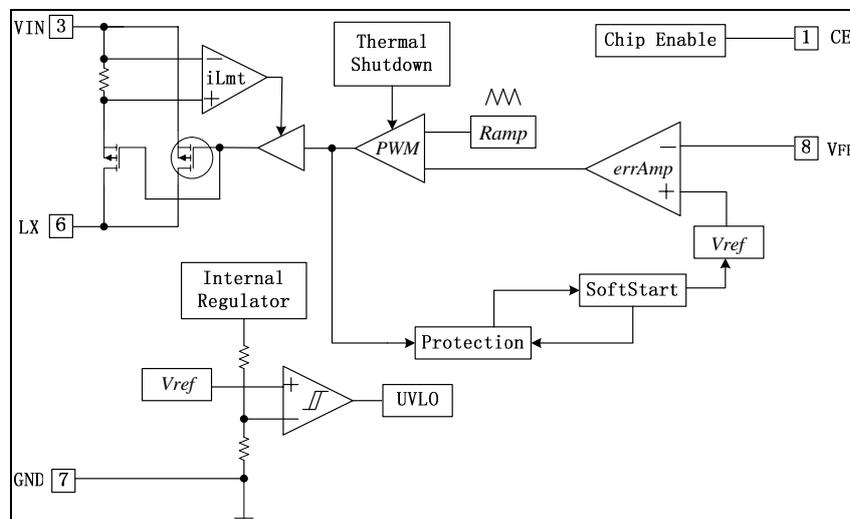
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
$V_{IN}$	Operating Voltage		2.5		18	V
$V_{FB}$	Feedback Voltage	$V_{IN}=V_{CE}=8\text{V}$ , $I_{FB}=100\text{mA}$	0.98	1.00	1.02	V
$\frac{\Delta V_{FB}}{\Delta T}$	Feedback Voltage Temperature coefficient	$-40^{\circ}\text{C} < T_{OPT} < 85^{\circ}\text{C}$		$\pm 100$		ppm/ $^{\circ}\text{C}$
$I_{Q1}$	Supply Current	$V_{IN}=V_{CE}=18\text{V}$ , $V_{FB}=2\text{V}$		100	300	$\mu\text{A}$
$I_{Q2}$	Shutdown Current	$V_{IN}=18\text{V}$ , $V_{CE}=V_{FB}=0\text{V}$		0.1	1	$\mu\text{A}$
$f_{OSC}$	Oscillator Frequency	$V_{IN}=V_{CE}=8\text{V}$ , $I_{FB}=100\text{mA}$	400	500	600	kHz
$D_{MAX}$	Maximum Duty Cycle		100			%
$D_{MIN}$	Minimum Duty Cycle				0	%
$V_{CEH}$	CE "H" Input Voltage	$V_{IN}=8\text{V}$ , $V_{FB}=0\text{V}$	1.5			V
$V_{CEL}$	CE "L" Input Voltage				0.3	V
$V_{UVLO1}$	UVLO Voltage	$V_{IN}=V_{CE}=2.5\text{V} \rightarrow 1.5\text{V}$ , $V_{FB}=0\text{V}$	1.75	2.0	2.4	V
$V_{UVLO2}$	UVLO Release Voltage	$V_{IN}=V_{CE}=1.5\text{V} \rightarrow 2.5\text{V}$ , $V_{FB}=0\text{V}$		$V_{UVLO1} + 0.1$	2.5	V
$T_{SST}$	Delay time by soft-start	$V_{IN}=8\text{V}$ , $I_{FB}=10\text{mA}$ , $V_{CE}=0\text{V} \rightarrow 2.5\text{V}$	5	10	20	ms
$R_{DS(ON)}$	Switch on resistance	$V_{IN}=18\text{V}$		0.3		$\Omega$
$I_{LMT}$	Switch current limit	$V_{IN}=18\text{V}$		2.3		A
$T_{TSD}$	Thermal Shutdown			160		$^{\circ}\text{C}$

**Note 3:** Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the recommended operating Range. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

**Note 4:** Typical values are measured at  $25^{\circ}\text{C}$  and represent the parametric norm.

**Note 5:** Datasheet min/max specification limits are guaranteed by design, test, or statistical analysis.

### SIMPLIFIED BLOCK DIAGRAM



### OPERATION DESCRIPTION

The PT1102 is a fixed frequency, voltage mode step-down switching regulator with internal power MOSFET capable of 1A continuous output current. A low ripple, high efficiency step-down DC/DC regulator can be easily composed of with a few readily available external components such as inductor, diode and capacitor.

The power stage of a PT1102 based step-down PWM switching regulator can be seen as an input voltage chopping circuit followed by an L-C filter. Unlike the linear regulator which operates the power transistor in the linear mode, the PWM switching regulator operates the power transistor either in saturation or cutoff regions. Due to low voltage-ampere product of power transistor under these two operation modes, high efficiency can be easily achieved. The DC input voltage is firstly chopped into square waves whose magnitude is the same as input voltage and whose duty cycle is determined based on the output voltage. Passing through an appropriately designed L-C filter, such 'PWM' waveforms become a ripple free DC voltage that is equal to the average of the duty cycle modulated DC input voltage. By sensing the DC feedback voltage and controlling duty cycle in a negative-feedback loop, the DC output voltage could be regulated against input line and output load changes.

### APPLICATION INFORMATION

- To avoid parasitic current into each pin, the voltage applied to CE pin should never be higher than the voltage level at the VIN pin.
- For high current applications, it's highly recommended to operate the PT1102 with VIN no less than 5V.

#### Adjusting Output Voltage

- The output voltage is set by a resistive voltage divider connected between the output and FB. The voltage divider

divides the output voltage down by the ratio  $V_{FB} = \frac{V_{OUT} \times R1}{R1 + R2}$ . Thus,  $V_{OUT} = \frac{R1 + R2}{R1} V_{FB}$ , R1 has a

typical value of 10KΩ. Thus R2 can be determined by  $R2 = (V_{OUT} - 1) \times R1$ . For example, for a 3.2V output voltage, R1 is 10KΩ and R2 is 22KΩ.

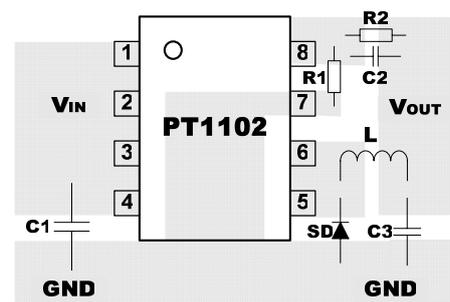
#### Phase Compensation

- In a DC/DC converter, phase delay might exceed 180 degree if the external component such as L or C changes. To avoid the system becoming unstable, an external compensation network formed by R2 and C2 should be chosen

carefully using the following equation  $C2 = \frac{\sqrt{L \cdot C3}}{R2}$ .

#### PCB Board Layout

- As in all switching regulator designs, careful attention must be paid to the PCB board layout and component placement. To maximize efficiency, switch rise and fall times are made as short as possible. To prevent electromagnetic interference (EMI) problems, proper layout of the high frequency switching path is essential. The voltage signal of the SW pin has sharp rise and fall edges. Minimize the length and area of all traces connected to the LX pin and always use a ground plane under the switching regulator to minimize interplane coupling. In addition, the ground connection for the feedback resistor R2 should be tied directly to the GND pin and not shared with any other



component, ensuring a clean, noise-free connection. Recommended component placement is shown in the right Figure.

### EXTERNAL COMPONENT SELECTION GUIDE

#### ● Inductor

The inductor's RMS current rating must be greater than the maximum load current and its saturation current should be at least 30% higher. For highest efficiency, the series resistance (DCR) should be less than 0.2. The optimum inductor for a given application may differ from the one indicated by this simple design guide. A larger value inductor provides a higher maximum load current, and reduces the output voltage ripple. If your load is lower than the maximum load current, then you can relax the value of the inductor and operate with higher ripple current. This allows you to use a physically smaller inductor, or one with a lower DCR resulting in higher efficiency. Be aware that the maximum load current will depend on input voltage. In addition, low inductance may result in discontinuous mode operation, which further reduces maximum load current.

The current in the inductor is a triangle wave with an average value equal to the load current. The peak switch current is equal to the output current plus half the peak-to-peak inductor ripple current. The PT1102 limits its switch current in order to protect itself and the system from overload faults. Therefore, the maximum output current that the PT1102 delivers depends on the switch current limit, the inductor value, and the input voltages. When the switch is off, the voltage across the inductor is the output voltage plus the catch diode drop. This gives the peak-to-peak ripple current in the inductor

$$\Delta I_L = \frac{V_{OUT} + V_F}{L \cdot f_{OSC}}$$

where  $f_{OSC}$  is the switching frequency,  $V_F$  is voltage drop of the diode and  $L$  is the value of the inductor. The peak inductor and switch current is

$$I_{L,peak} = I_{OUT} + \frac{\Delta I_L}{2}$$

Choosing an inductor value that keeps the ripple current small allows a maximum output current near the switch current limit.

#### ● Input Capacitors

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 shall be less than input source impedance to prevent high frequency switching current passing to the input. The combination of small size and low impedance (low equivalent series resistance or ESR) of ceramic capacitors makes them the preferred choice to bypass the input of PT1102. In general, a 4.7 $\mu$ F ceramic type capacitor is enough for stable operation.

#### ● Output Capacitors

The output capacitor is required to maintain the DC output voltage. Tantalum capacitors are recommended not only for stable operating but to keep output voltage ripple low. The output voltage ripple can be expressed as:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_{OSC} \times L} \left( 1 - \frac{V_{OUT}}{V_{IN}} \right) \times R_{ESR}$$

Where,  $V_{OUT}$  is the output voltage,  $V_{IN}$  is the input voltage,  $L$  is the inductor value,  $f_{OSC}$  is the 500KHz switching frequency, and  $R_{ESR}$  is the equivalent series resistance (ESR) value of output capacitors

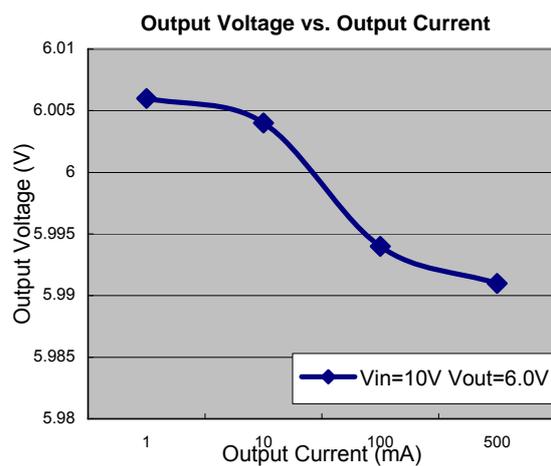
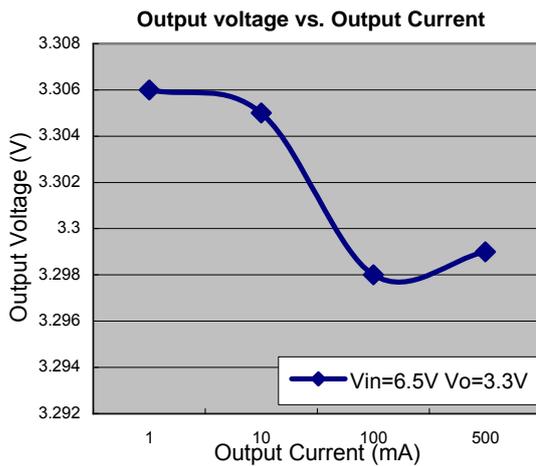
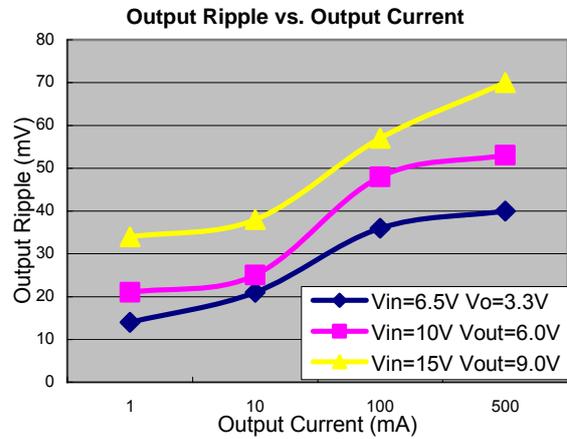
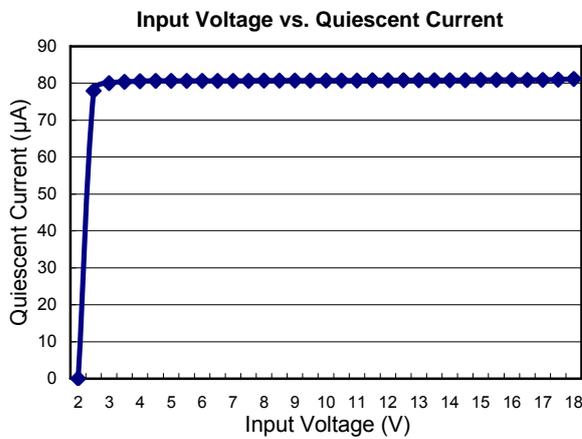
- **Diode**

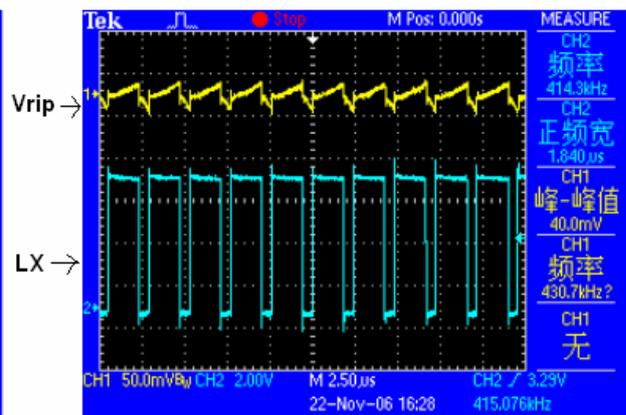
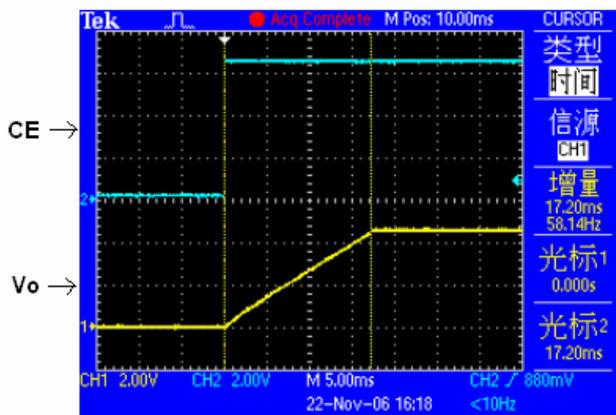
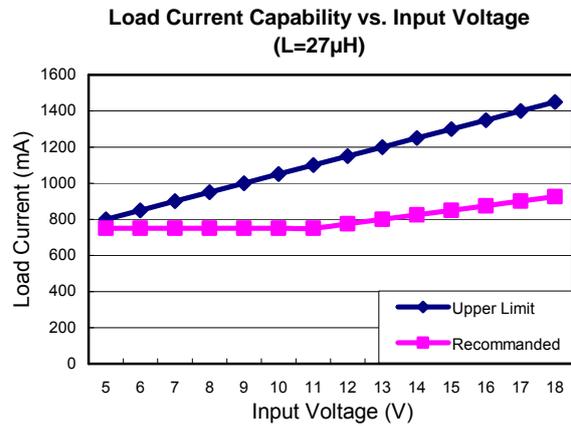
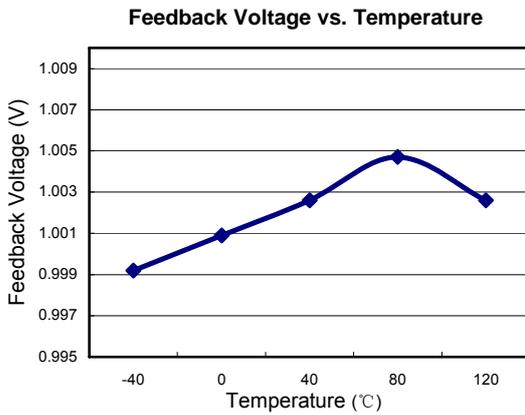
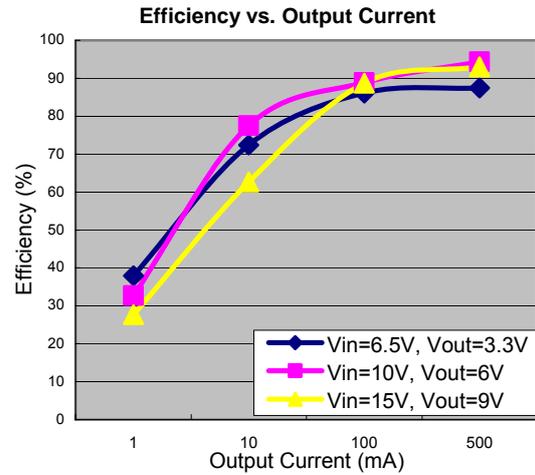
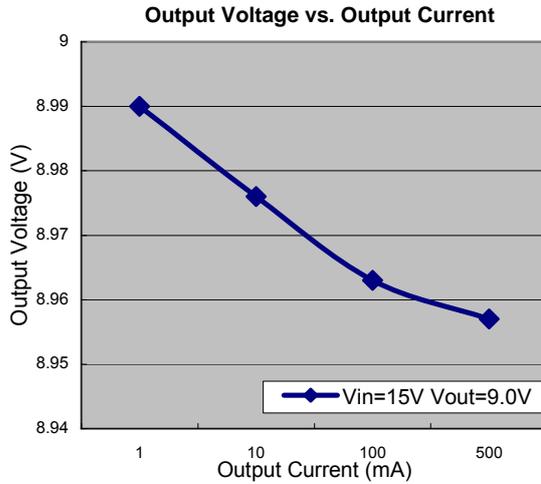
Use a diode with low  $V_F$  (A Schottky diode is recommended) and high switching frequency. Reverse voltage rating should be more than  $V_{IN}$  and current rating should be larger than  $I_{L,peak}$ .

### TYPICAL PERFORMANCE CHARACTERISTICS

Note: Typical characteristics are obtained with using the following components:

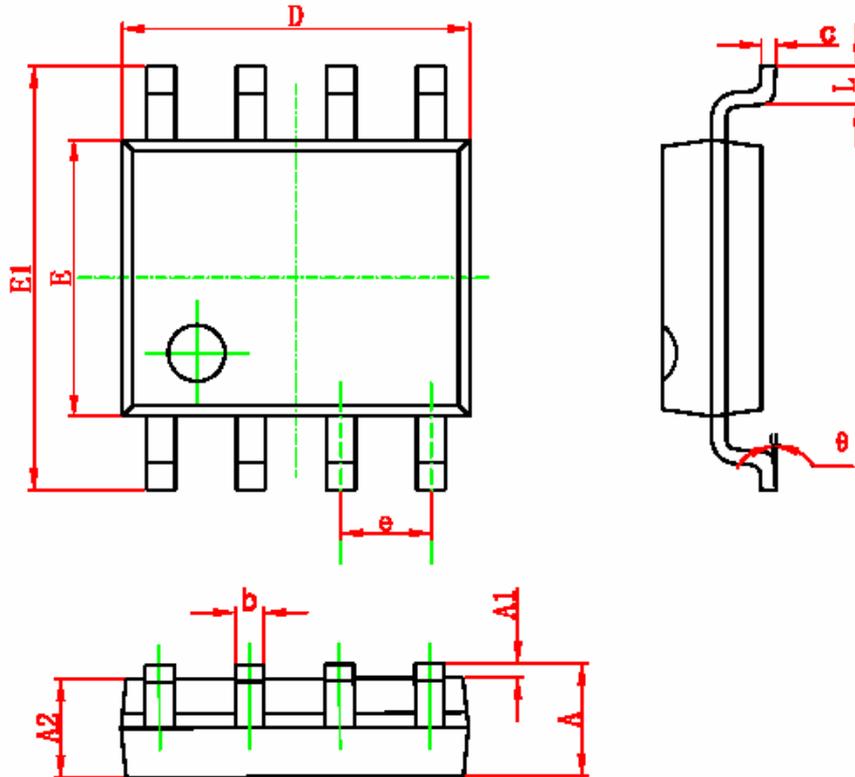
- |     |  |     |                              |
|-----|--|-----|------------------------------|
| L:  | CR105-270MC (Sumida, 27 $\mu$ H) or Equivalent | C3: | 47 $\mu$ F, Tantalum Type    |
| SD: | RB063L-30(Rohm) or Equivalent                  | R1: | 10k $\Omega$                 |
| C1: | 4.7 $\mu$ F, Ceramic Type                      | R2: | 40k $\Omega$ (For 5V Output) |
| C2: | 1nF, Ceramic Type                              |     |                              |





PACKAGE INFORMATION

**SOP8 PACKAGE OUTLINE DIMENSIONS**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°