



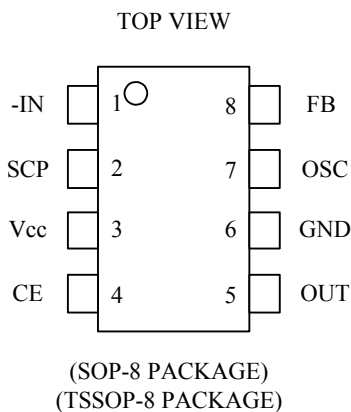
Preliminary and Provisional

## ONE-CHANNEL BOOST SWITCHING REGULATOR

### Features

- Under-voltage lockout protection
- Totem pole output
- Output short circuit protection
- Incorporates soft start function
- Wide operating frequency :  
10kHz to 1MHz
- Shut down control
- Low dissipation current :  
Typical 1.6mA in operation
- Sop-8 & Tssop-8 package available

### Pin Configuration



### General Description

The AAT1109A is a one-channel switching regulator control IC incorporating a soft start function and a short circuit protection function.

Each device consists of an on-chip voltage reference, error amplifier, pulse width modulation controller, under-voltage protection, soft start and short circuit protection circuits. Switching frequencies up to 1MHz are set by an external resistor and capacitor. Soft-start time can be implemented by the SCP capacitor.

Additionally, a chip enable feature is provided to power down reducing the supply current to 10uA.

With a minimum number of external components, the AAT1109A offers a simple and cost effective solution.

**Pin Description**

| Pin # | Name | I/O | Description   |
|-------|------|-----|---|
| 1     | -IN  | I   | Error amplifier inverting input pin   |
| 2     | SCP  | I   | Soft start and SCP capacitor connection pin                                 |
| 3     | Vcc  |     | Power supply  |
| 4     | CE   | I   | Chip enable input pin ( internal pull "H" )                                 |
| 5     | OUT  | O   | Totem-type output pin   |
| 6     | GND  |     | Ground  |
| 7     | OSC  | O   | Capacitor and resistor connection pin for setting the oscillation frequency |
| 8     | FB   | O   | Error amplifier output pin  |

**Absolute Maximum Ratings**

| CHARACTERISTICS                      | SYMBOL    | VALUE      | UNIT |
|--------------------------------------|-----------|------------|------|
| Supply voltage                       | $V_{DD}$  | 7          | V    |
| Output current                       | $I_o$     | -120/+120  | mA   |
| Operating free-air temperature range | $T_{ope}$ | -20 to 85  | °C   |
| Storage temperature range            | $T_{stg}$ | -65 to 150 | °C   |
| Power dissipation                    | $P_d$     | 500        | mW   |

**Recommended Operating Conditions**

|                                | Symbol    | Min | Max     | Unit |
|--------------------------------|-----------|-----|---------|------|
| Supply voltage, $V_{DD}$       | $V_{DD}$  | 2.6 | 6.5     | V    |
| Error amplifier input voltage  | $V_I$     | 0.5 | 1.6     | V    |
| OSC capacitor                  | $C_T$     | 100 | 10000   | pF   |
| OSC resistor                   | $R_T$     | 1.0 | 10      | k    |
| Oscillator frequency           | $f_{OSC}$ | 10  | 1000    | kHz  |
| Output current                 | $I_o$     |     | +30/-30 | mA   |
| Operating free-air temperature | $T_{ope}$ | -20 | 85      | °C   |

**Electrical Characteristics,  $V_{DD} = 3.3V$  (Unless Otherwise Specified) (See Note 1)****Oscillator**

| Parameter                            |           | Test Condition            | Min | Typ | Max | Unit |
|--------------------------------------|-----------|---------------------------|-----|-----|-----|------|
| Oscillation frequency                | $f_{OSC}$ | $C_T = 270pF, R_T = 4.2k$ | 400 | 500 | 600 | KHz  |
| Frequency variation with temperature | $f_{dT}$  |                           |     | 5   |     | %    |
| Frequency input stability            | $f_{dV}$  | $V_{DD} = 2.6V$ to $6.5V$ |     | 1   |     | %    |

**Under-voltage Protection**

| Parameter                          |           | Test Condition     | Min  | Typ  | Max  | Unit |
|------------------------------------|-----------|--------------------|------|------|------|------|
| Upper threshold voltage            | $V_{UPH}$ | $T_A = 25^\circ C$ | 2.12 | 2.47 | 2.85 | V    |
| Lower threshold voltage            | $V_{UPL}$ | $T_A = 25^\circ C$ | 1.96 | 2.28 | 2.63 | V    |
| Hysteresis ( $V_{UPH} - V_{UPL}$ ) | $V_{HYS}$ | $T_A = 25^\circ C$ |      | 0.3  |      | V    |

Note1 : Typical values of all parameters are specified at  $T_A = 25^\circ C$ .

**Short Circuit Protection Control**

| Parameter                              |           | Test Condition | Min  | Typ   | Max   | Unit    |
|--|-----------|----------------|------|-------|-------|---------|
| Input threshold voltage                | $V_{r1}$  |                | 1.16 | 1.262 | 1.36  | V       |
| Short-circuit detect threshold voltage | $V_{r2}$  |                | 1.16 | 1.262 | 1.36  | V       |
| Charging current                       | $I_{SCP}$ | $V_{scp}=0v$   | -1.0 | -1.5  | -2.15 | $\mu A$ |

**Soft start**

| Parameter                        |          | Test Condition | Min  | Typ   | Max   | Unit    |
|----------------------------------|----------|----------------|------|-------|-------|---------|
| Charging current                 | $I_{cs}$ | $V_{scp}=0v$   | -1.0 | -1.5  | -2.15 | $\mu A$ |
| Voltage at soft start completion | $V_{ts}$ |                | 1.16 | 1.262 | 1.36  | V       |

**Shun Down Control**

| Parameter                 |           | Test Condition | Min | Typ | Max | Unit |
|---------------------------|-----------|----------------|-----|-----|-----|------|
| Shut down release voltage | $V_{sdh}$ |                |     |     | 0.5 | V    |
| Shut down enable voltage  | $V_{sdl}$ |                | 2.0 |     |     | V    |

**Electrical Characteristics,  $V_{DD} = 3.3V$  (Unless Otherwise Specified) (See Note 1)****Idle period adjustment section**

| Parameter          |            | Test Conditions                               | Min | Typ | Max | Unit |
|--------------------|------------|---|-----|-----|-----|------|
| Maximum duty cycle | $t_{DUTY}$ | $C_T = 270pF, R_T = 4.2k$<br>$V_{FB} = 1.12V$ | 75  | 85  | 93  | %    |

**EA (Error Amplifier)**

| Parameter                        |           | Test Condition                        | Min   | Typ   | Max   | Unit    |
|----------------------------------|-----------|---------------------------------------|-------|-------|-------|---------|
| Input threshold voltage          | $V_T$     | $V_{FB} = 0.7V$                       | 1.249 | 1.262 | 1.275 | V       |
| $V_T$ input stability            | $V_{TdV}$ | $V_{DD} = 2.6$ to $6.5v$              |       | 2     | 8     | mV      |
| $V_T$ variation with temperature | $V_{TdT}$ | $T_A = -20^{\circ}C$ to $90^{\circ}C$ |       | 1     |       | %       |
| Input bias current               | $I_B$     |                                       |       | 0.1   | 1     | $\mu A$ |
| Output voltage swing             | $V_{OM+}$ |                                       | 1.4   | 1.7   |       | V       |
|                                  | $V_{OM-}$ |                                       |       | 0.05  | 0.2   |         |
| Output sink current              | $I_{OM+}$ | $FB=0.7V$                             | 3     | 20    |       | mA      |
| Output source current            | $I_{OM-}$ | $FB=0.7V$                             | -45   | -75   |       | $\mu A$ |
| Open-loop voltage amplification  | $A_{VD}$  |                                       | 70    | 85    |       | dB      |

**Output section**

| Parameter                 |            | Test Condition |     | Typ | Max | Unit |
|---------------------------|------------|----------------|-----|-----|-----|------|
| High-level output voltage | $V_{OH}$   | $I_O = -30mA$  | 1.9 | 2.3 |     | V    |
| Low-level output voltage  | $V_{OL}$   | $I_O = +30mA$  |     | 0.8 | 1.2 | V    |
| Rise time                 | $T_{rise}$ | $C_L = 1000pF$ |     | 100 |     | nS   |
| Fall time                 | $T_{fall}$ | $C_L = 1000pF$ |     | 100 |     | nS   |

**Operating Current**

| Parameter      |              | Test Condition     | Min | Typ | Max | Unit |
|----------------|--------------|--------------------|-----|-----|-----|------|
| Supply current | $I_{DD-OFF}$ | Output "OFF" state |     | 1.3 |     | mA   |
|                | $I_{DD-ON}$  | $R_T = 4.2k$       |     | 1.6 |     | mA   |



## How to set the time constant for soft start and short circuit protection

### 1. Soft start

At power on, the AAT1109A operates in soft start mode. The capacitor  $C_{scp}$  connected to SCP pin starts charging at a constant current. In the soft start mode, the voltage at SCP pin ( $V_{SCP}$ ) is input to the PWM comparator, so that the ON duty of the OUT pin is controlled by the  $V_{SCP}$ . On completion of soft start operation, the voltage at the SCP pin stays low, the input from soft start circuit to the PWM comparator stay high, and enter the short circuit protection waiting state.

Soft start time

$$T_s(\text{sec}) \sim 0.84 \times C_{SCP}(\mu\text{F})$$

### 2. Short circuit protection

If the switching regulator output suddenly drops due to loading effect, the error amplifier output is fixed at  $V_{OM}^+$  and capacitor  $C_{SCP}$  starts charging. When the voltage at the SCP pin reaches approximately 1.26V, the output pin set low and SCP pin stays low.

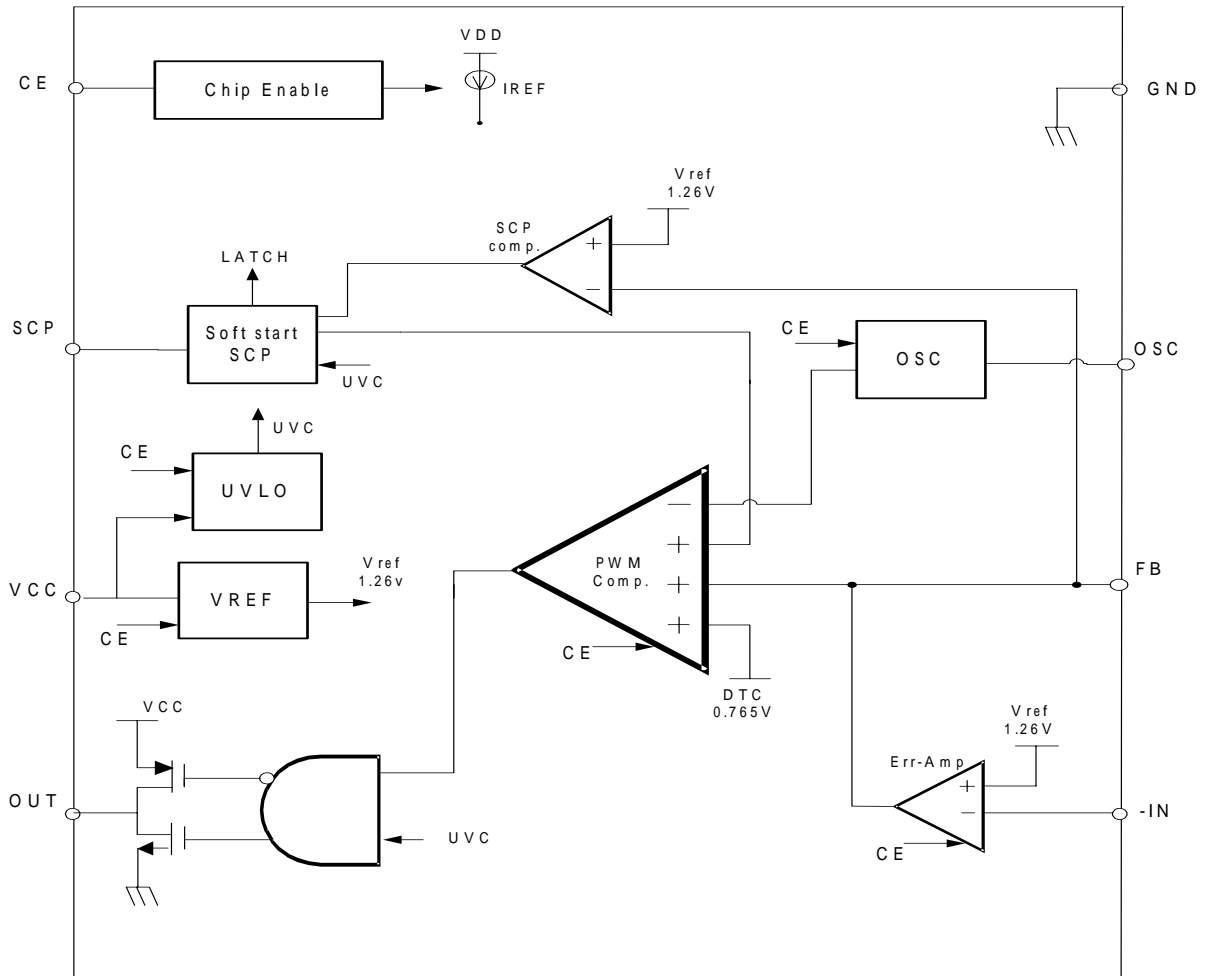
Once the protection circuit operates, the circuit can be recovered by setting the power supply.

Short circuit detection time

$$T_{scp}(\text{sec}) \sim 0.84 \times C_{SCP}(\mu\text{F})$$

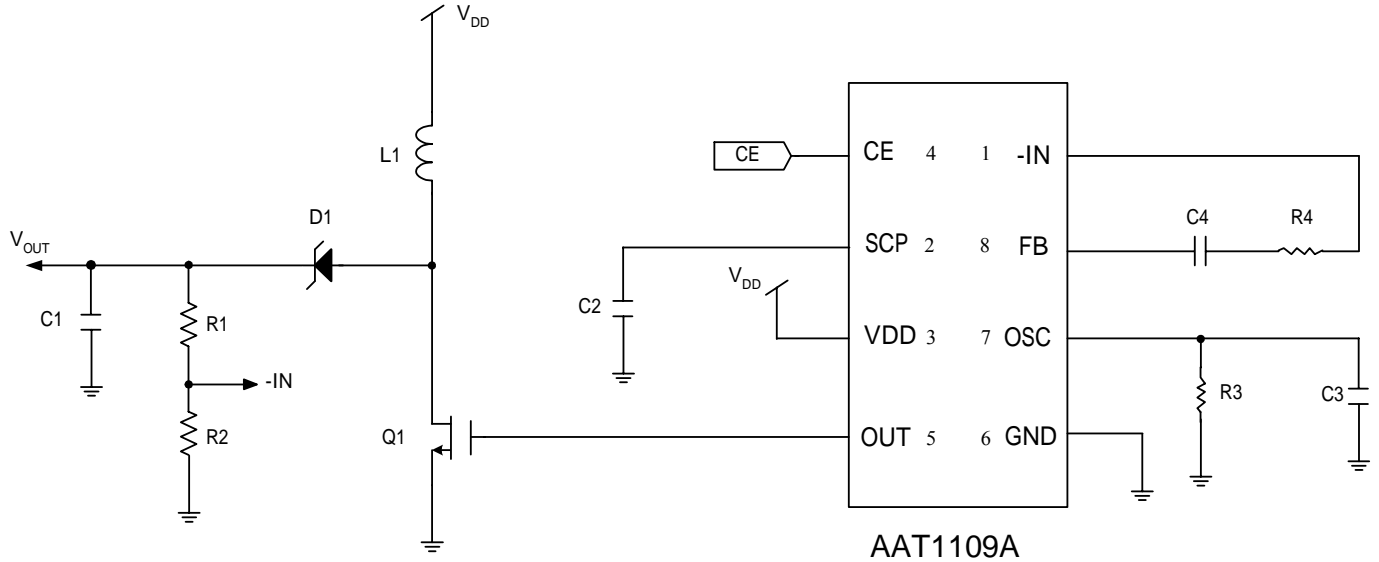


Function Block Diagram

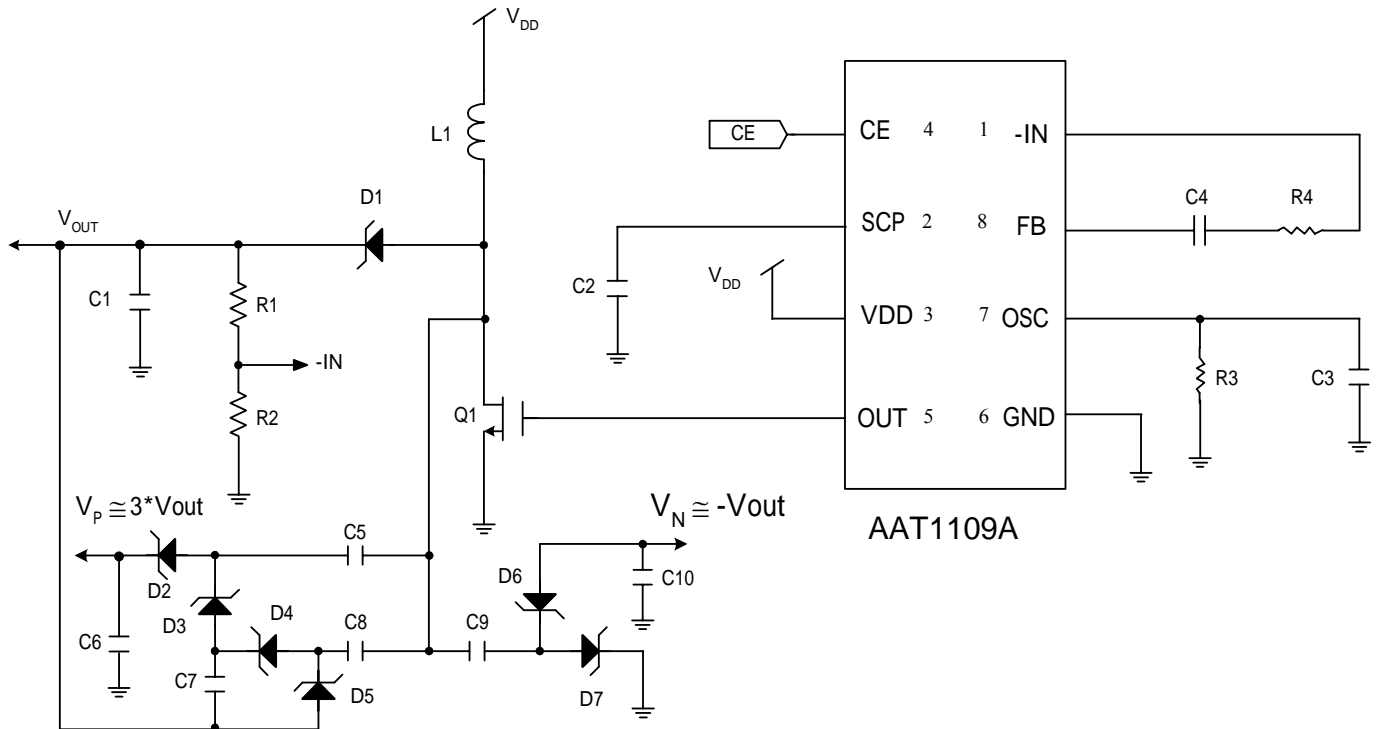




**Application Circuit 1 BOOST(step-up)**

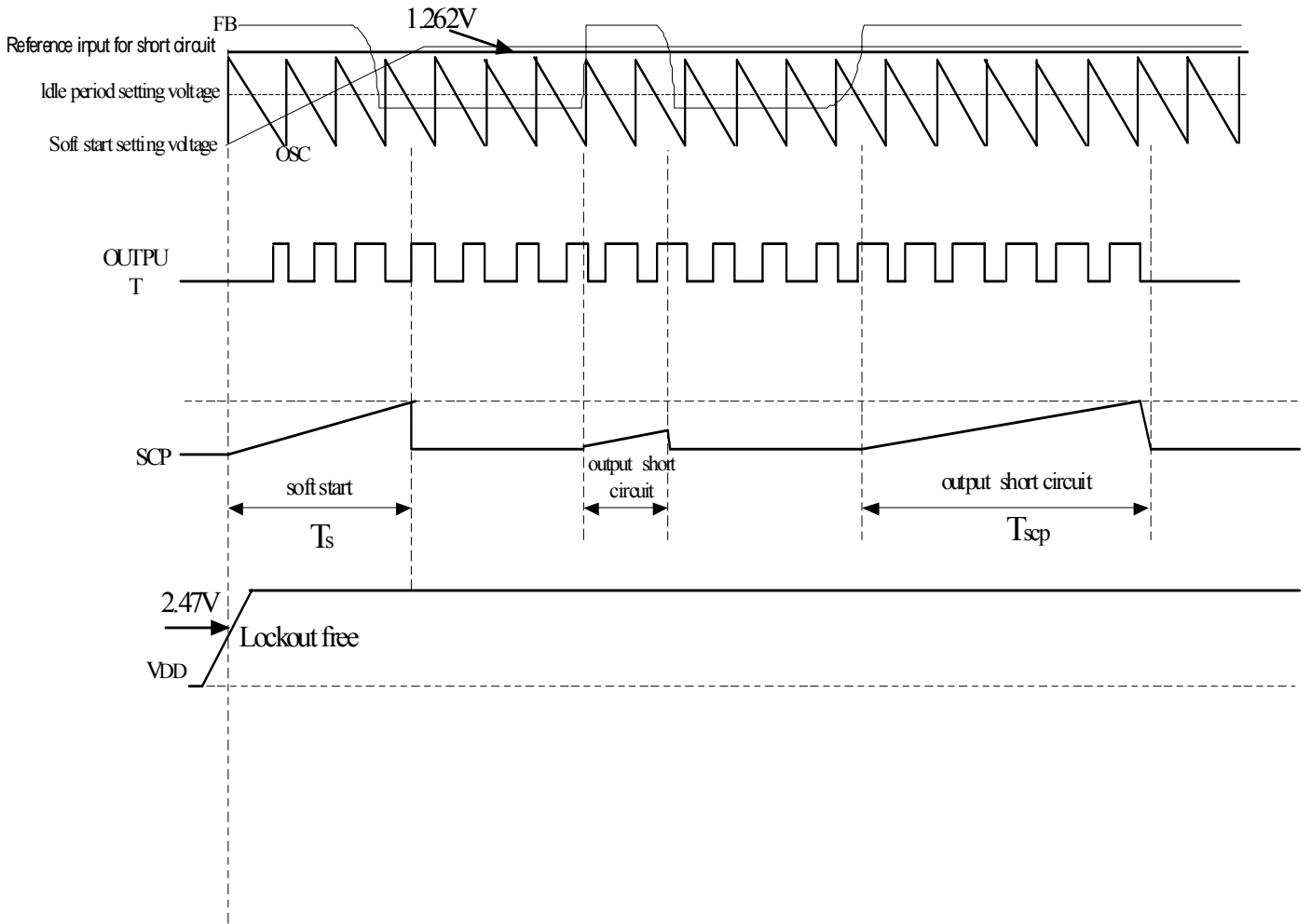


**Application Circuit 2 (with charge pump)**





**Boost ( Step-up ) Timing Chart**

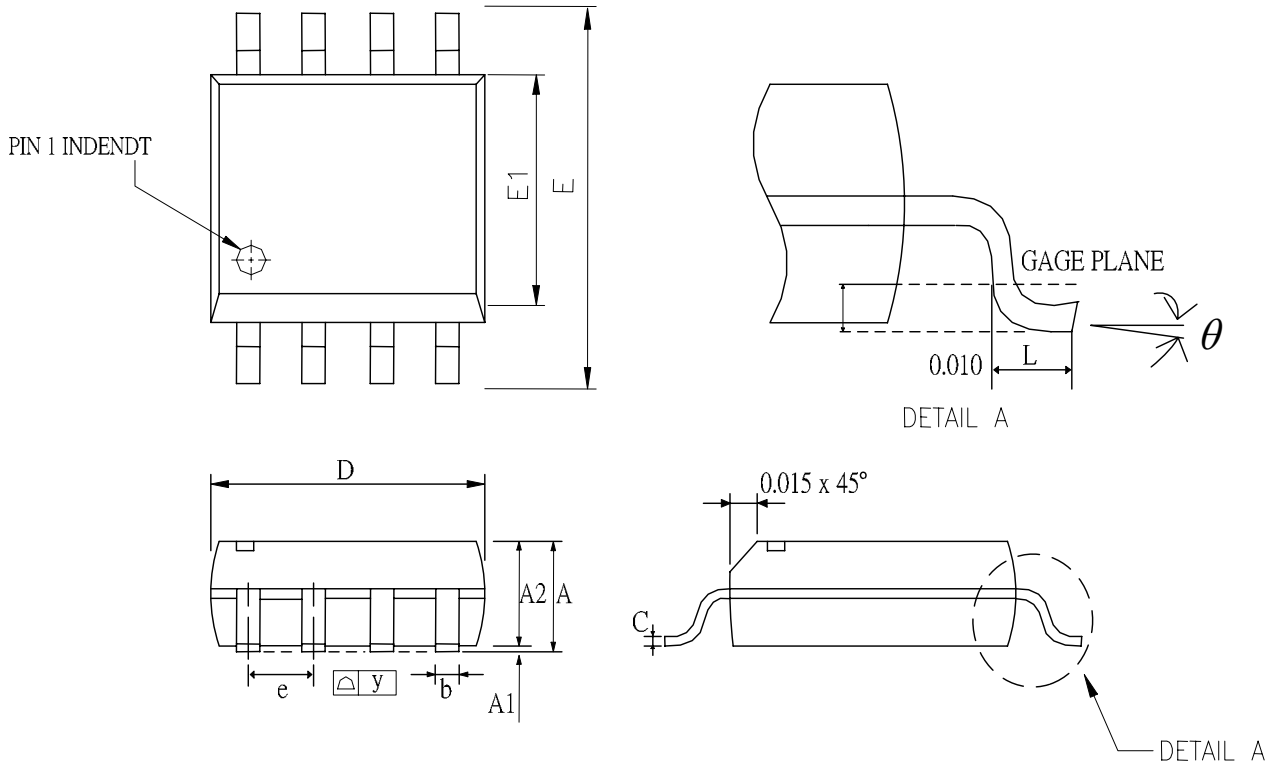






**Package Dimension (Unit: Mil)**

**8-pin SOP**

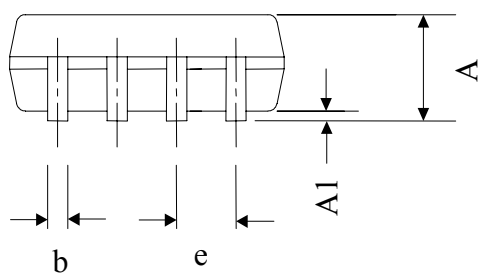
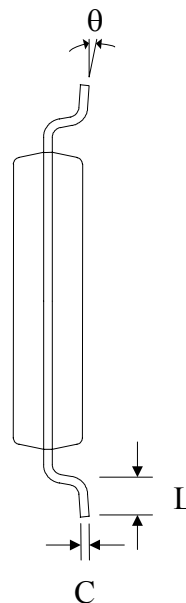
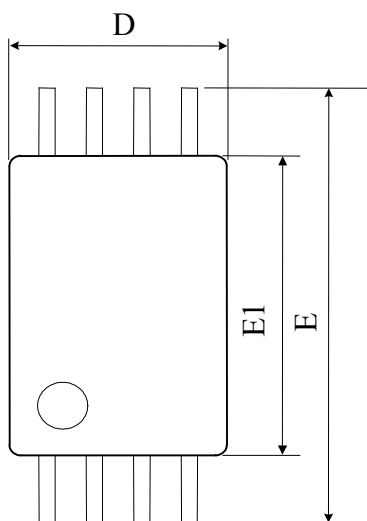


| SYMBOLS | DIMENSIONS IN MILLIMETERS |      |       | DEMINSIONS IN INCHES |       |        |
|---------|---------------------------|------|-------|----------------------|-------|--------|
|         | MIN                       | NOM. | MAX   | MIN                  | NOM.  | MAX    |
| A       | 1.47                      | 1.60 | 1.73  | 0.058                | 0.063 | 0.068  |
| A1      | 0.10                      | ---  | 0.22  | 0.004                | ---   | 0.008  |
| A2      | ---                       | 1.45 | ---   | ---                  | 0.057 | ---    |
| b       | 0.33                      | 0.41 | 0.51  | 0.013                | 0.016 | 0.020  |
| C       | 0.19                      | 0.20 | 0.25  | 0.0075               | 0.008 | 0.0098 |
| D       | 4.80                      | 4.85 | 4.95  | 0.189                | 0.191 | 0.195  |
| E       | 5.80                      | 6.00 | 6.20  | 0.228                | 0.236 | 0.244  |
| E1      | 3.80                      | 3.90 | 4.00  | 0.150                | 0.154 | 0.157  |
| e       | ---                       | 1.27 | ---   | ---                  | 0.050 | ---    |
| L       | 0.38                      | 0.71 | 1.27  | 0.015                | 0.028 | 0.050  |
| y       | ---                       | ---  | 0.076 | ---                  | ---   | 0.00.  |
| θ       | 0                         | ---  | 0     | 0                    | ---   | 0      |



Package Dimension (Unit: Mil)

8-pin TSSOP



| Dimension | Millimeters |       |       | Inches |       |       |
|-----------|-------------|-------|-------|--------|-------|-------|
|           | Min         | Nom   | Max   | Min    | Nom   | Max   |
| A         | 1.00        | 1.10  | 1.20  | 0.039  | 0.043 | 0.047 |
| A1        | 0.025       | 0.10  | 0.175 | 0.002  | 0.004 | 0.006 |
| b         | -----       | 0.22  | ----- | -----  | 0.008 | ----- |
| C         | -----       | 0.127 | ----- | -----  | 0.005 | ----- |
| D         | 2.90        | 3.00  | 3.10  | 0.114  | 0.118 | 0.122 |
| E         | 6.20        | 6.40  | 6.60  | 0.244  | 0.252 | 0.260 |
| E1        | 4.30        | 4.40  | 4.50  | 0.169  | 0.173 | 0.177 |
| e         | ---         | 0.65  | ---   | ---    | 0.026 | ---   |
| L         | 0.45        | 0.60  | 0.75  | 0.020  | 0.024 | 0.028 |
| θ         | 0°          | 3°    | 8°    | 0°     | 3°    | 8°    |