



Details are subject to change without notice

## ONE-CHANNEL STEP-DOWN PWM CONTROLLER

### Features

- Under-Voltage Lockout (UVLO) Protection
- Totem Pole Output
- Output Short Circuit Protection
- Incorporates 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

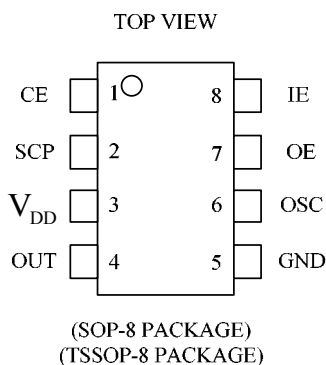
The AAT1110 is a one-channel step-down PWM controller incorporating a soft-start function and a short circuit protection (SCP) function.

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 enabled feature is provided to power down and reduce the supply current to 10µA .

With an optimized number of external components, the AAT1110 offers a simple and cost effective solution.

### Pin Configuration



**Pin Description**

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

**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**

Characteristics	Symbol	Min	Max	Unit
Supply Voltage, V <sub>DD</sub>	V <sub>DD</sub>	2.6	6.5	V
Error Amplifier Input Voltage	V <sub>I</sub>	0.5	1.6	V
OSC Capacitor	C <sub>OSC</sub>	100	10,000	pF
OSC Resistor	R <sub>OSC</sub>	1.0	10.0	kΩ
Oscillator 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		Test Condition	Min	Typ	Max	Unit
Oscillation Frequency	$f_{OSC}$	$C_{OSC} = 270pF,$ $R_{OSC} = 4.2 k\Omega$	400	500	600	kHz
Frequency Variation With Temperature	$f_{\Delta T}$			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

Note1: 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 Detect Threshold Voltage	$V_{tscd}$		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)****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	$V_{T\Delta V}$	$V_{DD} = 2.6$ to $6.5V$	-	2	8	mV
$V_T$ Variation with Temperature	$V_{T\Delta T}$	$T_C = -20$ °C to $90$ °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	Min	Typ	Max	Unit
High-Level Output Voltage	$V_{OH}$	$I_O = -30$ mA	1.9	2.3	-	V
Low-Level Output Voltage	$V_{OL}$	$I_O = +30$ mA	-	0.8	1.2	V
Rise Time	$t_{RISE}$	$C_L = 1,000$ pF	-	100	-	ns
Fall Time	$t_{FALL}$	$C_L = 1,000$ pF	-	100	-	ns

**Operating Current**

Parameter		Test Condition	Min	Typ	Max	Unit
Supply Current	$I_{DD-OFF}$	Output "OFF" State	-	1.3	-	mA
	$I_{DD-ON}$	$R_T = 4.2$ k $\Omega$	-	1.6	-	mA



## How to Set the Time Constant for Soft-Start and Short Circuit Protection

### 1. Soft-Start

At power on, the AAT1110 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  $V_{SCP}$ . At completion of the soft-start operation, the voltage at the SCP pin stays low; the input from soft-start circuit to the PWM comparator stays high, and enters 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 will be fixed at  $V_{OM+}$  and capacitor  $C_{SCP}$  will start charging. When the voltage at the SCP pin reaches approximately 1.26V, the output pin will set low and SCP pin will remain low.

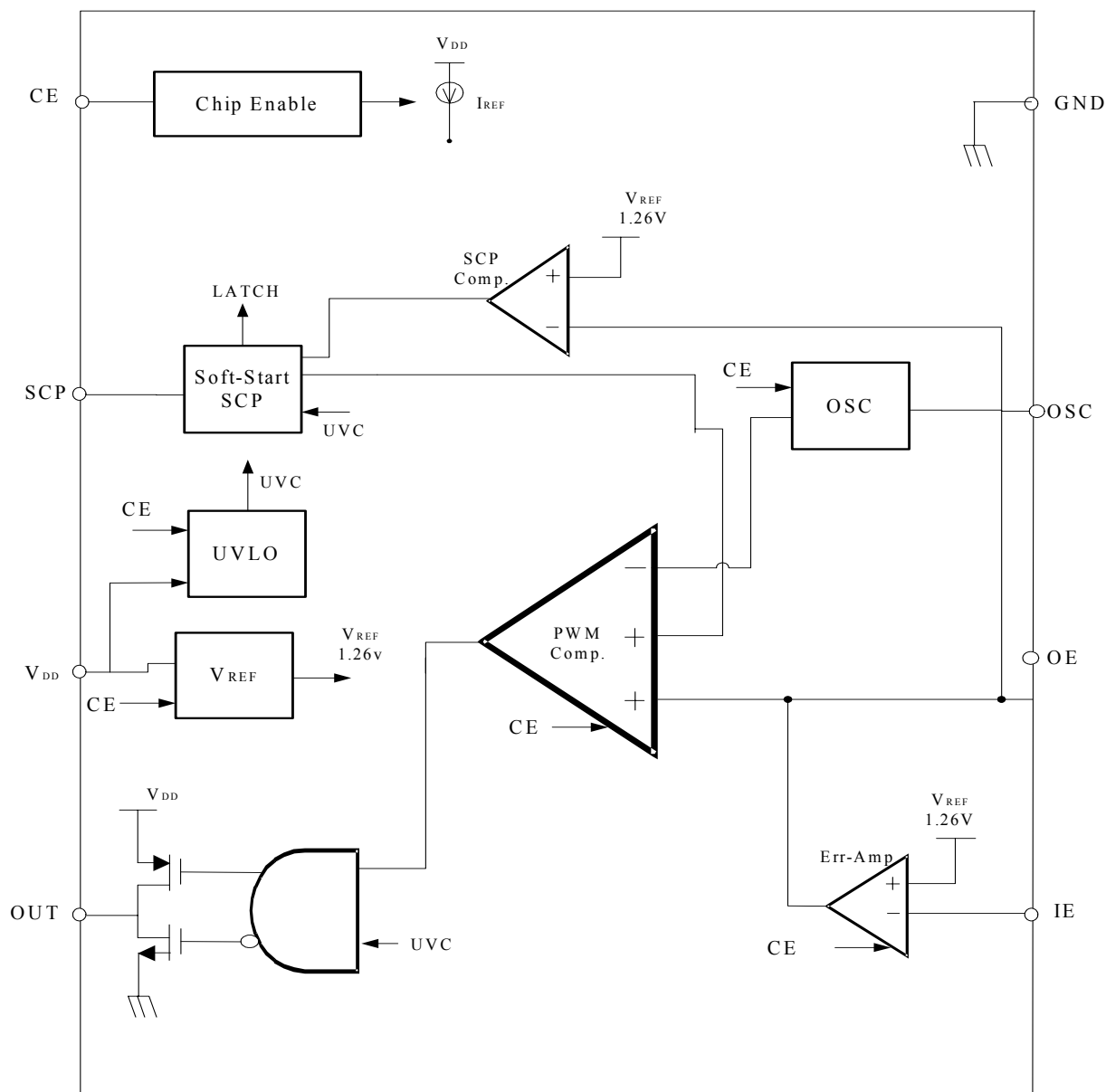
Once the protection circuit starts operating, the circuit can be recovered by setting the power supply.

#### Short Circuit Detection Time

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

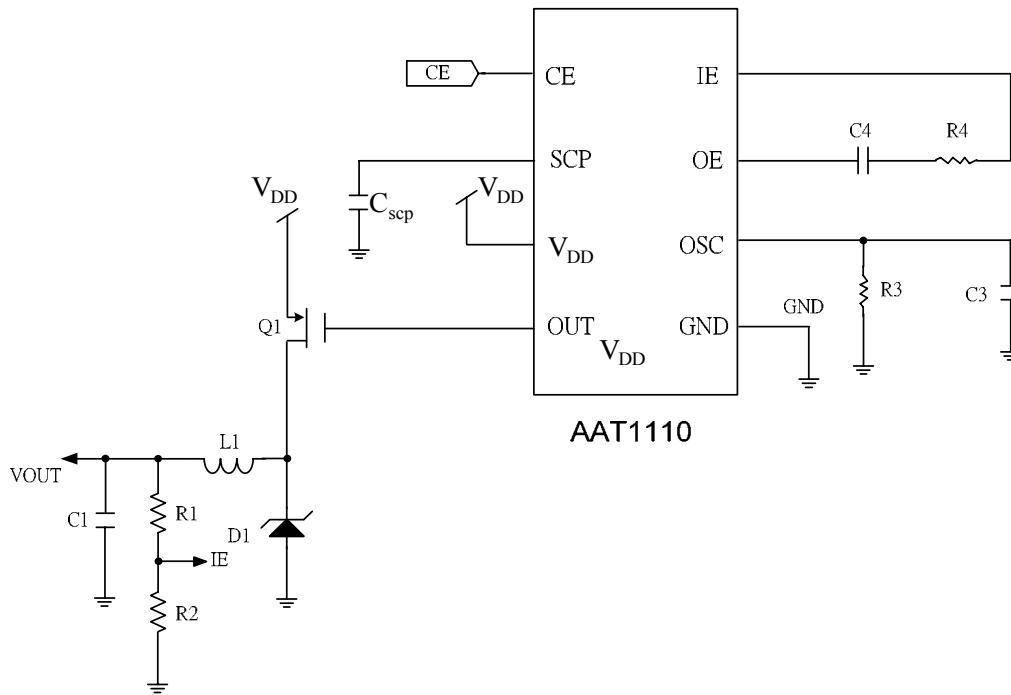


Block Diagram



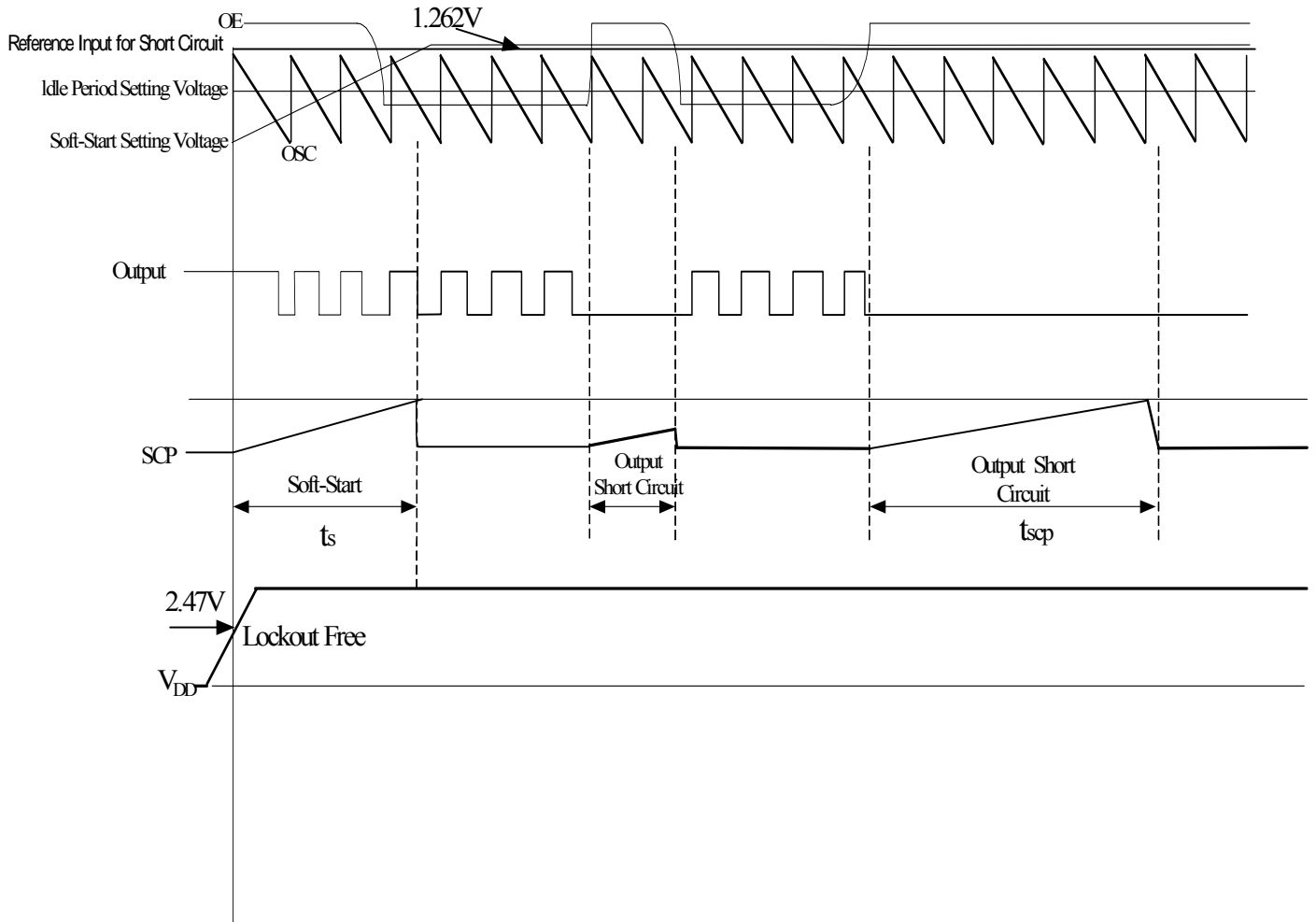


Application Circuit Buck (Step-Down)





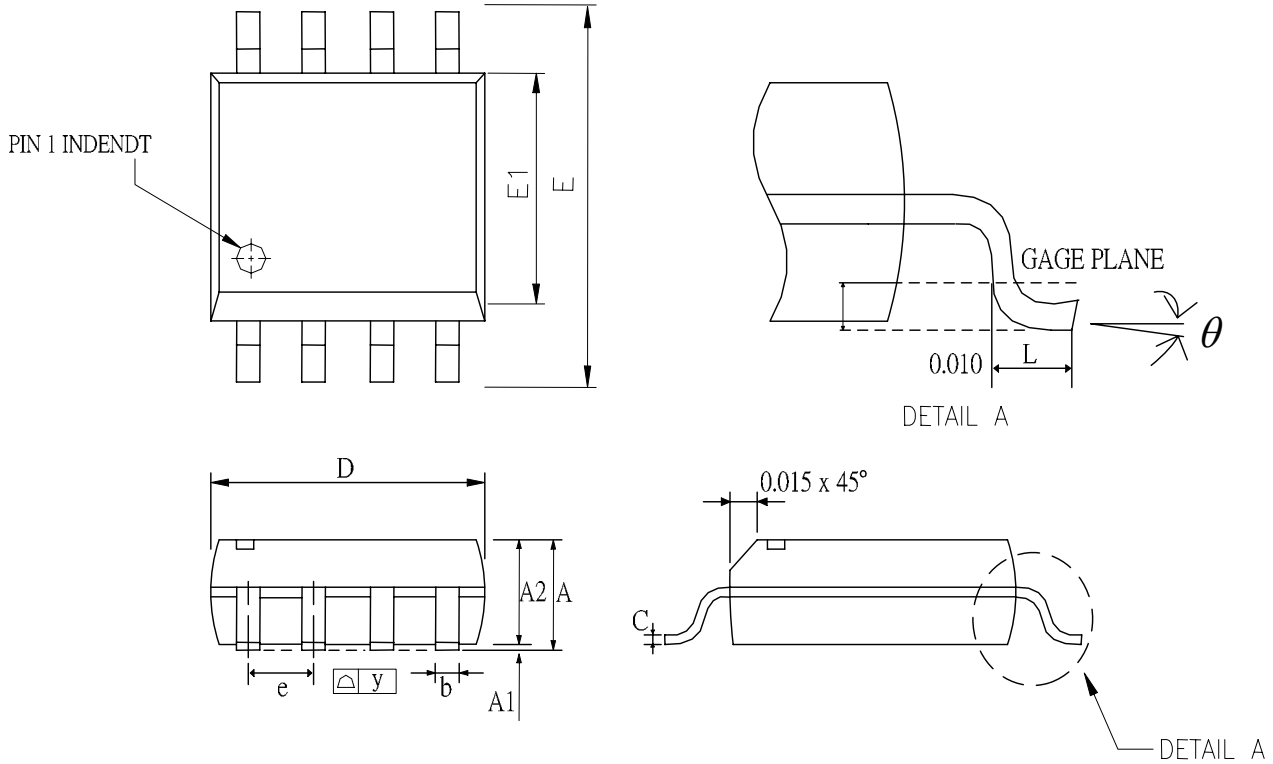
### Buck (Step-Down) Timing Chart







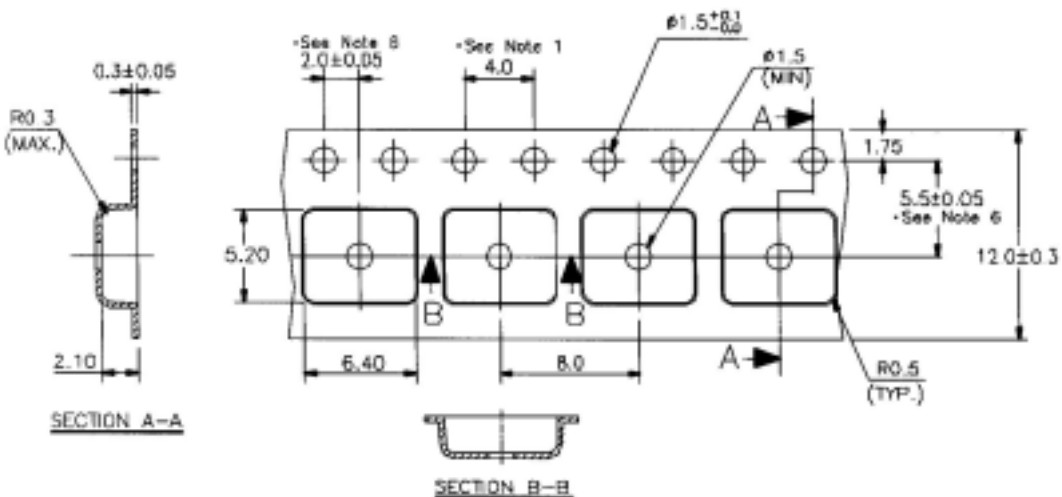
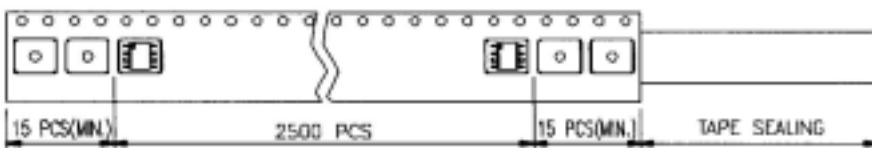
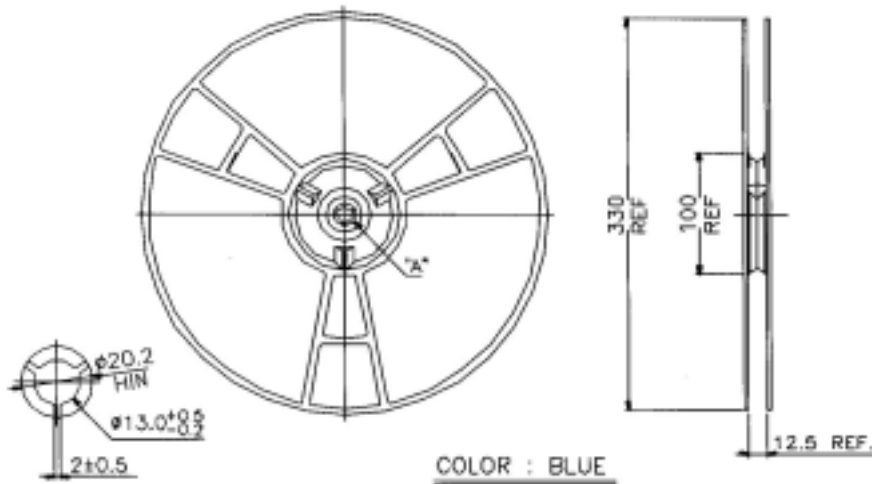
**Package Dimension**  
**8-Pin SOP**



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
θ	0	---	0	0	---	0

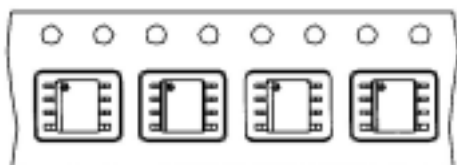


Tape and Reel  
8-PinSOP





**Tape and Reel**  
**8-Pin SOP (Cont.)**



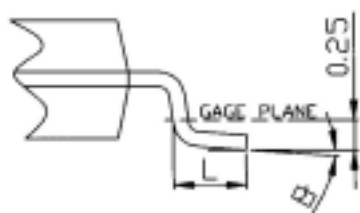
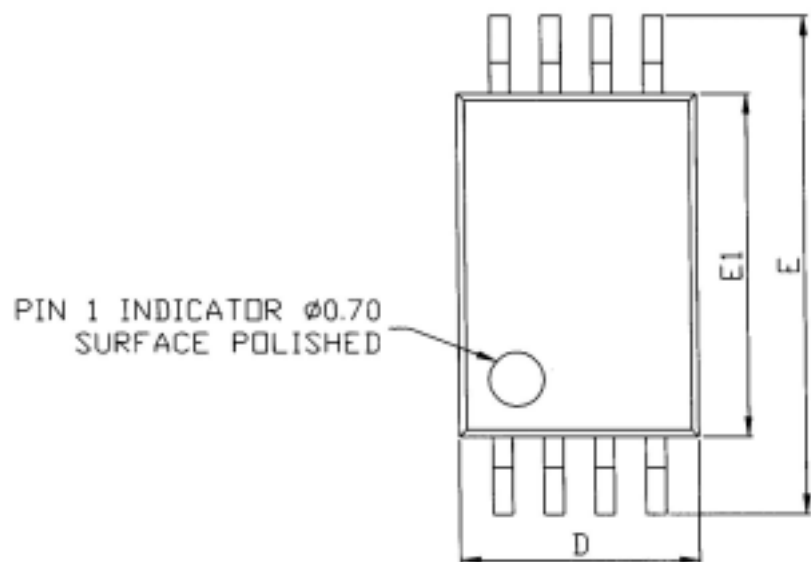
SOP 8N(150mil)

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**

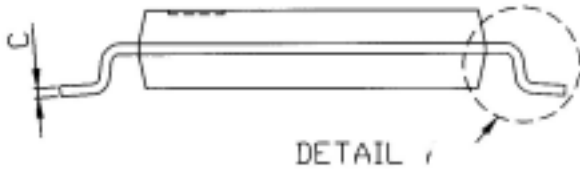


DETAIL A





**Package Dimension**  
**TSSOP-8**



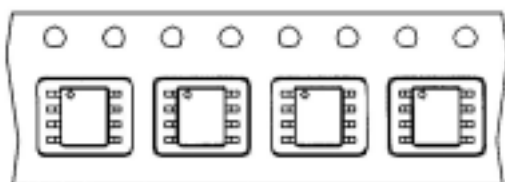
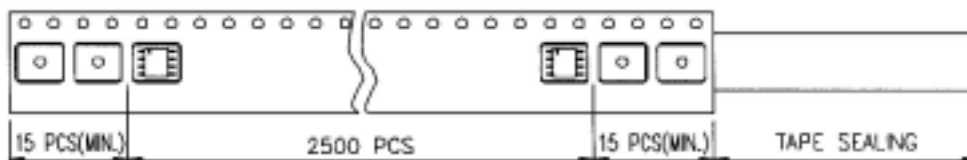
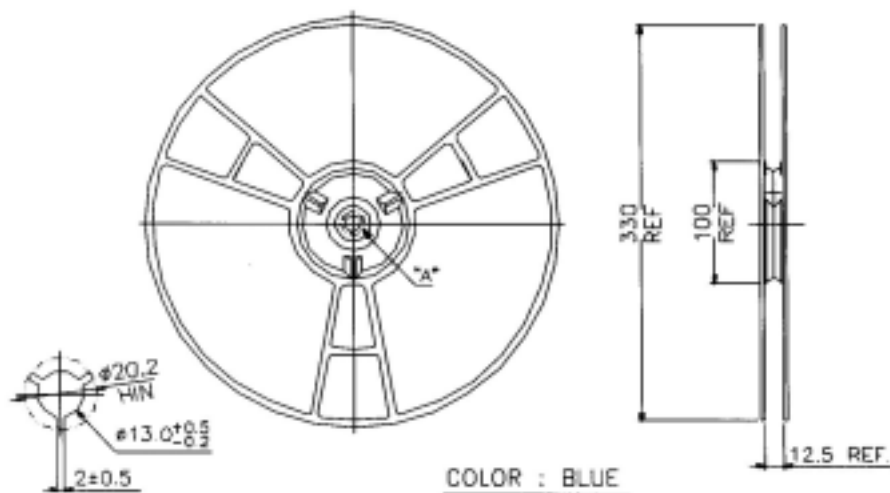
SYMBOL	DIMENSION IN MILLIMETERS			DIMENSION IN INCHES		
	MIN	TYP	MAX	MIN	TYP	MAX
A	1.05	1.10	1.20	0.041	0.043	0.047
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	-----	1.00	1.05	-----	0.039	0.041
b	0.25	-----	0.30	0.010	-----	0.012
C	-----	0.127	-----	-----	0.005	-----
D	2.90	3.05	3.10	0.114	0.120	0.122
E	6.20	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 BE 0.006" [0.15 MILLIMETERS] PER END. DIMENSION "E1" DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL BE 0.006" [0.15 MILLIMETERS] PER SIDE.
4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.0028" [0.07 MILLIMETERS] AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE LEAD. DAMBAR PROTRUSION AND AN ADJACENT LEAD TO BE 0.0028" [0.07 MILLIMETERS].
5. TOLERANCE: ± 0.010" [0.25 MILLIMETERS] UNLESS OTHERWISE SPECIFIED.
6. OTHERWISE DIMENSION FOLLOW ACCEPTABLE SPEC.
7. REFERENCE DOCUMENT: JEDEC SPEC MO-153.



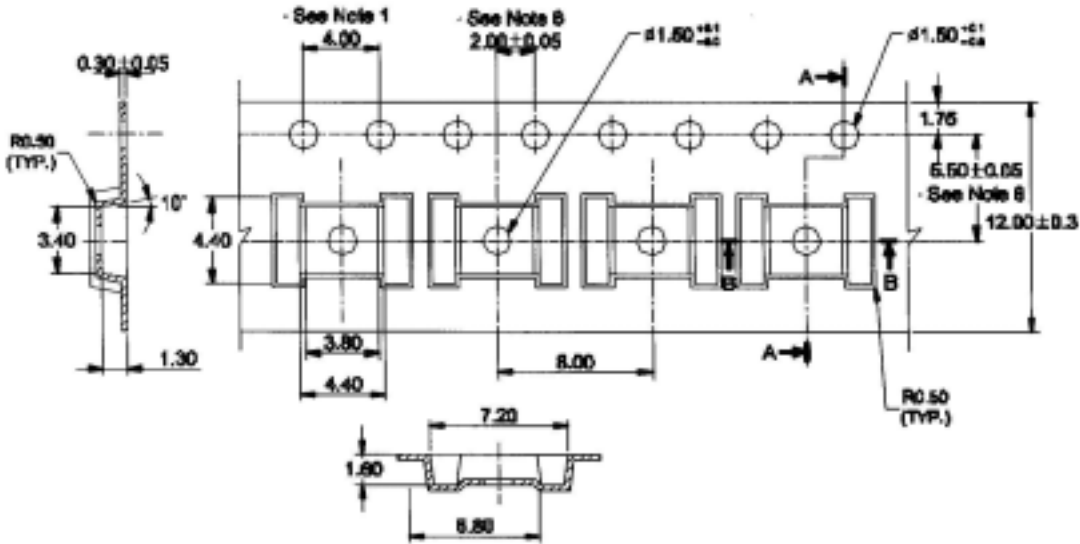
Tape and Reel  
TSSOP-8



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**

AAT1110  
XXXXXX

**SOP8 Back Marking**

YYWW

**Part Marking**

**TSSOP8 Top Marking**

AAT1110  
XXXXXX

**TSSOP8 Back Marking**

YYWW





Ordering Information

**AAT xxxxx-xx-x**

AAT Part Number

Package Code 1  
Sop8: S  
Tssop8: T2

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

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

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