## General Description

The EC9215 is a single PWM, step- up DC- DC controller with low operating voltage application integrating softstart and short circuit detection function. The oscillator switching frequency on chip can be operated by terminating OSC pin to connect capacitor and resistor for adjustable operating frequency. Soft- start is adjusted with the external capacitor, which sets the input current ramp. Besides, the external compensation FB pin will apply the flexibility in the dynamic loop status, which allows using small and low equivalent series resistance (ESR) ceramic output capacitors.
The EC9215 is available in a Pb- free, SOP- 8L and TSSOP-8L package.

## Features

- 2.5 to 5.5V Input Voltage Range
- Adjustable Frequency: Maximum 1MHZ
- Incorporates Soft- Start Function
- Built- in Short- Circuit Detection Circuit (SCP)
- Low Operating Current: Maximum to 1mA
- Low Shutdown Current: Maximum to 1μA
- Under- Voltage Lockout
- Package: SOP- 8 and TSSOP- 8
- Lead Free and Green Devices Available (RoHS Compliant)

## Applications

- LCD Display Power Source
- PDA, PMP, MP3
- Digital Camera

## Pin Assignments

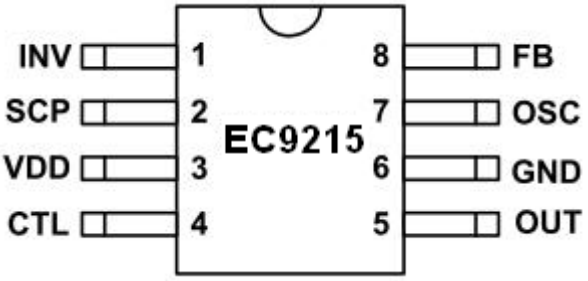
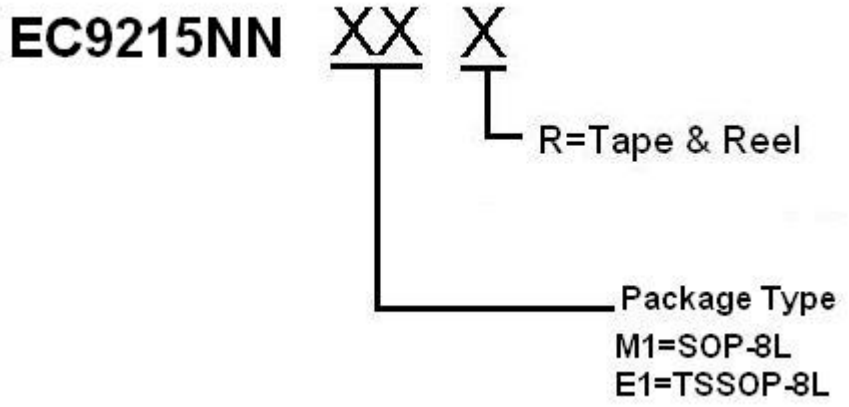



Figure1 Pin Configuration of EC9215(Top View)

## Pin Description

| Pin Number | Pin Name | Description |
|---|---|---|
| 1 | INV | Internal 0.5V reference voltage. Use a resistor divider to set the output voltage |
| 2 | SCP | Soft- start and short- circuit detection, connects a capacitor from the pin to ground. |
| 3 | VDD | Power supply input pin for IC voltage |
| 4 | CTL | Output control pin. Low = operating mode; High = shutdown mode. |
| 5 | OUT | External MOSFET driving pin. |
| 6 | GND | GND |
| 7 | OSC | Setting capacitor and resister to provide oscillation switching frequency adjustment. |
| 8 | FB | Error amplifier output pin. Setting circuit for IC compensation. |

## Ordering Information




| Part Number | Package | Marking | Marking Information |
|---|---|---|---|
| EC9215NNM1R | SOP-8L | EC9215<br>LLLLL<br>YYWWT | 1. LLLL：Last four number of Lot No<br>2. YYWW：Date Code<br>3. T：Internal Tracking Code |
| EC9215NNE1R | TSSOP-8L | | |

## Function Block

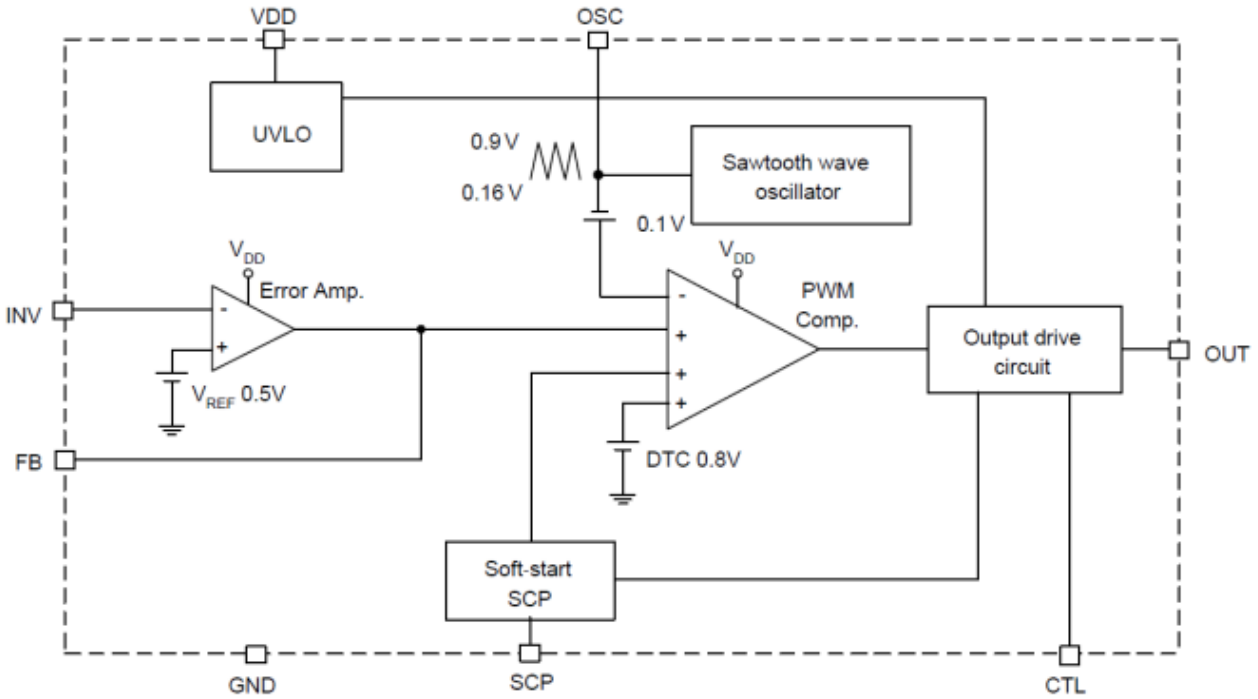



Figure 2 Function Block Diagram of EC9215

## Absolute Maximum Ratings

| Symbol | Parameter | Rating | Unit |
|---|---|---|---|
| $V_{DD}$ | Supply Voltage | - 0.3 to 7 | V |
| $V_{IO}$ | Input/Output Pins | - 0.3 to 7 | V |
| $T_A$ | Operating Ambient Temperature Range | - 40 to 85 | ℃ |
| $T_J$ | Junction Temperature Range | - 40 to 150 | ℃ |
| $T_{STG}$ | Storage Temperature Range | - 60 to 150 | ℃ |
| $T_{SDR}$ | Maximum Lead Soldering Temperature, 10 Seconds | 260 | ℃ |

## Recommended Operating Conditions

| Symbol | Parameter | Rating | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $V_{DD}$ | Supply Voltage | 2.5 | - | 5.5 | V |
| $V_{INV}$ | Error Amplifier Invert Input Voltage | -0.2 | | 1 | V |
| $V_{CTL}$ | Control Pin Input Voltage | -0.2 | | $V_{DD}$ | V |
| $C_{SCP}$ | SCP Pin Capacitor | | 0.1 | | uF |
| $R_T$ | Timing Resistance | 1.0 | 3.3 | 10 | KΩ |
| $C_T$ | Timing Capacitor | 100 | | 270 | pF |
| $F_{SW}$ | Oscillator Frequency | 200 | 600 | 1000 | KHz |

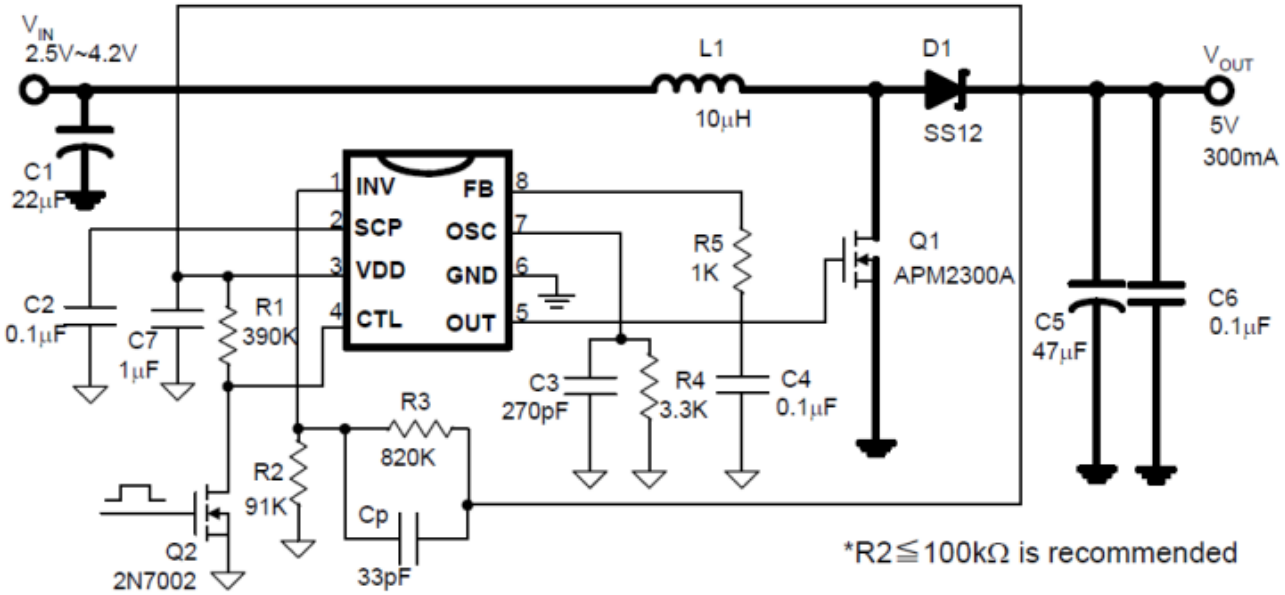
## Electrical Characteristics

(VDD = 3.3V, TA = 25°C unless otherwise specified)

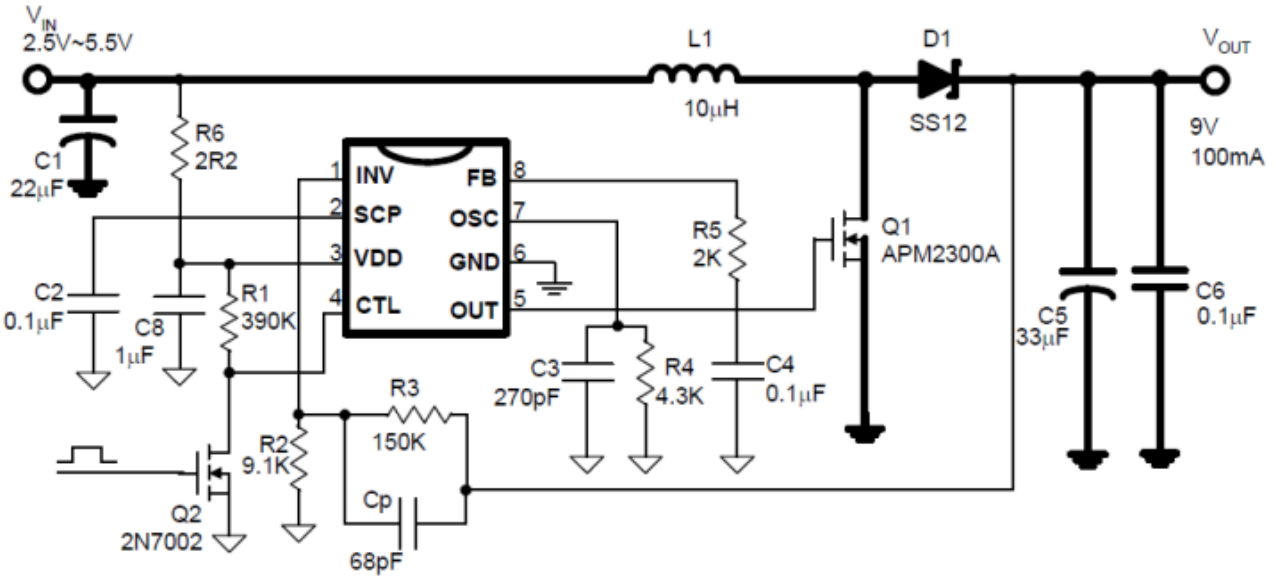
| Parameters | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **ENTIRE DEVICE** | | | | | | |
| Supply Voltage | $V_{DD}$ | | 2.5 | - | 5.5 | V |
| Supply Current | $I_{DD}$ | $V_{DD}$=2.5V to 5.5V | - | 0.7 | 1 | mA |
| Shutdown Current | $I_{SD}$ | CTL pin open or VDD | - | 0.1 | 1 | μA |
| Maximum Duty Cycle | $D_{MAX}$ | $R_T$ =3.3K, $C_T$ =270pF | 80 | 85 | 92 | % |
| **UNDER- VOLTAGE LOCKOUT PROTECTION** | | | | | | |
| VDD Startup Threshold Voltage | $V_{TH}$ | - | 2.0 | - | 2.4 | V |
| Hysteresis voltage | $V_R$ | - | - | 150 | - | mV |
| **SOFT- START** | | | | | | |
| Voltage at Soft- Start Completion | $V_{SS}$ | - | 0.7 | 0.8 | 0.9 | V |
| Soft- Start Charge Current | $I_{CS}$ | $V_{SCP}$ =0V | - 0.7 | - 1.0 | - 1.5 | μA |
| Voltage at Soft- Start Completion | $V_{SS}$ | - | 0.7 | 0.8 | 0.9 | V |
| Soft- Start Charge Current | $I_{CS}$ | $V_{SCP}$ =0V | - 0.7 | - 1.0 | - 1.5 | μA |
| **SHORT CIRCUIT PROTECTION (SCP)** | | | | | | |
| Threshold Voltage | $V_{SCP}$ | | 0.7 | 0.8 | 0.9 | V |
| Charge Current | $I_{SCP}$ | $V_{SCP}$ =0V | - 0.7 | - 1.0 | - 1.5 | μA |
| **SAWTOOTH WAVEFORM OSCILLATOR (OSC)** | | | | | | |
| Oscillator Frequency | $F_{OSC}$ | RT =3.3k, CT =270pF | 500 | 600 | 700 | kHz |
| Frequency Stability for Voltage | $F_{DV}$ | $V_{DD}$=2.5V to 5.5V | - | 2 | 5 | % |
| Frequency Stability for Temperature | $F_{DT}$ | $T_A$=- 40°C to 85°C | - | 5 | - | % |
| **ERROR AMPLIFIER** | | | | | | |
| **Reference Voltage** | $V_{REF}$ | $V_{FB}$=INV | 0.490 | 0.5 | 0.510 | V |
| **VREF Stability** | | $V_{DD}$= 2.5V to 5.5V | | 5 | 20 | mV |
| **VREF Variation with Temperature** | | TA=-40℃ to 85℃ | | 1 | | % |
| **Transconductance** | gm | | 1000 | 1300 | 1600 | uA/V |
| **Input Bias Current** | $I_B$ | INV=0V | | | 1 | uA |
| **Output Voltage Range** | $V_{OH}$ | | 1.6 | 1.8 | | V |
| | $V_{OL}$ | | | | 0.01 | V |

| Parameters | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Output Source Current | | INV=0V,FB=0.5V | -150 | -180 | -210 | uA |
| Output Sink Current | | INV=1V,FB=0.5V | 140 | 170 | 200 | uA |
| **PWM CONTROLLER DRIVER** | | | | | | |
| Output Source Current | $I_{SOURCE}$ | Duty<5%,OUT=0V | -150 | -200 | | mA |
| Output Sink Current | $I_{SINK}$ | Duty>5%,OUT=5V | 150 | 200 | | mA |
| **CONTROL BLOCK** | | | | | | |
| Control Voltage | $V_{IL}$ | Active mode | | | $0.2V_{DD}$ | |
| | $V_{IH}$ | Switch-off mode | $0.8V_{DD}$ | | | |

## Typical Application Circuit

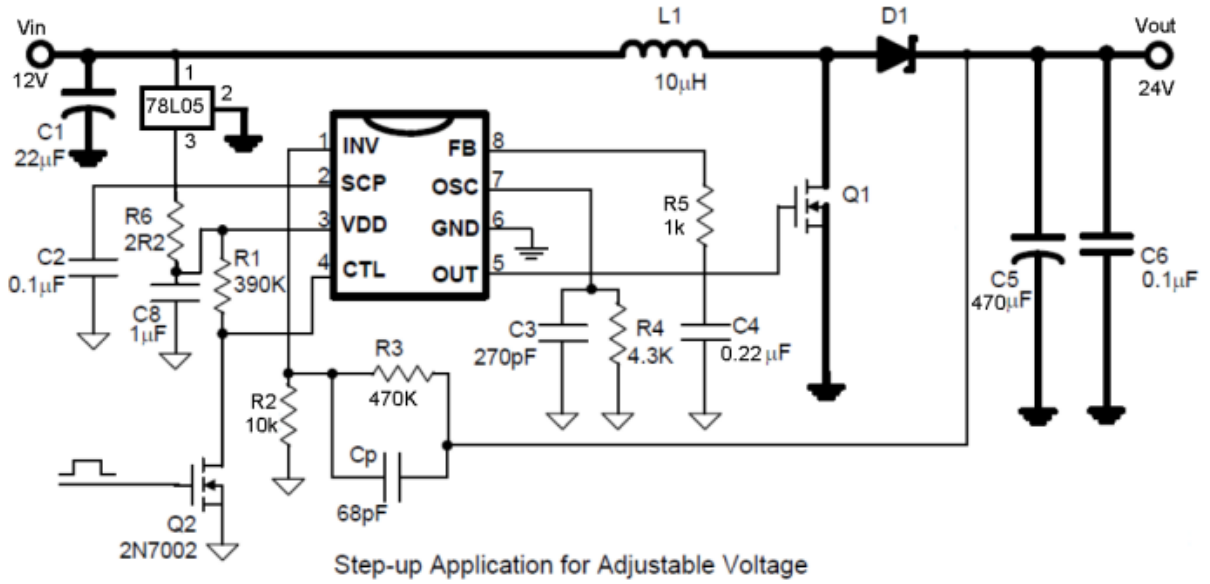



Step-up Application for Adjustable Voltage

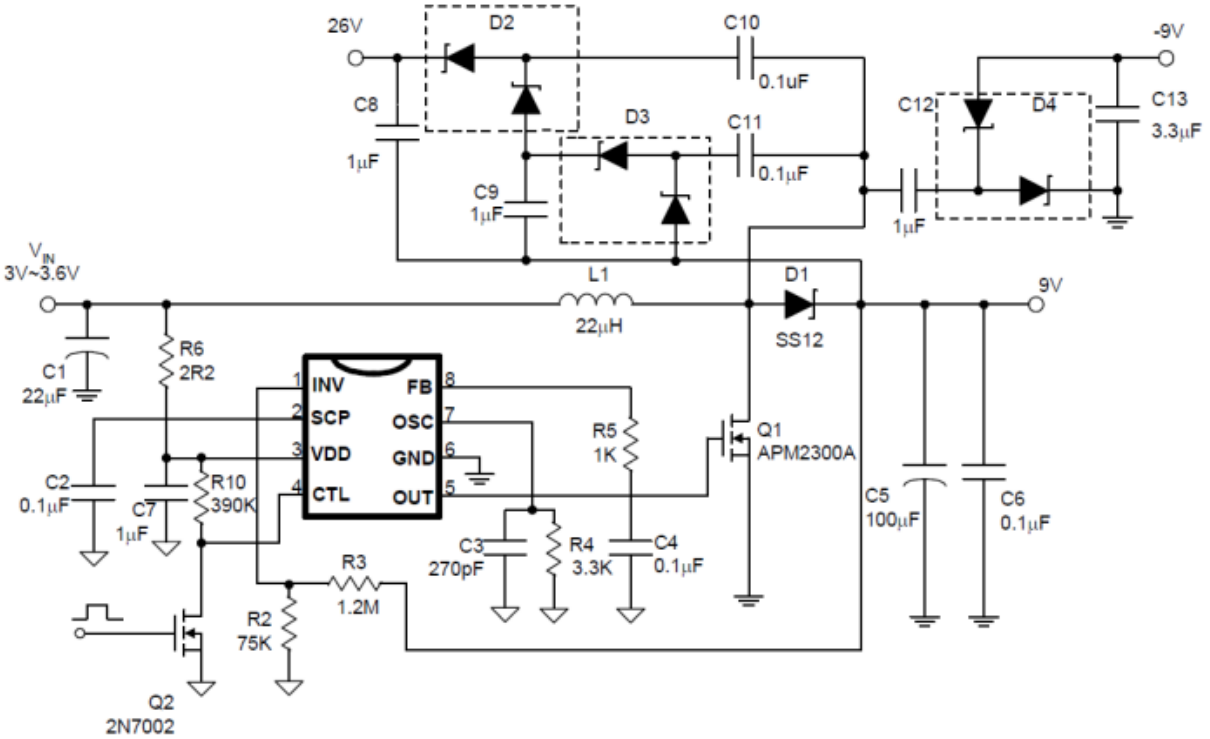



Step-up Application for Adjustable Voltage

## Typical Application Circuit

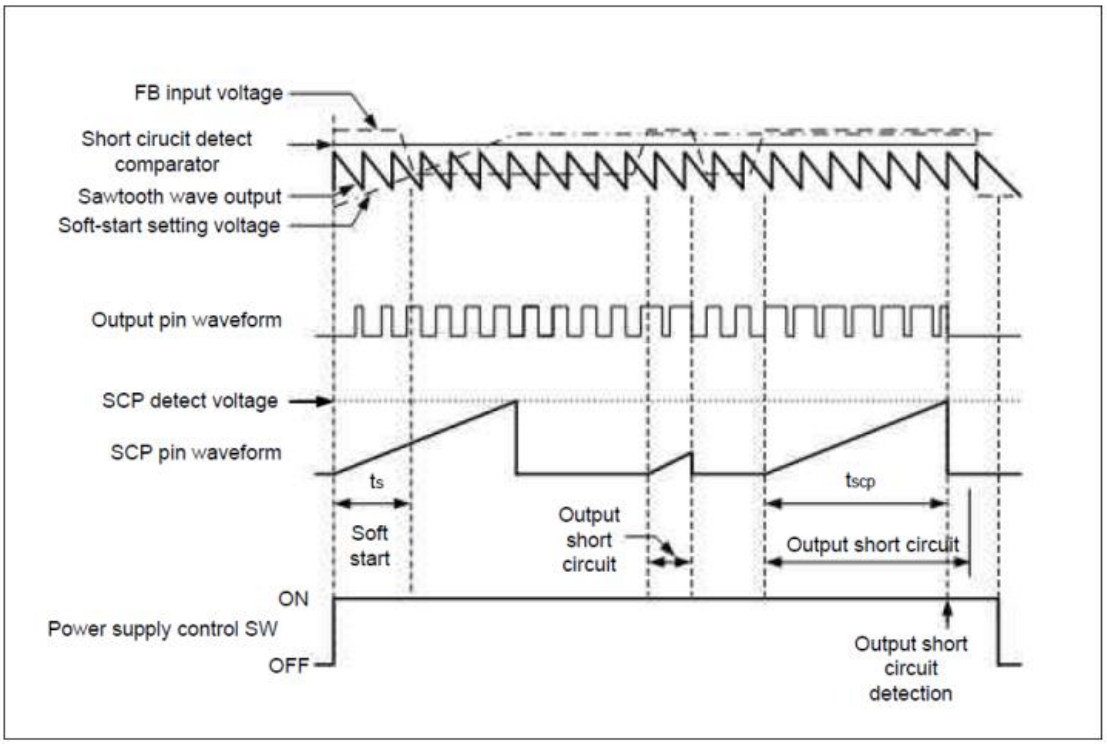



Step-up Application for Adjustable Voltage




Multiple-output for TFT LCD Panel Power

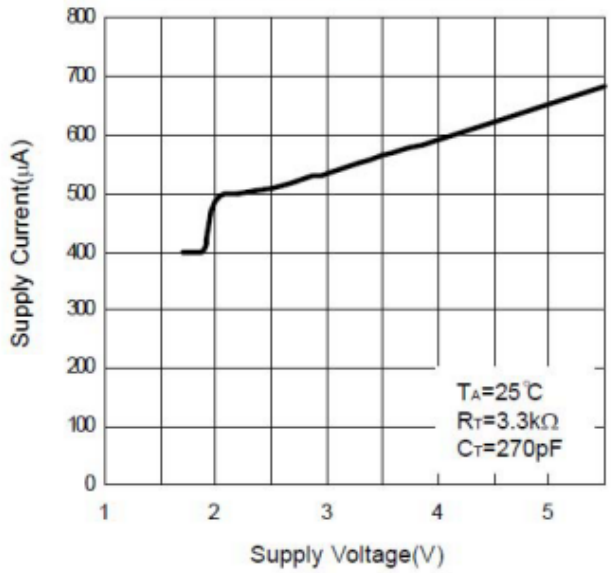
## Timing Diagram



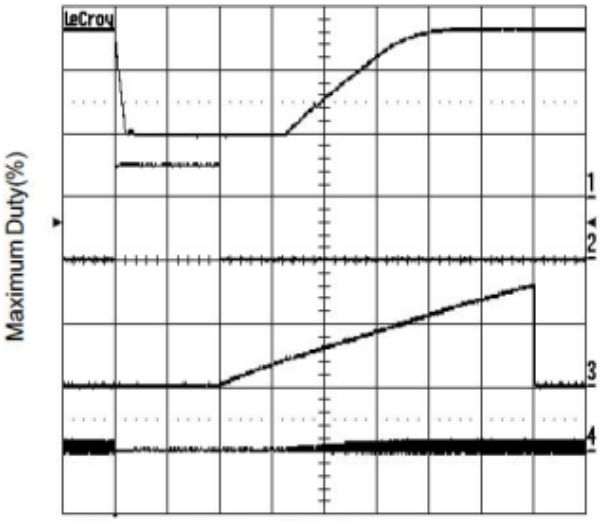
## Typical Performance Characteristics

($T_A$=25,$V_{DD}$=3.3V,unless otherwise specified)

Supply Current vs. Supply Voltage

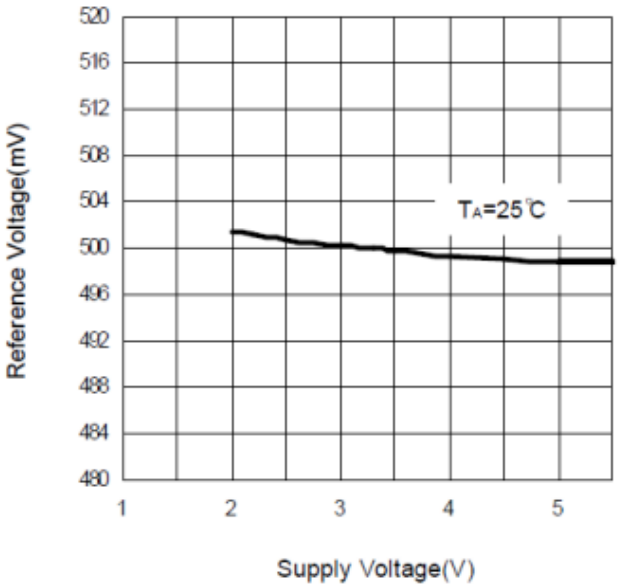



SHDN and Release

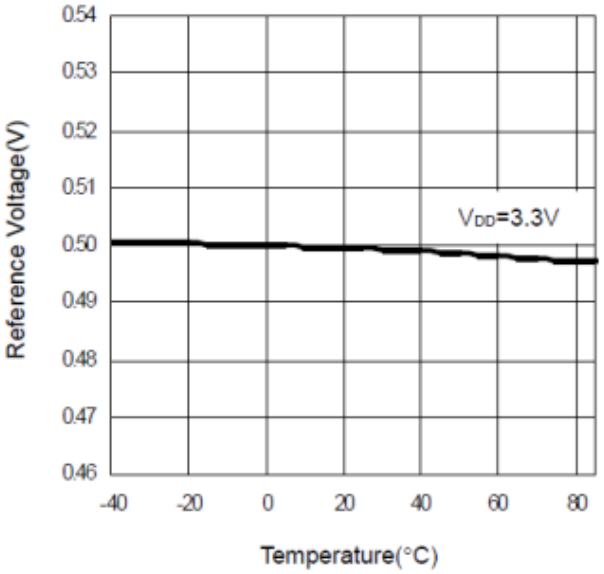



CH1=$V_{OUT}$ 2V/DIV TIME=20ms/DIV
CH2=$V_{CTL}$ 2V/DIV
CH3=$V_{SS}$ 0.5V/DIV
CH4=$I_L$ 1A/DIV

Reference Voltage vs. Supply Voltage



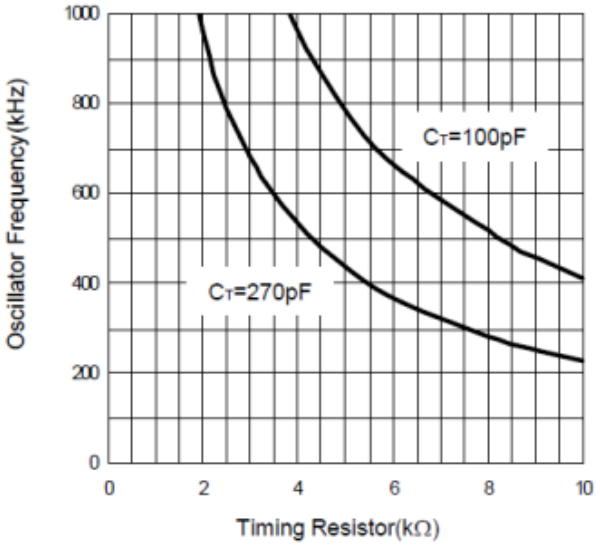

Reference Voltage vs. Temperature



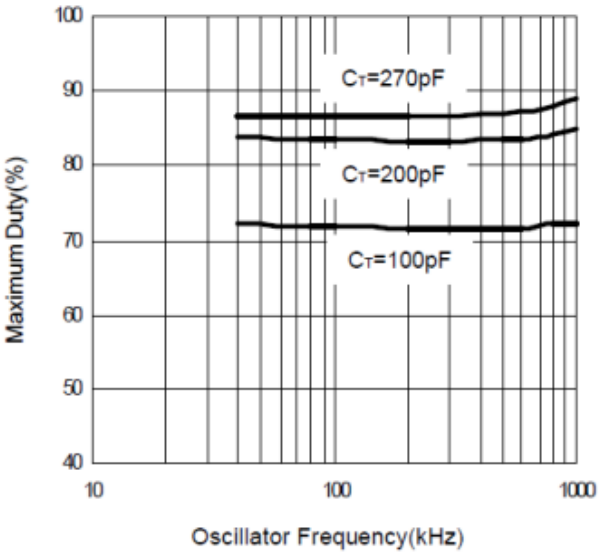
## Typical Performance Characteristics(Cont.)

($T_A$=25,$V_{DD}$=3.3V,unless otherwise specified)

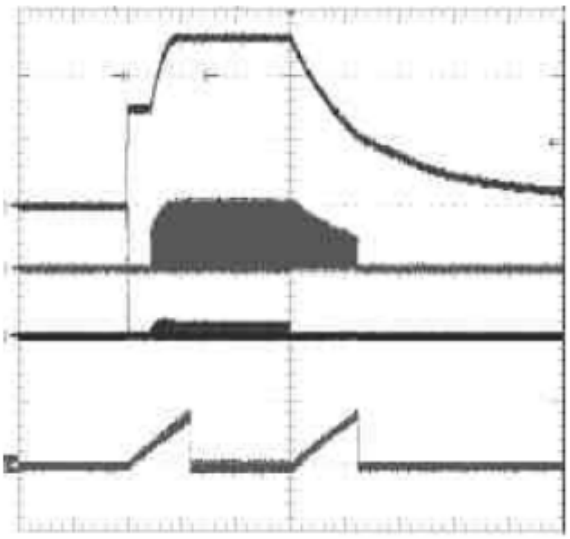
**Oscillator Frequency vs. Timing Resistor**




**Maximum Duty vs. Oscillator Frequency**

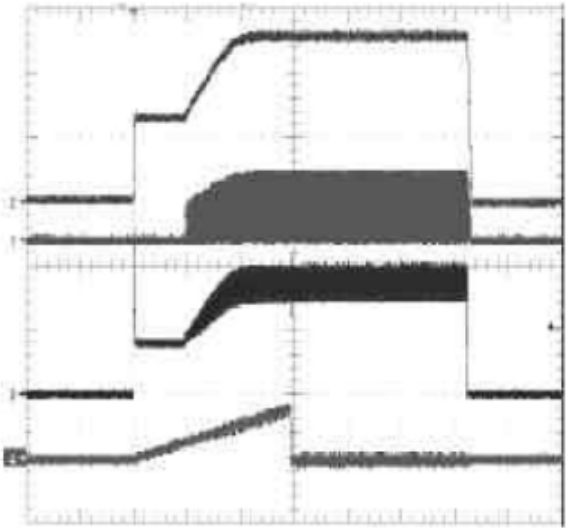



**Power on and off under light load**



$I_{OUT}$= 5mA, TIME=40ms/DIV
CH1=$V_{OUT}$ 5V/DIV
CH2=$V_{OUT}$=$V_{DD}$ 2V/DIV
CH3=$I_L$ 0.5A/DIV
CH4=$V_{SS}$ 1V/DIV

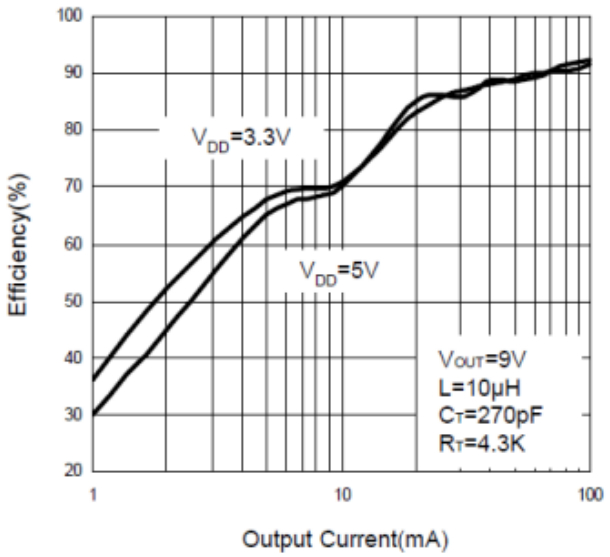
**Power on and off under heavy load**



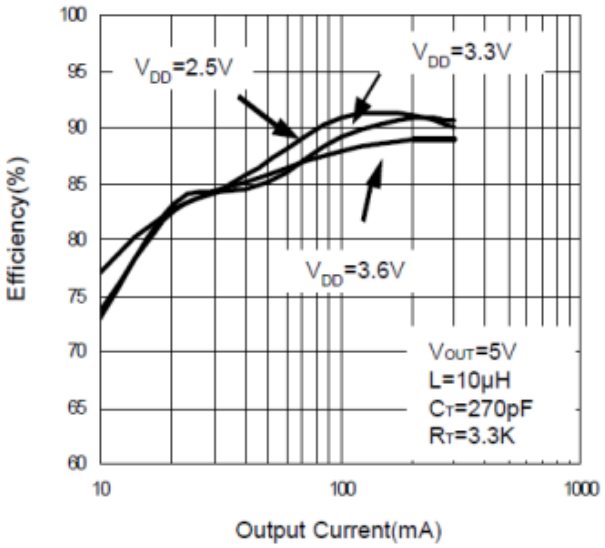
$I_{OUT}$= 400mA, TIME=40ms/DIV
CH1=$V_{OUT}$ 5V/DIV
CH2=$V_{OUT}$=$V_{DD}$ 2V/DIV
CH3=$I_L$ 0.5A/DIV
CH4=$V_{SS}$ 1V/DIV

## Typical Performance Characteristics(Cont.)

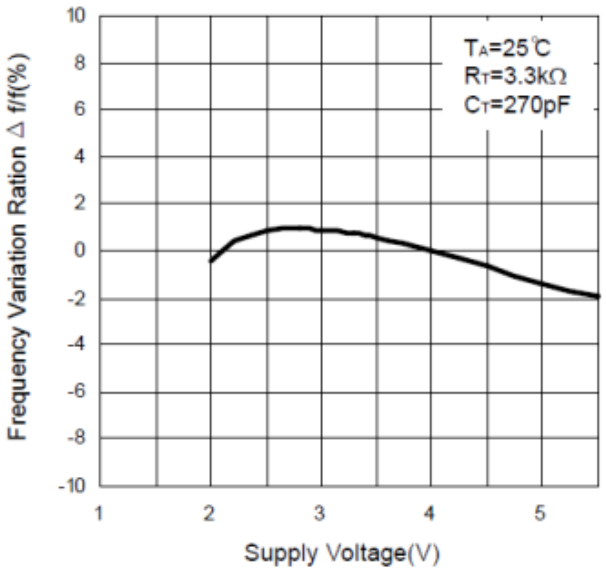
**Efficiency**



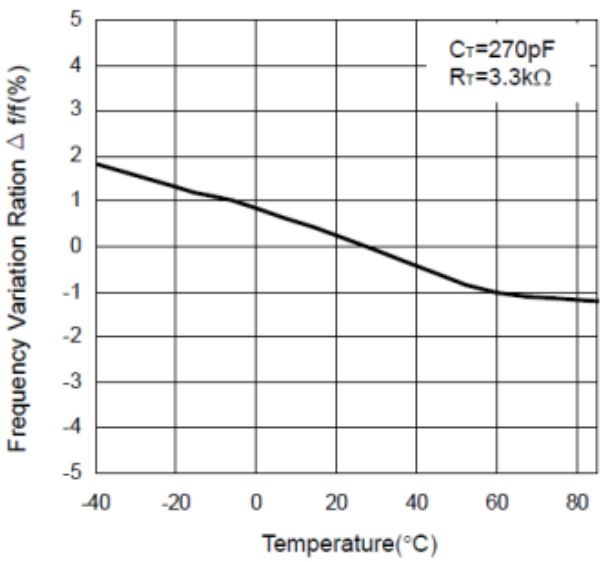

**Efficiency**




**Frequency Variation Ratio vs. Supply Voltage**



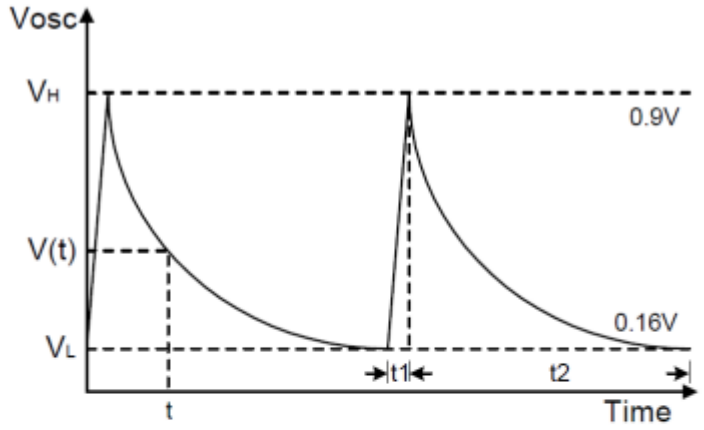

**Frequency Variation Ratio vs. Temperature**



## Function Description

### Setting Oscillating Frequency

The oscillator circuit generates a triangular saw tooth wave with a peak of 0.9V and through 0.16V using the timing capacitor (CT) and the timing resistor (RT ) that are connected to OSC pin. This oscillator can provide oscillating frequency up to 1MHz




$$i=c\frac{\Delta V}{\Delta t}$$

$$t_1 = C_T \times \frac{0.9V - 0.16V}{2mA} = 370C_T$$

$$V(t) = V_H \times e^{\frac{1}{R_T C_T}}$$

$$t_2 = R_T C_T \ln(\frac{V_H}{V_L}) = 1.72R_T C_T$$

$$T = t_1 + t_2 = C_T(370 + 1.72R_T)$$

### Setting Output Voltage

The output voltage is set using the INV pin and a resistor divider connected to the output is shown in the Typical Operating Circuit. The internal reference voltage is 0.5V with 2% variation, so the ratio of the feedback resistors sets the output voltage according to the following equation:

$$V_{OUT} = (1 + \frac{R3}{R2}) \times 0.5V$$

To avoid the thermal noise from feedback resistor, the resistance R2 is smaller than 100kW and 1% variation is recommended.

### Error Amplifier

The error amplifier detects the output voltage of the switching regulator and outputs the PWM control signal. The voltage gain is fixed, and connecting a phase compensation resistor and capacitor to the FB pin (pin 8) provides stable phase compensation for the system.

### PWM Comparator

The voltage comparator has one inverting and three non-inverting inputs. The comparator is a voltage/pulse width converter that controls the ON time of the output pulse depending on the input voltage. The output level is high (H) when the saw-tooth wave is lower than the error amplifier output voltage, soft- start setting voltage, and idle period setting voltage

### Output Circuit

The output circuit is a typical push- pull configuration to drive an external NMOS transistor directly. It can provide a 200mA source/sink to/from OUT (pin 5).

### Soft-Start and Short Circuit Detection

Soft-start operation is set by connecting capacitor CSCP to the SCP pin (pin 2).Soft-start prevents a current spike on start-up. On completion of the soft- start operation, the SCP pin (pin 2) stays low and enters the short circuit detection wait state. When an output short circuit occurs, the error amplifier output is fixed at 1.8V and capacitor CSCP starts charging.
After charging to approximately 0.8 V, the output pin (pin5) is set low and the SCP pin stays low. Once the protection circuit operates, the circuit can be restored by resetting the power supply. Short circuit detection time can be calculate as below:

$$t_{SCP} = 0.8 \times C_{SCP}(uF)$$

### Under-Voltage Lock Out (UVLO)

Transients during powering on or instantaneous glitches in the supply voltage can cause system damage or failure. The circuit prevents malfunction at low input voltage detects a low input voltage by comparing the supply voltage with the internal reference voltage. On detection, the circuit fixes the output pin to low. The system recovers when the supply voltage rises back above the threshold voltage of thermal function prevention circuit.

## Layout Consideration

### Switching Noise Decoupling Capacitor

A 0.1uF ceramic capacitor should be placed close to the VOUT pin and the GND pin of the chip to filter the switching spikes in the output voltage monitored by the VOUT pin.

### Feedback Network

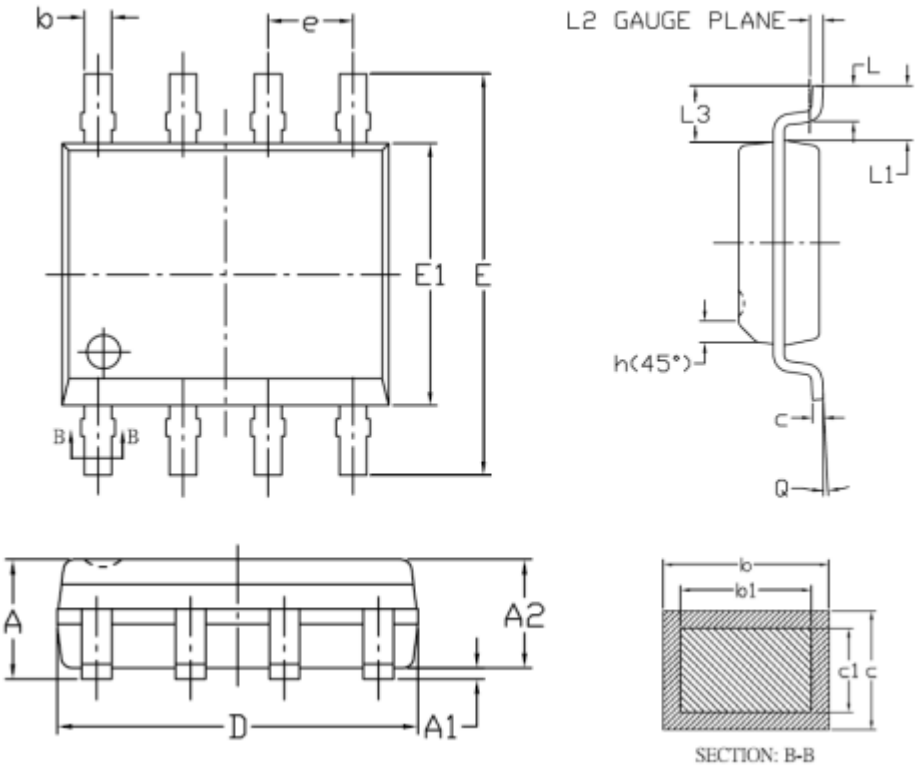
The feedback networks should be connected directly to a dedicated analog ground plane and this ground plane must connect to the GND pin. If no analog ground plane is available, and then this ground must tie directly to the GND pin. The feedback network, resistors R2 and R3, should be kept close to the FB pin, and away from the inductor.

### Input Capacitor

The input capacitor CIN in VIN must be placed close to the IC. This will reduce copper trace resistance which effects input voltage ripple of the IC. For additional input voltage filtering, a 1uF capacitor can be placed in parallel with $C_{IN,}$ close to the VDD pin, to shunt any high frequency noise to the ground.

## Package Information

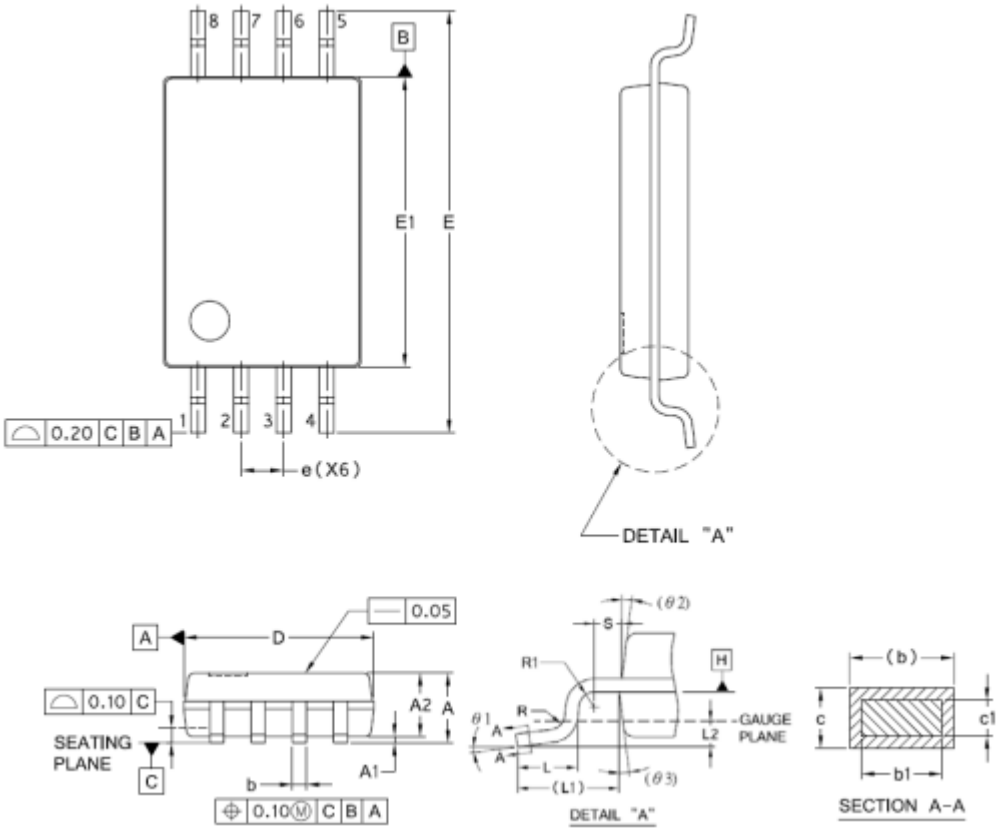
### SOP-8L Package Outline Dimensions




| SYMBOLS | DIMENSIONS | | | |
|---|---|---|---|---|
| | mm | | inch | |
| | MIN. | MAX. | MIN. | MAX. |
| A | — | 1.75 | — | 0.069 |
| A1 | 0.10 | 0.25 | 0.004 | 0.010 |
| A2 | 1.25 | — | 0.049 | — |
| b | 0.31 | 0.51 | 0.012 | 0.020 |
| b1 | 0.31 | 0.48 | 0.012 | 0.019 |
| c | 0.17 | 0.25 | 0.007 | 0.010 |
| c1 | 0.17 | 0.23 | 0.007 | 0.009 |
| D | 4.90BSC | | 0.193BSC | |
| E | 6.00BSC | | 0.236BSC | |
| E1 | 3.90BSC | | 0.154BSC | |
| e | 1.27BSC | | 0.050BSC | |
| h | 0.25 | 0.50 | 0.010 | 0.020 |
| L | 0.40 | 1.27 | 0.016 | 0.050 |
| L1 | 1.04REF | | 0.041REF | |
| L2 | 0.25BSC | | 0.010BSC | |
| L3 | 1.04REF | | 0.041REF | |
| θ | 0° | 8° | 0° | 8° |

## Package Information

### TSSOP-8L Package Outline Dimensions




| SYMBOL | INCHES | | MM | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | – | 0.047 | – | 1.200 |
| A1 | 0.002 | 0.006 | 0.050 | 0.150 |
| A2 | 0.030 | 0.040 | 0.800 | 1.050 |
| b | 0.007 | – | 0.190 | – |
| b1 | 0.007 | 0.010 | 0.190 | 0.250 |
| c | – | 0.008 | – | 0.200 |
| c1 | 0.004 | 0.006 | 0.090 | 0.160 |
| D | 0.114 | 0.122 | 2.900 | 3.100 |
| E | 0.252 BSC | | 6.400 BSC | |
| E1 | 0.169 | 0.177 | 4.300 | 4.500 |
| e | 0.026 BSC | | 0.650 BSC | |
| L | 0.018 | 0.030 | 0.450 | 0.750 |
| L1 | 0.040 REF | | 1.00 REF | |
| L2 | 0.010 | | 0.250 | |
| R | 0.004 | – | 0.090 | – |
| R1 | 0.004 | – | 0.090 | – |
| S | 0.008 | – | 0.200 | – |
| θ1 | 0° | 8° | 0° | 8° |
| θ2 | 12° REF | | 12° REF | |
| θ3 | 12° REF | | 12° REF | |