



Details are subject to change without notice.

## ONE-CHANNEL STEP-UP PWM CONTROLLER

### FEATURES

- Under-Voltage Lockout (UVLO) Protection
- Totem Pole Output
- Output Short Circuit Protection
- Soft-Start Function
- Wide Operating Frequency :  
10 kHz to 1MHz
- Shutdown Control
- Low Dissipation Current :  
Typical 1.6mA in Operation
- SOP-8 & TSSOP-8 Package Available

### GENERAL DESCRIPTION

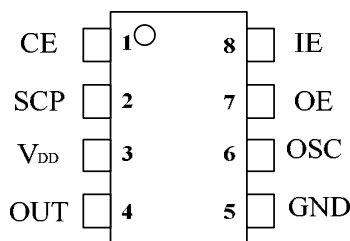
The AAT1109 is a one-channel step-up PWM controller incorporating a soft-start and a short circuit protection (SCP) function.

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

Additionally, a chip-enable feature is also provided to power down and reduce the current supply to 10µA. With the minimal external components, the AAT1109 offers a simple and economical solution.

### PIN CONFIGURATION

TOP VIEW



(SOP-8 PACKAGE)  
(TSSOP-8 PACKAGE)

**PIN DESCRIPTION**

PIN NO.	NAME	I/O	DESCRIPTION
1	CE	I	Chip Enable Input Pin ( Internal Pull "H" )
2	SCP	I	Soft-Start and SCP Capacitor Connection Pin
3	V <sub>DD</sub>	-	Power Supply
4	OUT	O	Totem Pole Type Output Pin
5	GND	-	Ground
6	OSC	O	Capacitor and Resistor Connection Pin for Setting the Oscillation Frequency
7	OE	O	Output Pin of Error Amplifier
8	IE	I	Inverting Input Pin of Error Amplifier

**ABSOLUTE MAXIMUM RATINGS**

CHARACTERISTICS	SYMBOL	VALUE	UNIT
Supply Voltage	V <sub>DD</sub>	7	V
Output Current	I <sub>O</sub>	-120/+120	mA
Operating Free-Air Temperature Range	T <sub>C</sub>	-20 to +85	°C
Storage Temperature Range	T <sub>storage</sub>	-45 to +125	°C
Power Dissipation	P <sub>d</sub>	500	mW

**RECOMMENDED OPERATING CONDITIONS**

	SYMBOL	MIN	MAX	UNIT
Supply Voltage	V <sub>DD</sub>	2.6	6.5	V
Error Amplifier Input Voltage	V <sub>I</sub>	0.5	1.6	V
Oscillator (OSC) Capacitance	C <sub>OSC</sub>	100	10,000	pF
Oscillator (OSC) Resistance	R <sub>OSC</sub>	1.0	10.0	kΩ
Oscillator (OSC) Frequency	f <sub>OSC</sub>	10	1,000	kHz
Output Current	I <sub>O</sub>		+30/-30	mA
Operating Free-Air Temperature	T <sub>C</sub>	-20	+85	°C

**ELECTRICAL CHARACTERISTICS,  $V_{DD} = 3.3V$  (UNLESS OTHERWISE SPECIFIED) (SEE NOTE 1)****OSCILLATOR**

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Oscillation Frequency	$f_{OSC}$	$C_{OSC} = 270pF$ $R_{OSC} = 4.2k\Omega$	400	500	600	kHz
Frequency Variation with Temperature	$f_{\Delta T}$	$T_C = -20^{\circ}C$ to $+85^{\circ}C$		5		%
Frequency Input Stability	$f_{\Delta V}$	$V_{DD} = 2.6V$ to $6.5V$		1		%

**UNDER-VOLTAGE PROTECTION**

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
Upper Threshold Voltage	$V_{UPH}$	$T_C = 25^{\circ}C$	2.12	2.47	2.85	V
Lower Threshold Voltage	$V_{UPL}$	$T_C = 25^{\circ}C$	1.96	2.28	2.63	V
Hysteresis ( $V_{UPH} - V_{UPL}$ )	$V_{HYS}$	$T_C = 25^{\circ}C$		0.19		V

Note 1: Typical values of all parameters are specified at  $T_C = 25^{\circ}C$ .

**SHORT CIRCUIT PROTECTION CONTROL**

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
Input Threshold Voltage	$V_{r1}$		1.160	1.262	1.360	V
Short-Circuit Detection Threshold Voltage	$V_{r2}$		1.160	1.262	1.360	V
Charging Current	$I_{SCP}$	$V_{SCP} = 0V$	-2.15	-1.50	-1.00	$\mu A$

**SOFT-START**

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
Charging Current	$I_{CS}$	$V_{SCP} = 0V$	-2.15	-1.50	-1.00	$\mu A$
Voltage at Soft-Start Completion	$V_{ts}$		1.160	1.262	1.360	V

**SHUTDOWN CONTROL**

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
Shutdown Enable Voltage	$V_{SE}$				0.5	V
Shutdown Release Voltage	$V_{SR}$		2.0			V



**ELECTRICAL CHARACTERISTICS,  $V_{DD} = 3.3V$  (UNLESS OTHERWISE SPECIFIED (SEE NOTE 1))**

**IDLE PERIOD ADJUSTMENT SECTION**

PARAMETER		TEST CONTION	MIN	TYP	MAX	UNIT
Maximum Duty Cycle	$t_{Duty}$	$C_{OSC} = 270pF$ $R_{OSC} = 4.2k\Omega, V_{OE} = 1.12V$	75	85	93	%

**EA (ERROR AMPLIFIER)**

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
Input Threshold Voltage	$V_T$	$V_{OE} = 0.7V$	1.249	1.262	1.275	V
$V_T$ Input Stability	$V_{TAV}$	$V_{DD} = 2.6$ to $6.5V$		2	8	mV
$V_T$ Variation with Temperature	$V_{TAT}$	$T_C = -20^\circ C$ to $+85^\circ C$		1		%
Input Bias Current	$I_B$			0.1	1.0	$\mu A$
Output Voltage Swing	$V_{OS+}$		1.4	1.7		V
	$V_{OS-}$			0.05	0.20	
Output Sink Current	$I_{OS+}$	$V_{OE} = 0.7V$	3	20		mA
Output Source Current	$I_{OS-}$	$V_{OE} = 0.7V$	-45	-75		$\mu A$
Open-Loop Voltage Gain	$A_{VO}$		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	$t_{RISE}$	$C_L = 1,000pF$		100		ns
Fall Time	$t_{FALL}$	$C_L = 1,000pF$		100		ns

**OPERATING CURRENT**

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
Supply Current	$I_{DD-OFF}$	Output "OFF" State		1.3		mA
	$I_{DD-ON}$	$R_{OSC} = 4.2k\Omega$		1.6		mA



## HOW TO SET THE TIME CONSTANT FOR SOFT-START AND SHORT CIRCUIT PROTECTION

### 1. Soft-Start

AAT1109 operates in soft-start mode. The PWM comparator monitors the voltage at soft-start setting and SCP pin, which varies proportionally to each other. This proportion relation controls the ON duty of the OUT pin and activates the soft-start operation. 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 determined by the  $V_{SCP}$ . When the soft-started mode is completed, its setting voltage remains high and the circuit enters the output short circuit protection wait state while  $V_{SCP}$  remains low.

Soft-Start Time

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

### 2. Short Circuit Protection

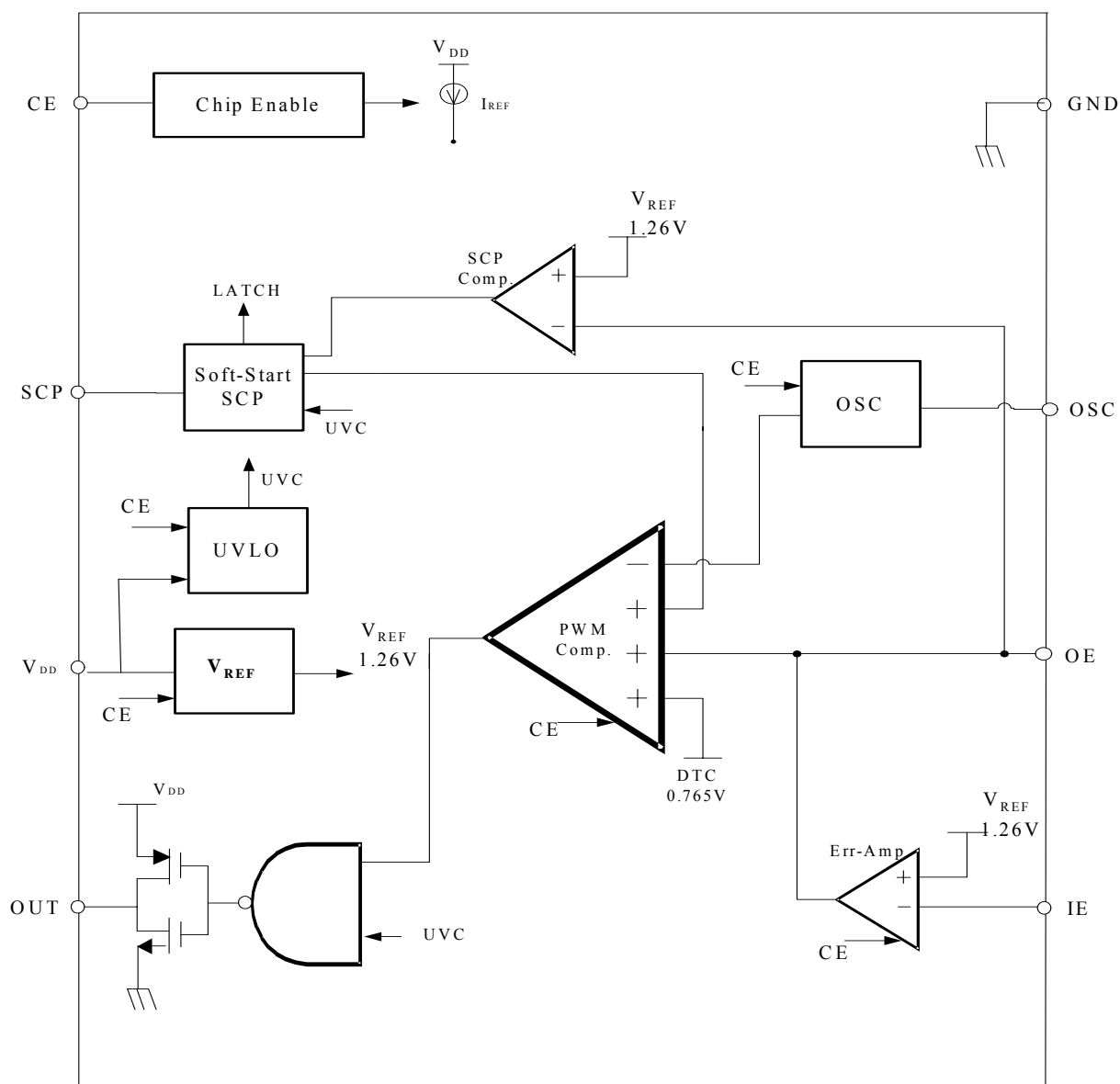
In response to a sudden drop of the switching regulator output, the device locks the error amplifier, OE pin, at  $V_{OS+}$ , and starts feeding currents into the capacitor at SCP pin to achieve in a voltage value of approximately 0.84V at this pin. This chain reaction protects the circuit by keeping the SCP pin and output pin low. Users could reverse this process by restarting the device.

Short Circuit Detection Time

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

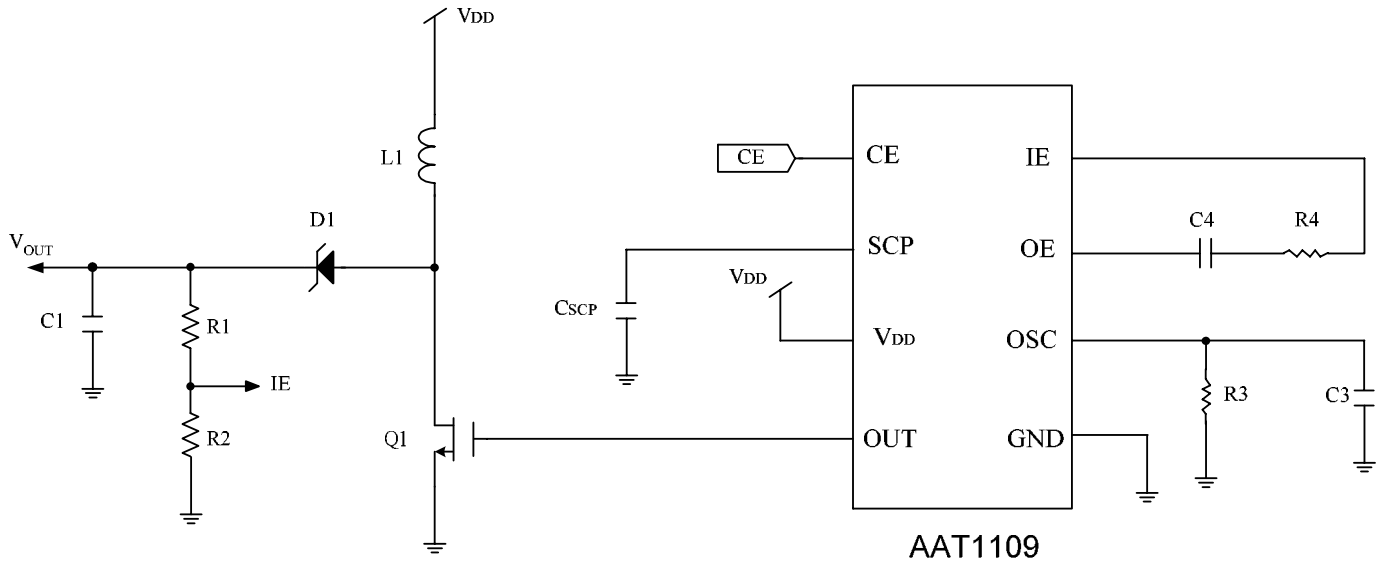


**BLOCK DIAGRAM**



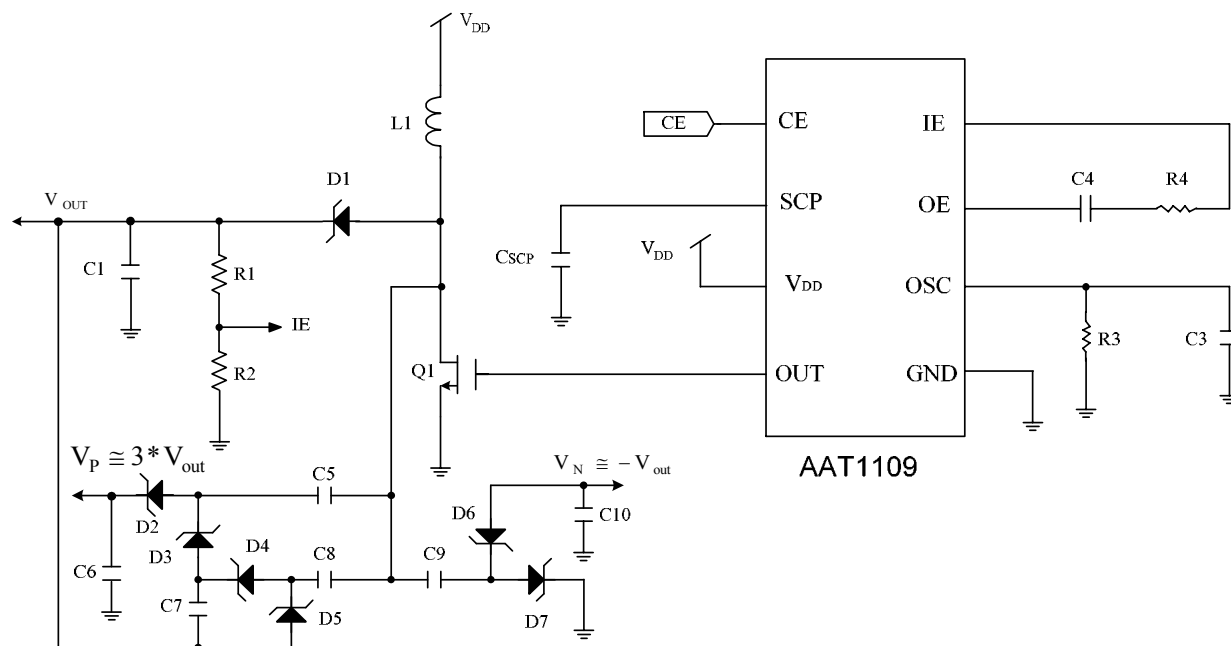


APPLICATION CIRCUIT 1 BOOST (STEP-UP)





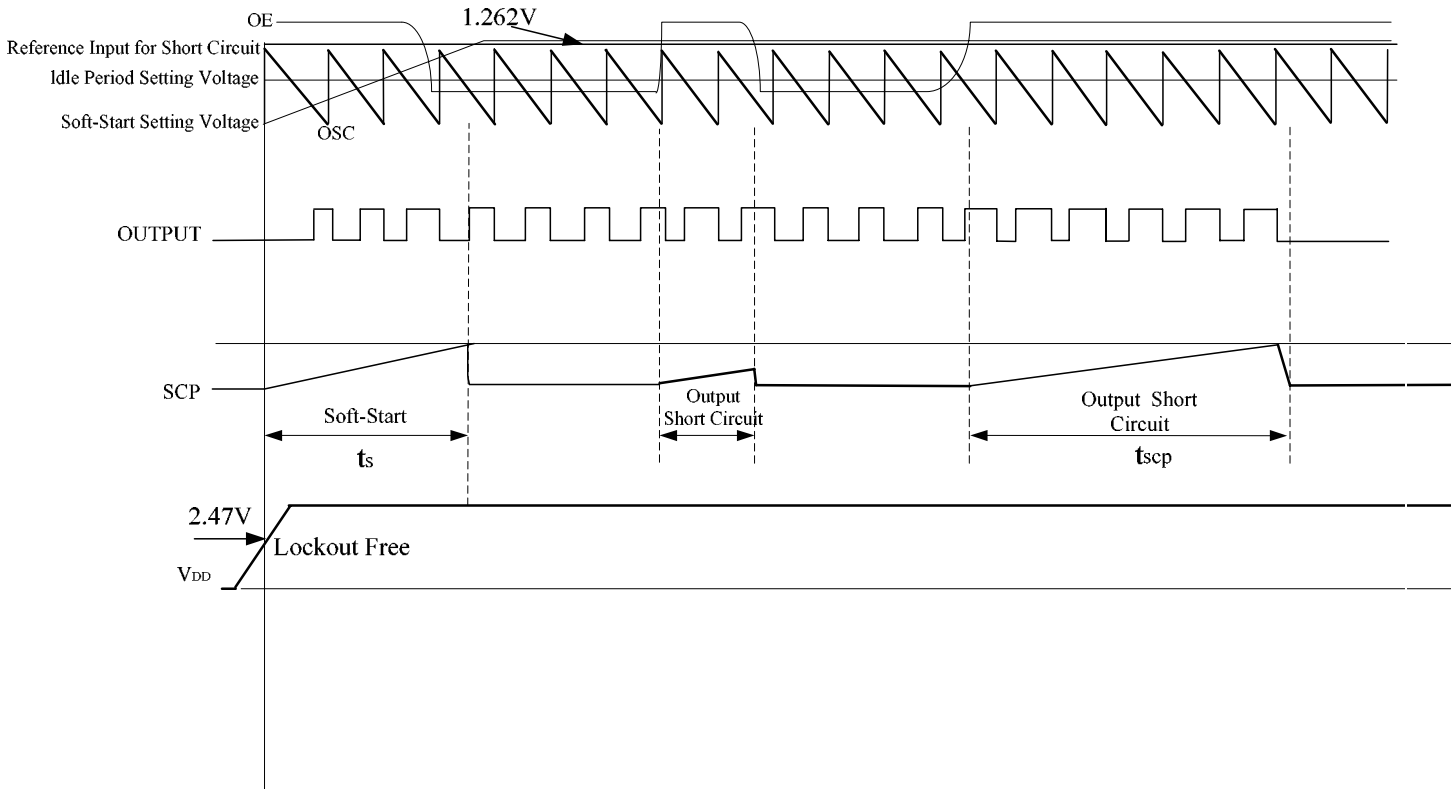
APPLICATION CIRCUIT 2 (WITH CHARGE PUMP)





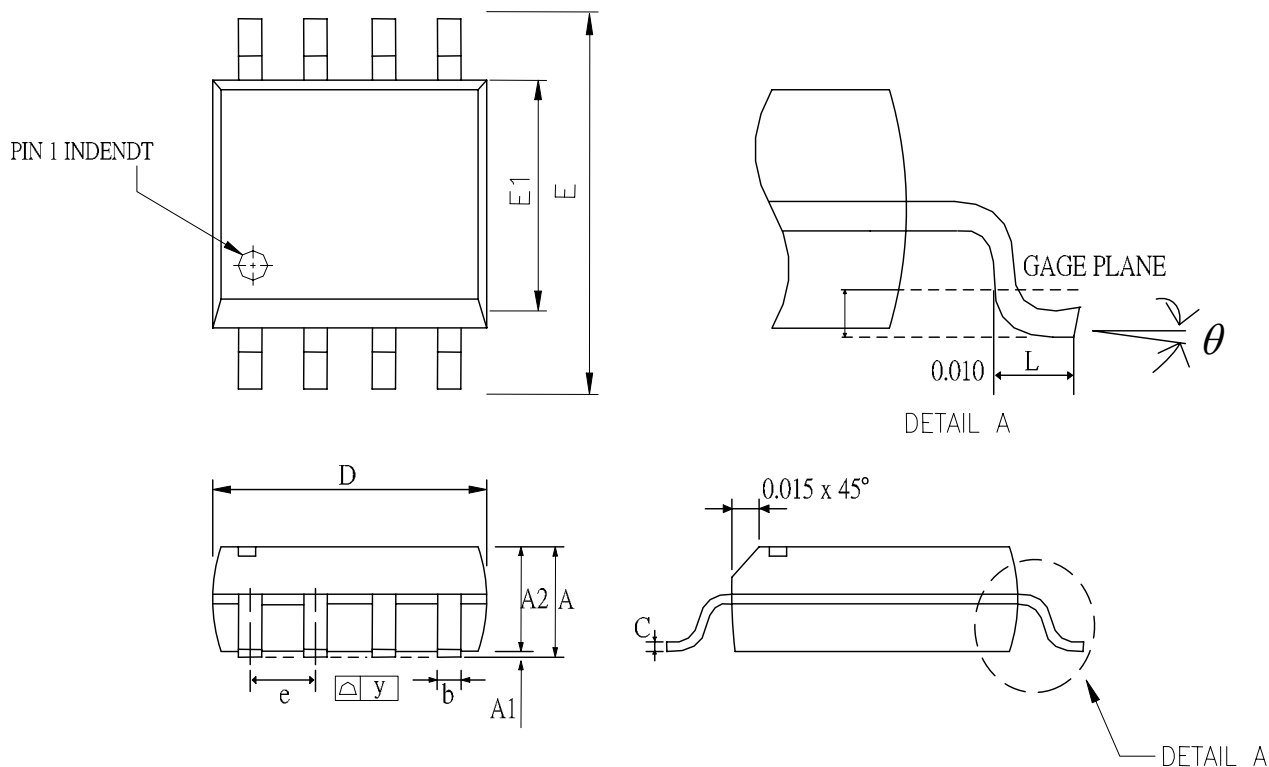


**BOOST (STEP-UP) TIMING CHART**





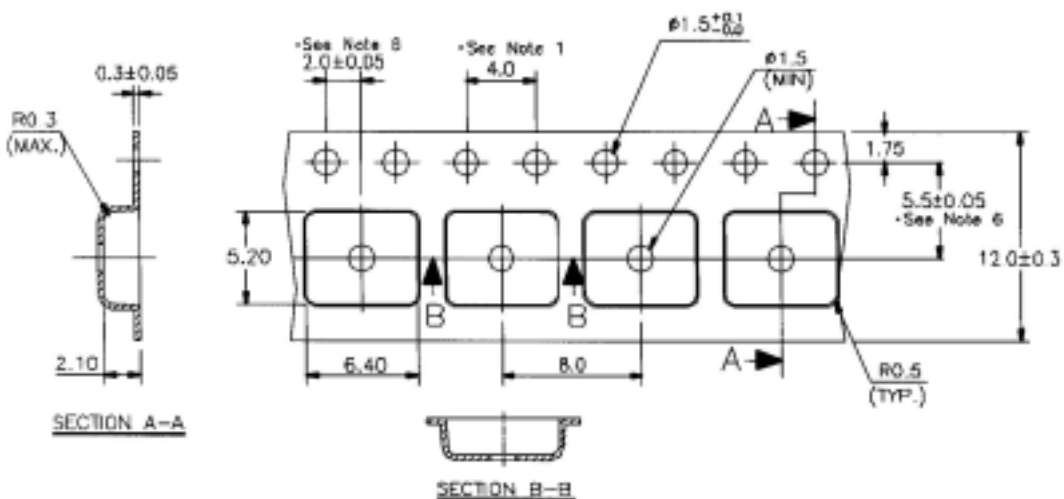
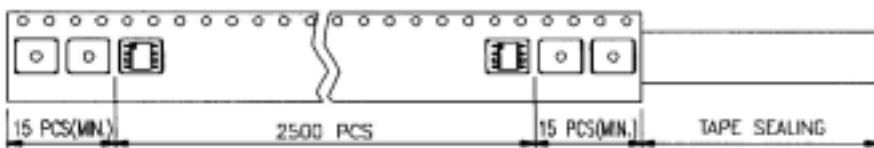
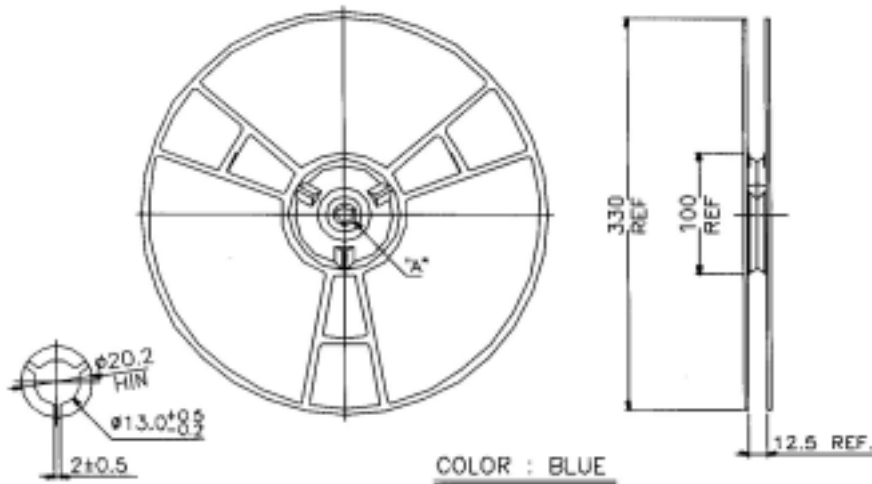
**PACKAGE DIMENSION**  
**8-PIN SOP**



SYMBOLS	DIMENSIONS IN MILLIMETERS			DEMINSIONS IN INCHES		
	MIN	TYP	MAX	MIN	TYP	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
theta	0	---	0	0	---	0

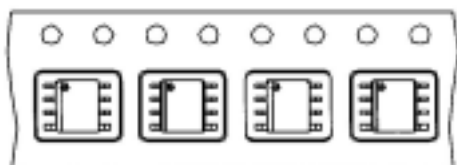


**TAPE AND REEL**  
**8-PIN SOP**





**TAPE AND REEL**  
**8-PIN SOP (CONT.)**



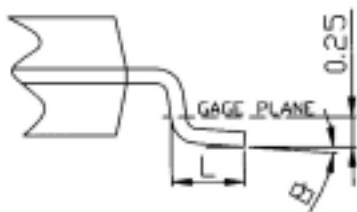
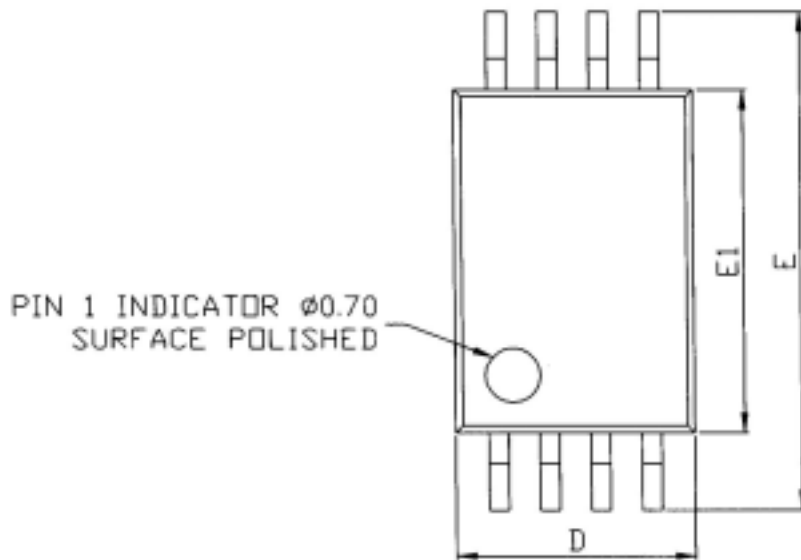
SOP 8N(150mil)

NOTE:

1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE  $\pm 0.2$  MILLIMETERS.
2. CAMBER NOT TO EXCEED 1 MILLIMETER IN 100 MILLIMETERS
3. MATERIAL: ANTI-STATIC BLACK ADVANTEK POLYSTYRENE.
4.  $A_0$  AND  $B_0$  ARE MEASURED ON A PLANE 0.3 MILLIMETERS ABOVE THE BOTTOM OF THE POCKET.
5.  $K_0$  IS MEASURED FROM A PLANE ON THE INSIDE BOTTOM OF THE POCKET TO THE TOP SURFACE OF THE CARRIER.
6. POCKET POSITION RELATIVE TO SPROCKET HOLE IS MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE.



**PACKAGE DIMENSION**  
**TSSOP-8**



DETAIL A





**PACKAGE DIMENSION**  
**TSSOP-8**



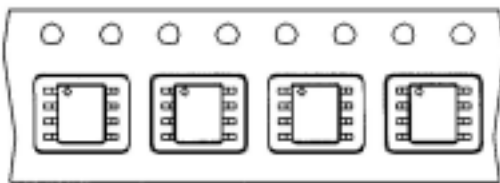
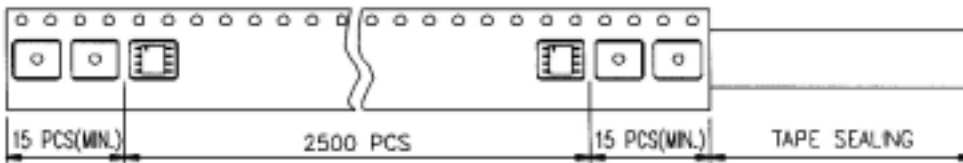
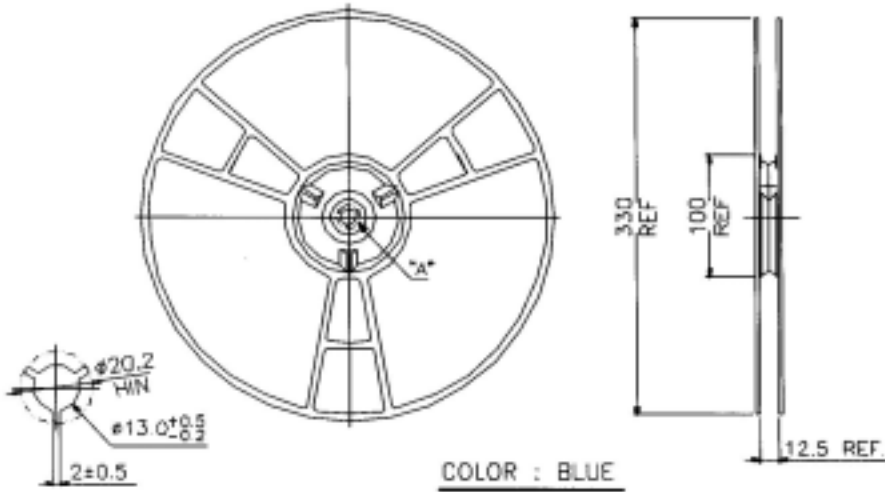
SYMBOL	DIMENSION IN MILLIMETERS			DIMENSION IN INCHES		
	MIN	TYP	MAX	MIN	TYP	MAX
A	1.05	1.10	1.20	0.041	0.043	0.047
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	-----	1.00	1.05	-----	0.039	0.041
b	0.25	-----	0.30	0.010	-----	0.012
C	-----	0.127	-----	-----	0.005	-----
D	2.90	3.05	3.10	0.114	0.120	0.122
E	6.20	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	0.50	0.60	0.70	0.020	0.024	0.028
y	-----	-----	0.076	-----	-----	0.003
θ	0°	4°	8°	0°	4°	8°

NOTE:

1. CONTROLLING DIMENSION: MILLIMETERS.
2. LEAD FRAME MATERIAL: OLIN C7025/EFTEC 64T.
3. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, TIE BAR BURRS AND GATE BURRS. MOLD FLASH, TIE BAR BURRS AND GATE BURRS SHALL NOT EXCEED 0.006" [0.15 MILLIMETERS] PER END. DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" [0.25 MILLIMETERS] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.003" [0.08 MILLIMETERS] TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028" [0.07 MILLIMETERS].
5. TOLERANCE: ± 0.010" [0.25 MILLIMETERES] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT: JEDEC SPEC MO-153.



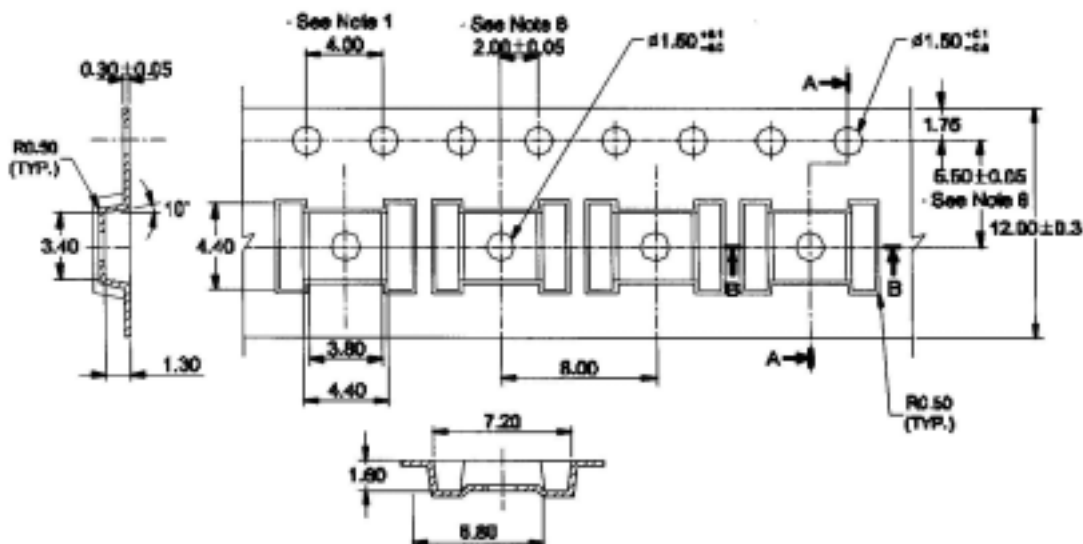
**TAPE AND REEL**  
**TSSOP-8**



TSSOP 8L



**TAPE AND REEL**  
**TSSOP-8 (CONT.)**



X.XXX X ± 0.0025  
X.XXX ± 0.006  
X.XX ± 0.025  
X.X ± 0.10  
X ± 0.25  
UNIT: MILLIMETERS

NOTE:

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**PART MARKING**

**SOP8 TOP MARKING**

AAT1109  
XXXXXX

**SOP8 BACK MARKING**

YYWW

**PART MARKING**

**TSSOP8 TOP MARKING**

AAT1109  
XXXXXX

**TSSOP8 BACK MARKING**

YYWW



**ORDERING INFORMATION**

**AAT xxxxx-xx-x**

AAT Part Number

Package Code 2  
T=Taping Reel  
Blank=Tube or Tray

Package Code 1  
Sop8: S  
Tssop8: T2

**Remark:**  
**T=Taping Reel**  
PS.  
Tssop8→2,500pcs/reel  
Sop8→2,500pcs/reel

**Blank=Tube**  
PS.  
Sop8→98pcs/tube