

## AX1509

### 150KHz, 2A PWM Buck DC/DC Converter

#### Description

The AX1509 is Monolithic IC that design for a step-down DC/DC Converter, and own the ability of driving a 2A load without additional transistor component. The output version included 3.3V, 5V, 12V and an adjustable type. It operates at a switching frequency of 150KHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. Other features include a guaranteed  $\pm 4\%$  tolerance on output voltage under specified input voltage and output load conditions, and  $\pm 15\%$  on the oscillator frequency. Regarding protected function, thermal shutdown is to prevent over temperature operating from damage, and current limit is against over current operating of the output switch.

#### Features

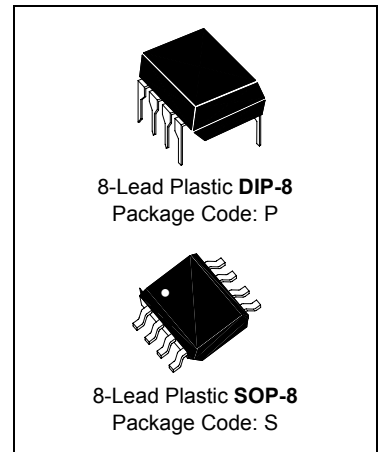
- 3.3V, 5V, 12V and adjustable
- Adjustable version output voltage range: 1.25-18V
- $\pm 4\%$  max over line and load conditions
- 150KHz  $\pm 15\%$  fixed switching frequency
- TTL shutdown capability
- Operating voltage can be up to 22V
- Output load current: 2A
- SOP-8 and DIP-8 packages
- Low power standby mode
- Thermal-shutdown and current-limit protection
- High efficiency
- Built-in switching a transistor on chip, requires only 4 external components

#### Applications

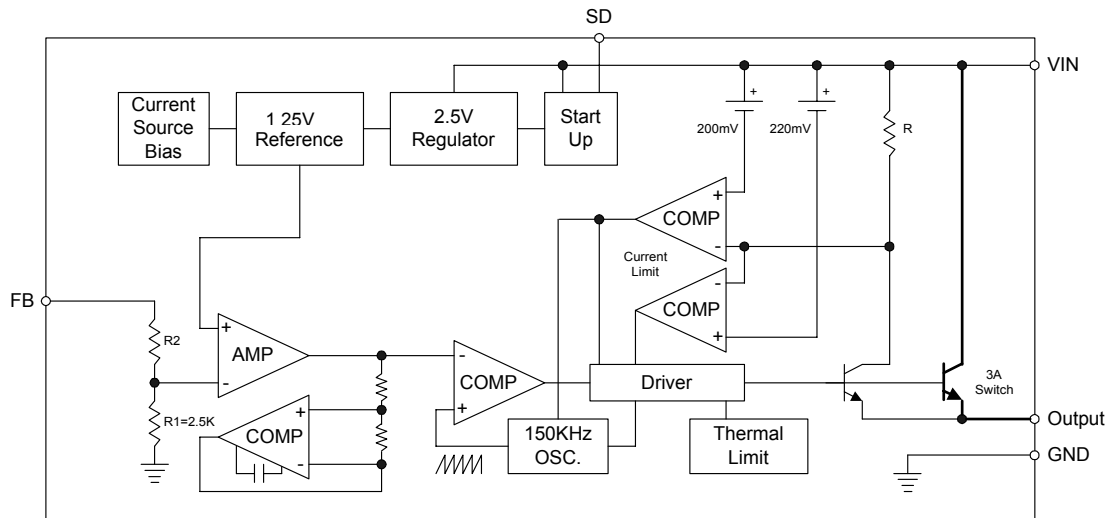
- Simple High-efficiency step-down regulator
- Positive to negative converter
- On-card switching regulators

#### Pin Connections

	Pin1: Operating Voltage Input	Pin5: Ground
	Pin2: Switch Output	Pin6: Ground
	Pin3: Output Voltage Feedback Control	Pin7: Ground
	Pin4: ON/OFF Shutdown	Pin8: Ground



## Pin Connections



## Absolute Maximum Rating (Note1)

Parameter	Symbol	Value	Unit
Supply Voltage	$V_{CC}$	+24	V
On/Off Pin Input Voltage	$V_{SD}$	-0.3~+18	V
Feedback Pin Voltage	$V_{FB}$	-0.3~+18	V
Output Voltage to Ground	$V_{OUT}$	-1	V
Power Dissipation	$P_D$	Internally Limited	W
Operating Temperature	$T_{opr}$	-40~+125	°C
Storage Temperature	$T_{stg}$	-65~+150	°C
Operating Voltage	$V_{OP}$	+4.5~+22	V

## Electrical Characteristics (Continued)

Specifications with **boldface type** apply over for full operating temperature range, the other type are for  $T_J=25^{\circ}C$  (Note 2)

Part No.	Parameter	Symbol	Conditions	Min.	Typ. (Note3)	Max. (Note4)	Unit
AX1509-3.3	Output Voltage	$V_{OUT}$	$4.75V \leq V_{IN} \leq 22V, 0.2A \leq I_{LOAD} \leq 2A$	3.168 <b>3.135</b>	3.3	3.342 <b>3.465</b>	V
	Efficiency	$\eta$	$V_{IN}=12V, I_{LOAD}=2A$	-	73	-	%
AX1509-5.0	Output Voltage	$V_{OUT}$	$7V \leq V_{IN} \leq 22V, 0.2A \leq I_{LOAD} \leq 2A$	4.800 <b>4.750</b>	5.0	5.200 <b>5.250</b>	V
	Efficiency	$\eta$	$V_{IN}=12V, I_{LOAD}=2A$	-	80	-	%
AX1509-12	Output Voltage	$V_{OUT}$	$15V \leq V_{IN} \leq 22V, 0.2A \leq I_{LOAD} \leq 2A$	11.52 <b>11.40</b>	12.0	12.48 <b>12.60</b>	V
	Efficiency	$\eta$	$V_{IN}=25V, I_{LOAD}=2A$	-	90	-	%
AX1509-ADJ	Output Voltage	$V_{OUT}$	$4.5V \leq V_{IN} \leq 22V, 0.2A \leq I_{LOAD} \leq 2A$ $V_{OUT}$ programmed for 3V	1.213 <b>1.200</b>	1.25	1.287 <b>1.300</b>	V
	Efficiency	$\eta$	$V_{IN}=12V, V_{OUT}=3V, I_{LOAD}=2A$	-	73	-	%

## All Output Voltage Versions Electrical Characteristics

Specifications with **boldface type** apply over for full operating temperature range, the other type are for  $T_J=25^{\circ}\text{C}$

(Unless otherwise specified,  $V_{IN}=12\text{V}$  for the 3.3V, 5V, and adjustable version and  $V_{IN}=18\text{V}$  for the 12V version,  $I_{LOAD}=500\text{mA}$ )

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit	
<b>Device Parameters</b>							
Feedback Bias Current	$I_b$	Adjustable Version Only, $V_{FB}=1.3\text{V}$	-	-10	-50 <b>-100</b>	nA	
Oscillator Frequency	$f_O$	(Note 5)	120 <b>110</b>	150	173 <b>173</b>	KHz	
Saturation Voltage	$V_{SAT}$	$I_{OUT}=2\text{A}$ (Note 6,7)	-	1.3	1.4 <b>1.5</b>	V	
Max. Duty Cycle (ON) Min. Duty Cycle (OFF)	DC	(Note 7) (Note 8)	-	100 0	-	%	
Current Limit	$I_{CL}$	Peak Current (Note 6,7)	3.6	4.5	6.5 <b>7.5</b>	A	
Output Leakage Current	$I_L$	Output=0V (Note 6,8)	-	-	-50	$\mu\text{A}$	
Quiescent Current	$I_Q$	(Note 8)	-	5	10	mA	
Standby Quiescent Current	$I_{STBY}$	ON/OFF pin=5V (Note 9)	-	150	250 <b>300</b>	$\mu\text{A}$	
Thermal Resistance	$\theta_{JC}$	DIP-8	Junction to Case	-	14	-	$^{\circ}\text{C/W}$
		SOP-8		-	15	-	
	$\theta_{JA}$ (Note 10)	DIP-8	Junction to ambient	-	80	-	$^{\circ}\text{C/W}$
		SOP-8		-	70	-	
<b>ON/OFF Control</b>							
ON/OFF Pin Logic Input Threshold Voltage	$V_{IH}$	Low (Regulator ON)	-	1.3	0.6	V	
	$V_{IL}$	High (Regulator OFF)	2.0		-		
ON/OFF Pin Input Current	$I_{IH}$	$V_{LOGIC}=2.5\text{V}$ (Regulator OFF)	-	-5	-15	$\mu\text{A}$	
	$I_{IL}$	$V_{LOGIC}=0.5\text{V}$ (Regulator ON)	-	-0.02	-5		

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

Note 2: External components such as the catch diode, inductor, input and output capacitors, and voltage programming resistors can affect switching regulator system performance.

Note 3: Typical numbers are at  $25^{\circ}\text{C}$  and represent the most likely norm.

Note 4: All limits guaranteed at room temperature (standard type face) and at temperature extremes (bold type face). All room temperature limits are 100% production tested. All limits at temperature extremes are guaranteed via correlation using standard Statistical Quality Control (SQC) methods. All limits are used to calculate Average Outgoing Quality Level (AOQL).

Note 5: The switching frequency is reduced when the second stage current limit is activated.

Note 6: No diode, inductor or capacitor connected to output pin.

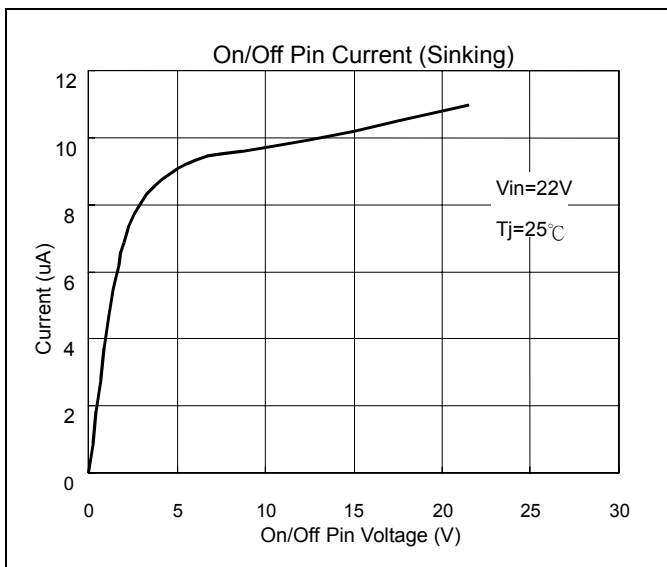
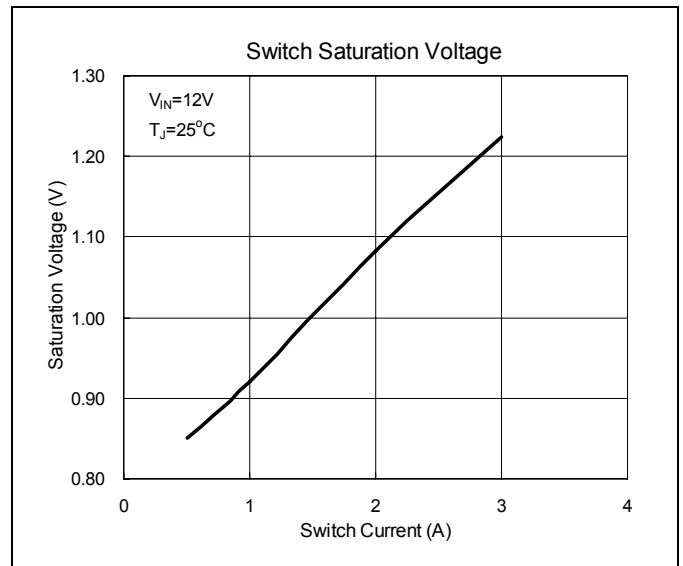
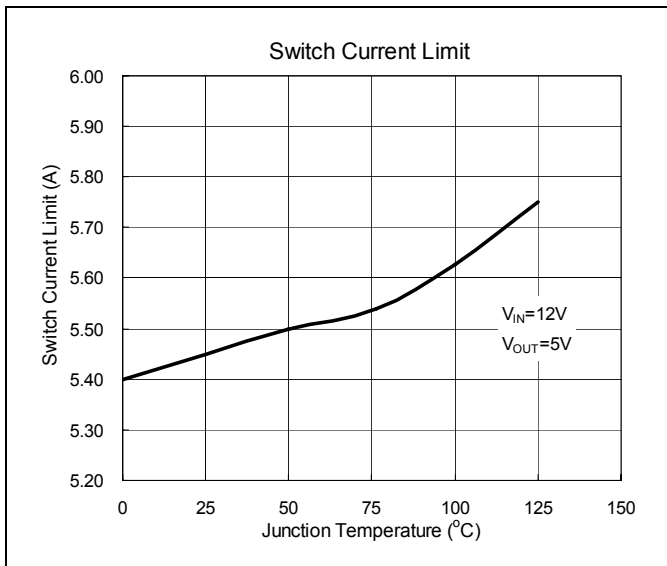
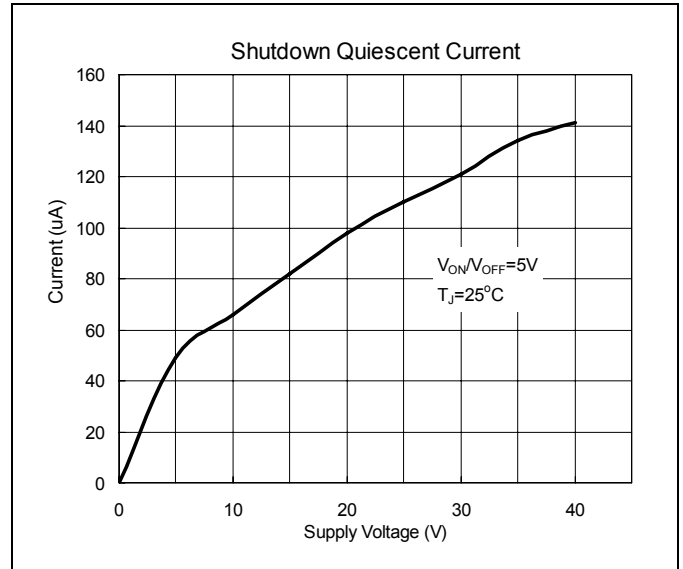
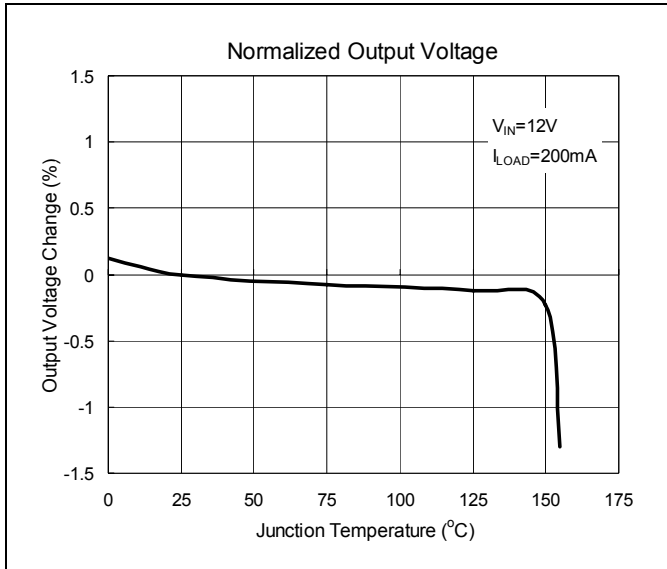
Note 7: Feedback pin removed from output and connected to 0V to force the output transistor switch ON.

Note 8: Feedback pin removed from output and connected to 12V for the 3.3V, 5V, ADJ. version, and 15V for the 12V version, to force the output transistor switch OFF.

Note 9:  $V_{IN}=22\text{V}$ .

Note 10: Junction to ambient thermal resistance. (With copper area of approximately  $3\text{in}^2$ )

## Characteristics Curve



## Typical Application Circuit

Fig.1 Fixed Type Circuit

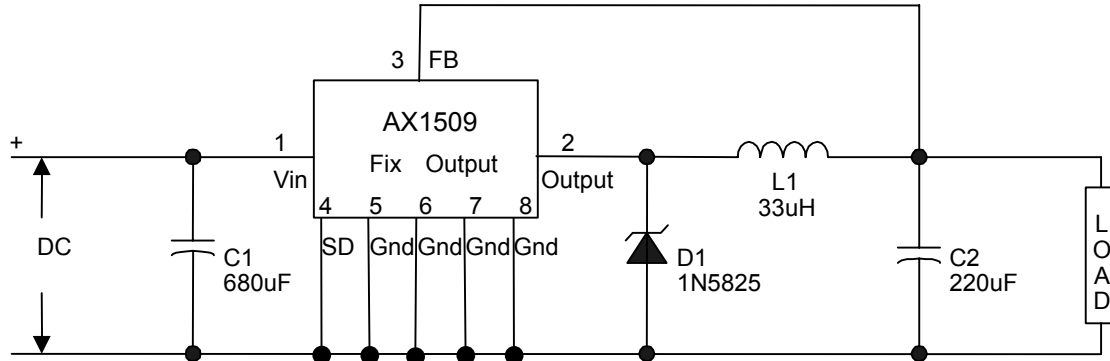
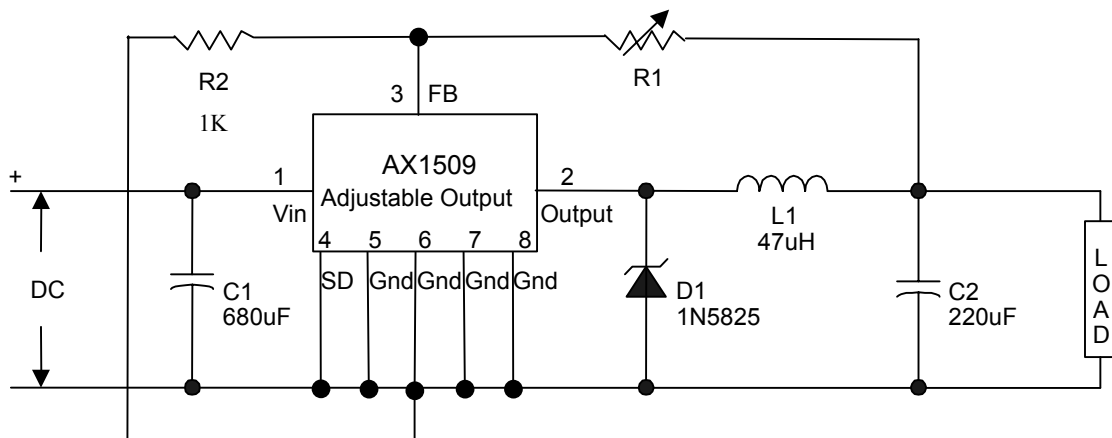
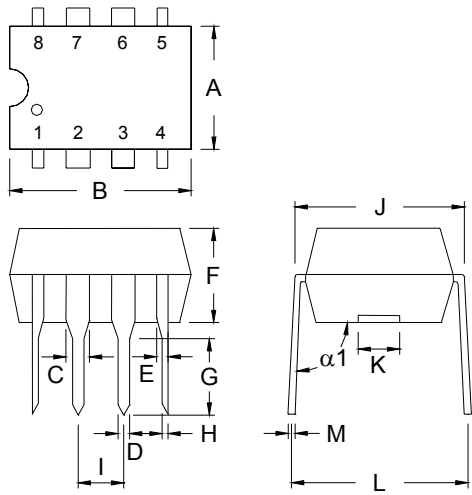


Fig.2 Adjustable Output Voltage Versions



## DIP-8 Dimension



8-Lead DIP-8  
Plastic Package  
Package Code: P

**Marking:**

Pb Free Mark  
Pb-Free: "♦" (000)  
Normal: None

Product Series  
ADJ,3,3,5,0,12

Date Code

Control Code

Note: Green label is used for pb-free packing

Pin Style: 1.Vin 2.Output 3.FB 4.SD  
5.Gnd 6.Gnd 7.Gnd 8.Gnd

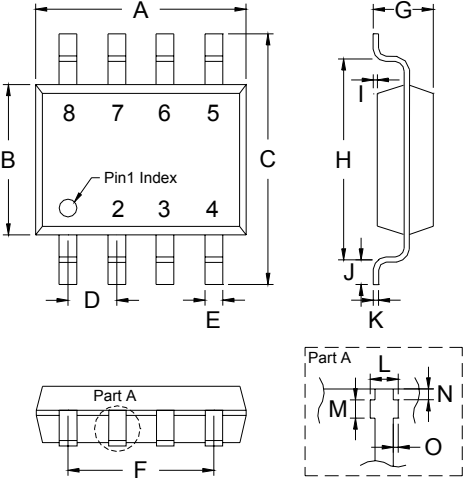
Material:  

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	6.29	6.40
B	9.22	9.32
C	-	*1.52
D	-	*1.27
E	-	*0.99
F	3.25	3.35
G	3.17	3.55
H	0.38	0.53
I	2.28	2.79
J	7.49	7.74
K	-	*3.00
L	8.56	8.81
M	0.229	0.381
$\alpha 1$	94°	97°

\*: Typical, Unit: mm

## SOP-8 Dimension



8-Lead SO-8 Plastic  
Surface Mounted Package  
Package Code: S

**Marking:**

Pb Free Mark  
Pb-Free: "♦" (000)  
Normal: None

Product Series  
ADJ,3,3,5,0,12

Pin 1 Index

Date Code

Control Code

Note: Green label is used for pb-free packing

Pin Style: 1.Vin 2.Output 3.FB 4.SD  
5.Gnd 6.Gnd 7.Gnd 8.Gnd

Material:  

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	4.85	5.10
B	3.85	3.95
C	5.80	6.20
D	1.22	1.32
E	0.37	0.47
F	3.74	3.88
G	1.45	1.65
H	4.80	5.10
I	0.05	0.20
J	0.30	0.70
K	0.19	0.25
L	0.37	0.52
M	0.23	0.28
N	0.08	0.13
O	0.00	0.15

\*: Typical, Unit: mm

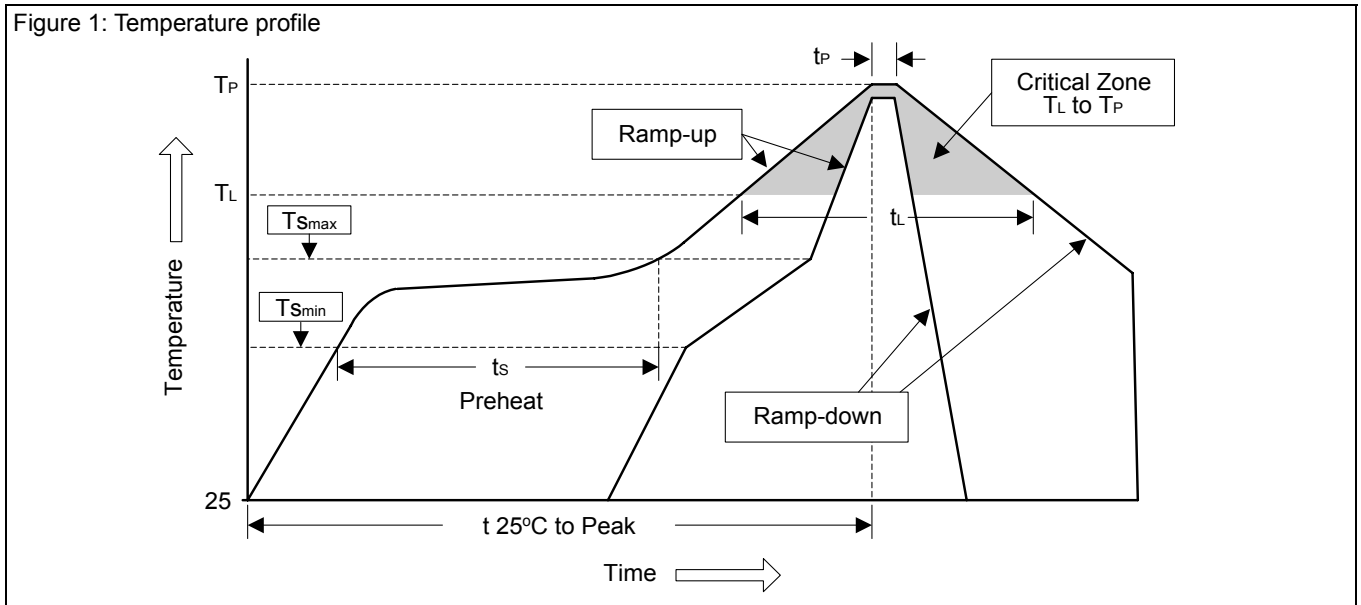
## Ordering Information

Part Number	Package	Part Number	Package
AX1509S-ADJ	SOP-8	AX1509P-ADJ	DIP-8
AX1509S-3.3	SOP-8	AX1509P-3.3	DIP-8
AX1509S-5.0	SOP-8	AX1509P-5.0	DIP-8
AX1509S-12	SOP-8	AX1509P-12	DIP-8

## Soldering Methods for Orister's Products

1. Storage environment: Temperature=10°C~35°C Humidity=65%±15%
2. Reflow soldering of surface-mount devices

Figure 1: Temperature profile



Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	<3°C/sec	<3°C/sec
Preheat		
- Temperature Min ( $T_{Smin}$ )	100°C	150°C
- Temperature Max ( $T_{Smax}$ )	150°C	200°C
- Time (min to max) ( $t_s$ )	60~120 sec	60~180 sec
$T_{Smax}$ to $T_L$		
- Ramp-up Rate	<3°C/sec	<3°C/sec
Time maintained above:		
- Temperature ( $T_L$ )	183°C	217°C
- Time ( $t_L$ )	60~150 sec	60~150 sec
Peak Temperature ( $T_P$ )	240°C +0/-5°C	260°C +0/-5°C
Time within 5°C of actual Peak Temperature ( $t_P$ )	10~30 sec	20~40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<8 minutes

3. Flow (wave) soldering (solder dipping)

Products	Peak temperature	Dipping time
Pb devices.	245°C ±5°C	5sec ±1sec
Pb-Free devices.	260°C +0/-5°C	5sec ±1sec

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