

CMOS Current-Mode PWM Voltage Controller

Features

- Ultralow start-up current (25 μ A typical)
- Low operating current (2mA typical)
- Fast output rise/fall times :
–15ns rise/10ns fall
- High output drive (1.2A peak current)
- CMOS outputs with rail-to-rail swing
- Current-mode operation up to 1MHz
- Trimmed 5V bandgap reference
- Pin-to-pin compatible with MIC38HC4X
- Trimmed oscillator discharge current
- UVLO with hysteresis
- Low cross-conduction currents

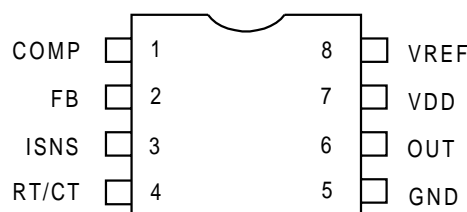
General Description

The APW38HC4XA family are fixed frequency, high performance, current-mode PWM controller with 1.2 A drive current capability. Undervoltage lockout circuitry allows the APW38HC42A and APW38HC44A versions to start up at 14.5V and operate down to 9V, and the APW38HC43A and APW38HC45A versions start at 8.4V with operation down to 7.6V. All versions operate up to 24V. The ultra low start-up current 25 μ A (typical), and operating current 2mA (typical) have been designed to improve the converter efficiency. High output driving capability up to 1.2A ensures the fast switching to minimize the switching losses. The APW38HC4XA features a trimmed and temperature compensated oscillator discharge current and bandgap reference. APW38HC4XA is available in both 8-pin plastic DIP and SOP packages.

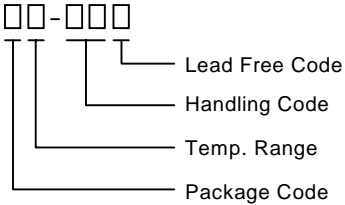
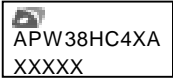
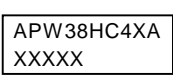
Applications

- Current-mode , Off-line , Switched-mode Power Supplies
- Current-mode , DC-to-DC converters
- Various converters (step-down, step-up, flyback , forward, and synchronous FET)

Pin Description



Ordering and Marking Information

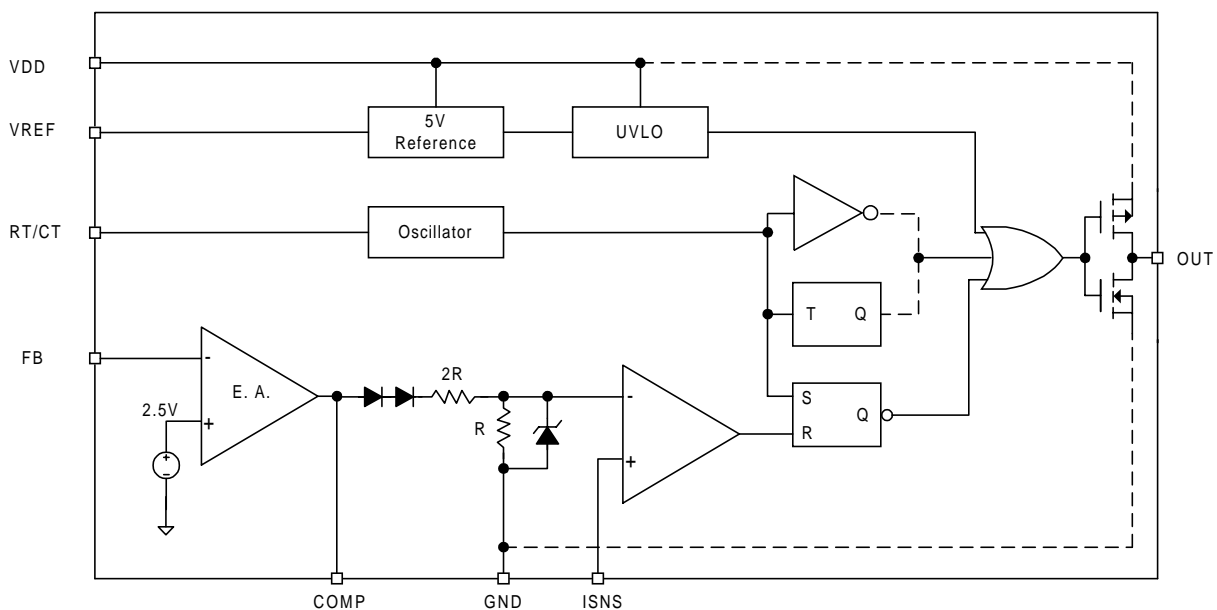
<p>APW38HC4XA</p> 	<p>Package Code J : DIP - 8 K : SOP-8 Temp. Range C : 0 to 70 °C I : -40 to 85 °C Handling Code TU : Tube TR : Tape & Reel Lead Free Code L : Lead Free Device Blank : Original Device</p>
<p>APW384XA J :</p> 	<p>X - 2/3/4/5 XXXXX - Date Code</p>
<p>APW384XA K :</p> 	<p>X - 2/3/4/5 XXXXX - Date Code</p>

customers to obtain the latest version of relevant information to verify before placing orders.

Selection Guide

Duty Cycle	Startup 8.4V Minimum Operating 7.6V	Startup 14.5V Minimum Operating 9V
0~96%	APW38HC43A	APW38HC42A
0~50%	APW38HC45A	APW38HC44A

Block Diagram



Functional Pin Description

Pin Name	Pin Number	Function Description
1	COMP	Compensation: Connect external compensation network to modify the error amplifier output.
2	FB	Feedback (Input): Error amplifier input. Feedback is 2.5V at desired output voltage.
3	ISNS	Current Sense (Input): Current sense comparator input. Connect to current sensing resistor or current transformer.
4	RT/CT	Timing Resistor/Timing Capacitor: Connect external RC network to select switching frequency.
5	GND	Ground: Combined analog and power ground.
6	OUT	Power Output: Totem-pole output.
7	VDD	Analog Supply (Input): Controller circuitry supply input. Return to analog ground (AGND).
8	VREF	5V Reference (Output): Connect external RC network.

Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{DD}	Supply Voltage	24	V
V_{ISNS}	Current Sense Voltage	-0.3 to 5.5	V
V_{FB}	Feedback Voltage	-0.3 to 5.5	V
T_J	Junction Temperature Range	300	°C
T_{STG}	Storage Temperature	-65 to 150	°C
T_{SDR}	Soldering Temperature	300,10 Seconds	°C
V_{ESD}	Minimum ESD Rating	±3	kV

Thermal Characteristics

Symbol	Parameter	Value	Unit
θ_{JA}	Thermal Resistance in Free Air DIP SOP	125 175	°C/W

Electrical Characteristics

$V_{DD} = 15V$, Note3 ; $RT=9.09K\Omega$; $CT=3.3nF$; $-40^{\circ}C \leq T_A \leq 85^{\circ}C$; unless noted

Symbol	Parameter	Test Conditions	APW38HC4XA			Unit
			Min.	Typ.	Max.	
REFERENCE VOLTAGE						
V _{REF}	Reference Voltage	T _A =25°C, I _o (Output Current)=1mA	4.90	5.00	5.10	V
REG _{line}	Line Regulation	12V ≤ V _{DD} ≤ 18V, I _o =5μA		1	20	mV
REG _{load}	Load Regulation	1mA ≤ I _o ≤ 20mA		6	25	mV
	Temp. Stability			0.2		mV/°C
	Total Output Variation	Line, Load, Temp.	4.82		5.18	V
	Output Noise Voltage	10Hz ≤ f ≤ 10kHz, T _A = 25°C		50		μV
	Long Term Stability	T _A = 125°C, 1000 hrs		5	25	mV
I _{sc}	Output Short Circuit		-25	-55	-120	mA
OSCILLATOR						
F _{osc}	Initial Accuracy	T _A =25°C, Note 4	49	52	55	kHz
	Voltage Stability	12V ≤ V _{DD} ≤ 18V		0.2	1.0	%
	Temp. Stability	T _{MIN} ≤ T _A ≤ T _{MAX}		0.03		%/°C
I _{DISCHG}	Clock Ramp Reset Current	T _A =25°C, V _{RT/CT} =2V	7.7	8.4	9.0	mA
		T _A =T _{MIN} to T _{MAX}	7.2	8.4	9.5	
V _{osc}	Amplitude	V _{RT/CT} peak to peak		1.6		V _{P-P}
ERROR AMPLIFIER						
	Input Voltage	V _{COMP} =2.5V	2.42	2.50	2.58	V

Electrical Characteristics (Cont.)

V_{DD} =15V, Note3 ; RT=9.09KΩ; CT=3.3nF; -40°C ≤ T_A ≤ 85°C; unless noted

Symbol	Parameter	Test Conditions	APW38HC4XA			Unit
			Min.	Typ.	Max.	
ERROR AMPLIFIER						
I _{FB}	Input Bias Current	V _{FB} =5V			0.1	μA
A _{VOL}	Open Loop Gain	2≤ V _O ≤ 4V	60	70		dB
BW	Unity Gain Bandwidth		0.7	1.0		MHz
	PSRR	12≤ V _{DD} ≤ 18V	60			dB
	Output Sink Current	V _{FB} =2.7V, V _{COMP} =1.1V	2	7		mA
	Output Source Current	V _{FB} =2.3V, V _{COMP} =5V	-0.5	-1		mA
V _{OH}	Output Voltage (High)	V _{FB} =2.3V, R _L =15k to GND	5	5.4		V
V _{OL}	Output Voltage (Low)	V _{FB} =2.7V, R _L =15k to V _{REF}		0.01	1.1	V
CURRENT SENSE						
A	Gain	Notes 1,2	2.85	3.0	3.15	V/V
V _{THM}	Maximum Threshold	V _{COMP} =5V, Note 1	0.9	1.0	1.1	V
	PSRR	12≤ V _{DD} ≤ 18V, Note 1		70		dB
I _{ISNS}	Input Bias Current	V _{ISNS} =5V			0.1	μA
T _D	Delay to Output			120	250	ns
OUTPUT						
	R _{DS(ON)} High	Sourcing Current = 200mA		6.3		Ω
	R _{DS(ON)} Low	Sinking Current = 200mA		4		
t _R	Rise Time	T _A =25°C, C _L =1nF		15	30	ns
t _F	Fall Time	T _A =25°C, C _L =1nF		10	20	ns
UNDERVOLTAGE LOCKOUT						
V _{DD(ST)}	Start Threshold	APW38HC42/4A	13.5	14.5	15.5	V
		APW38HC43/5A	7.8	8.4	9.0	
V _{DD(MIN)}	Minimum Operating Voltage	APW38HC42/4A	8.0	9.0	10.0	V
		APW38HC43/5A	7.0	7.6	8.2	
PULSE WIDTH MODULATOR						
D _{MAX}	Maximum Duty Cycle	APW38HC42/3A	94	96		%
		APW38HC44/5A	46	50		
D _{MIN}	Minimum Duty Cycle				0	%
TOTAL STANDBY CURRENT						
I _{DD(ST)}	Start-Up Current	V _{DD} =13V, APW38HC42/4A		30	150	μA
		V _{DD} =7.5V, APW38HC43/5A		25	150	
I _{DD(OP)}	Operating Supply Current	V _{FB} = V _{ISNS} = 0V, C _L =1nF		2.0	4.0	mA

Note 1 : Parameter measured at trip point of latch with V_{FB}=0V.

Note 2 : Gain defined as :

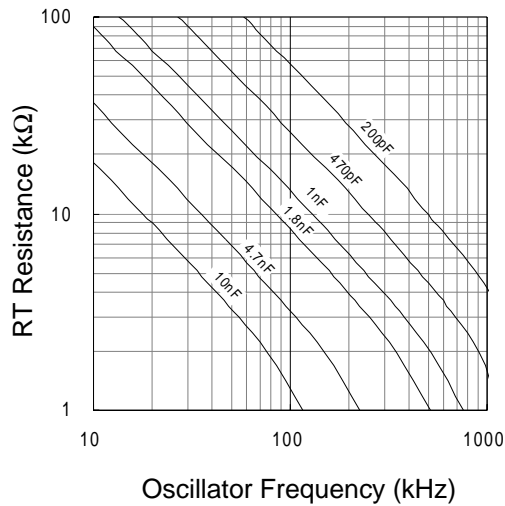
$$A = \frac{\Delta V_{COMP}}{\Delta V_{TH(ISNS)}}, 0 < V_{TH(ISNS)} < 0.8V$$

Note 3 : Adjust V_{DD} above the start threshold before setting at 15V.

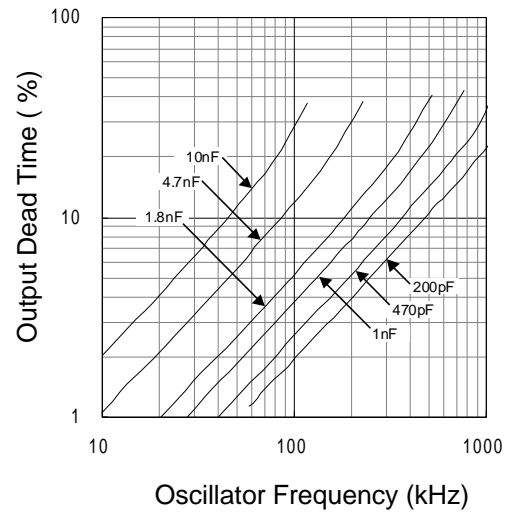
Note 4 : Output frequency equals oscillator frequency for the APW38HC42A and APW38HC43A. Output frequency for APW38HC44A and APW38HC45A equals one half of the oscillator frequency.

Typical Characteristics

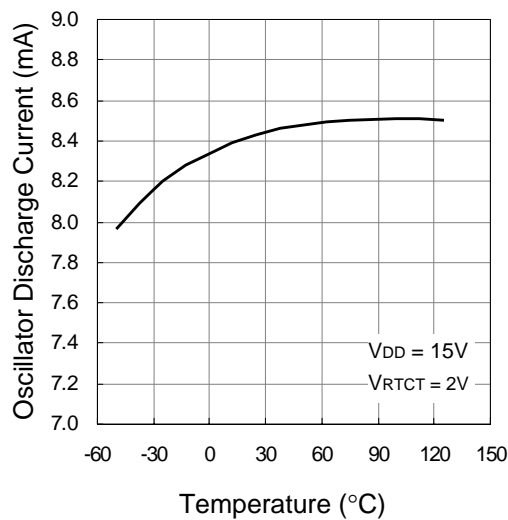
Oscillator Frequency Configuration



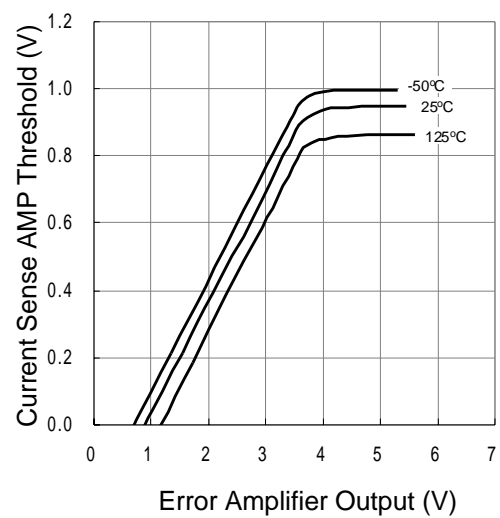
Output Dead Time vs. Oscillator Frequency



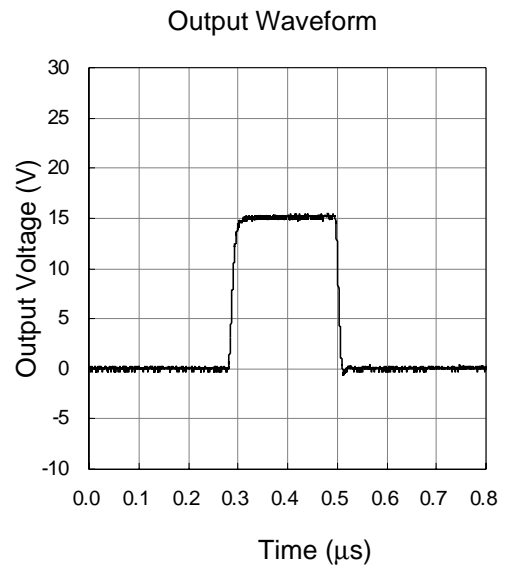
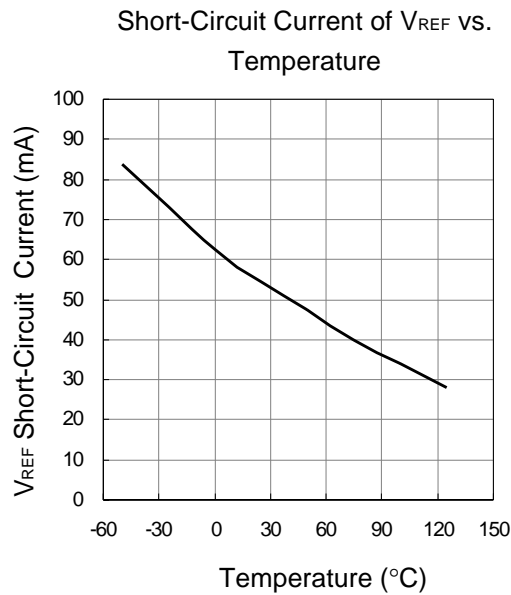
Oscillator Discharge Current vs. Temperature



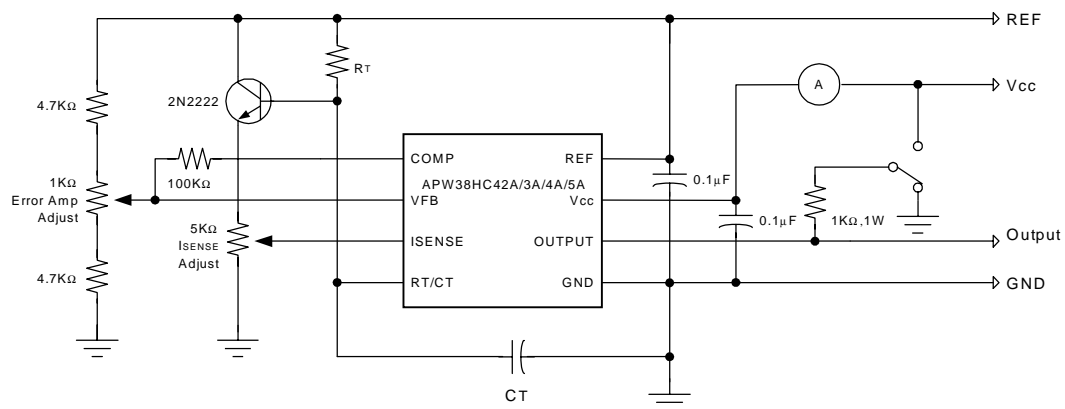
Current Sense Amplifier Threshold vs. Error Amplifier Output



Typical Characteristics (Cont.)

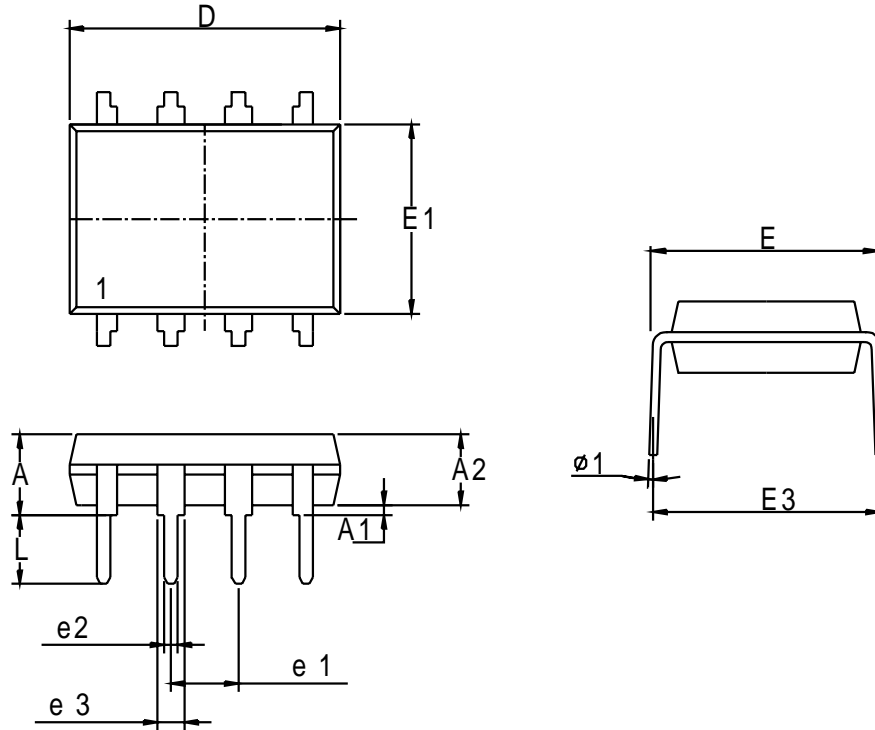


Open Loop test Circuit



Packaging Information

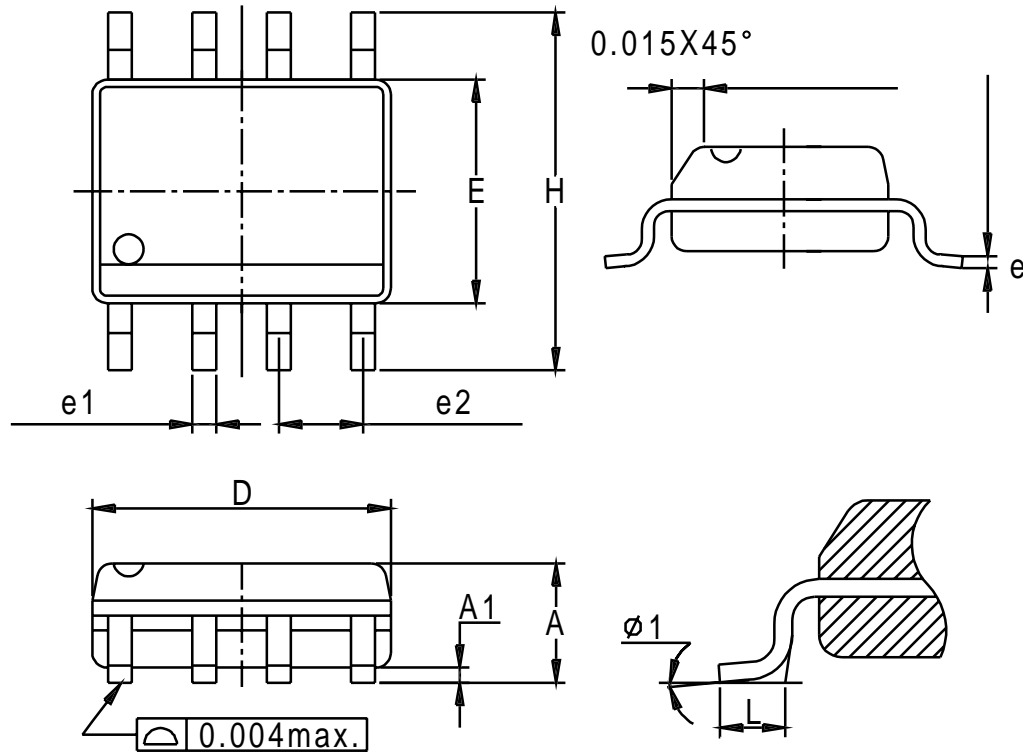
PDIP-8 pin (Reference JEDEC Registration MS-001)



Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A		5.33		0.210
A1	0.38		0.015	
A2	2.92	3.68	0.115	0.145
L	9.02	10.16	0.355	0.400
e1	2.54BSC		0.100BSC	
e2	0.36	0.56	0.014	0.022
e3	1.14	1.78	0.045	0.070
E	7.62 BSC 8.26		0.300 BSC 0.325	
E1	6.10	7.11	0.240	0.280
E3		10.92		0.430
L	2.92	3.81	0.115	0.150
$\phi 1$	0°	15°	0°	15°

Package Information

SOP- 8 pin (Reference JEDEC Registration MS-012)

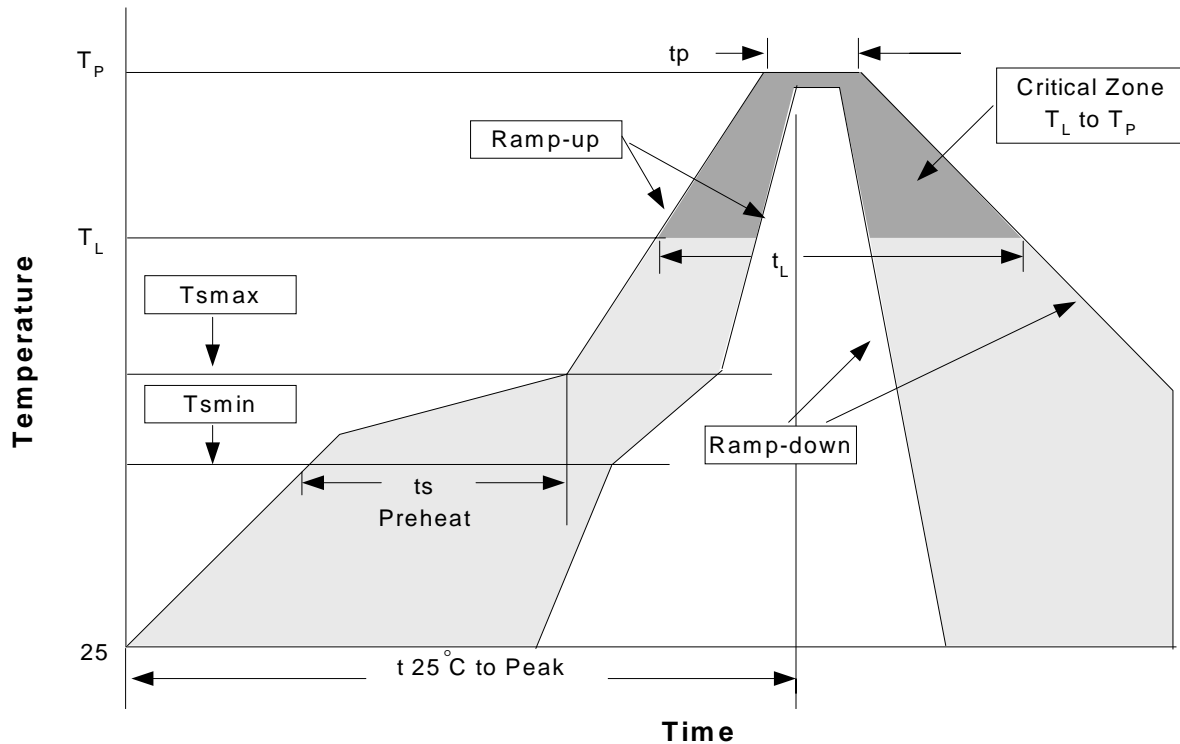


Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
D	4.80	5.00	0.189	0.197
E	3.80	4.00	0.150	0.157
H	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
e1	0.33	0.51	0.013	0.020
e2	1.27BSC		0.50BSC	
Ø1	8°		8°	

Physical Specifications

Terminal Material	Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb), 100%Sn
Lead Solderability	Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3.

Reflow Condition (IR/Convection or VPR Reflow)



Classificatin Reflow Profiles

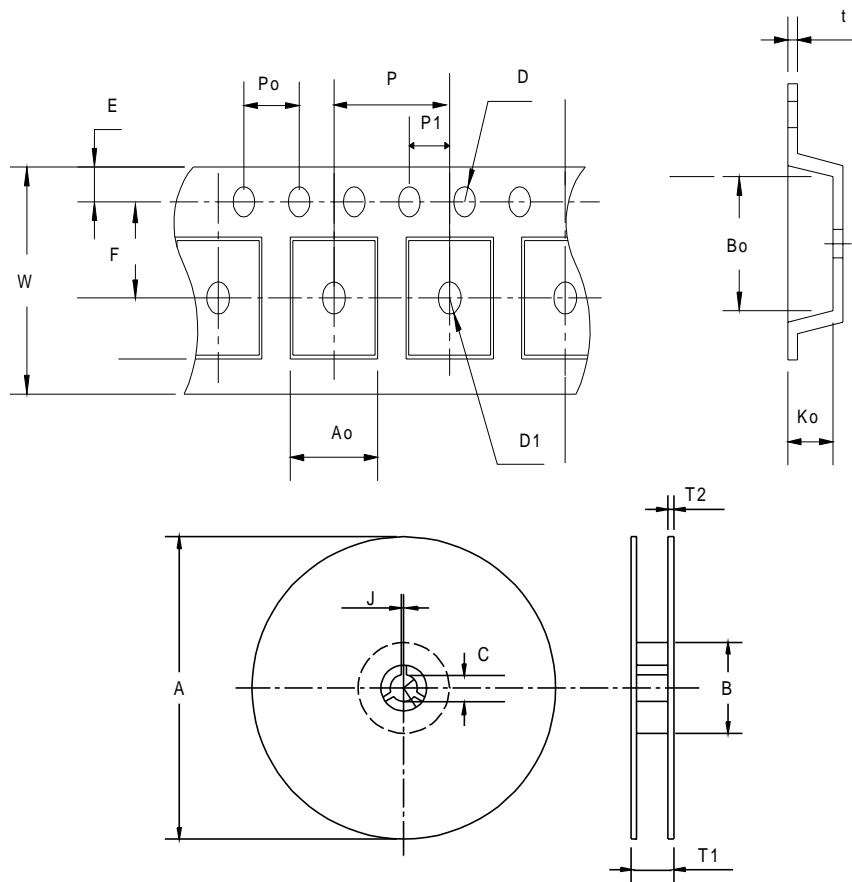
Profile Feature	Sn-Pb Eutectic Assembly		Pb-Free Assembly	
	Large Body	Small Body	Large Body	Small Body
Average ramp-up rate (T_L to T_P)	3°C/second max.		3°C/second max.	
Preheat				
- Temperature Min (T_{smin})	100°C		150°C	
- Temperature Mix (T_{smax})	150°C		200°C	
- Time (min to max)(t_s)	60-120 seconds		60-180 seconds	
T_{smax} to T_L			3°C/second max	
- Ramp-up Rate				
T_{smax} to T_L				
- Temperature(T_L)	183°C		217°C	
- Time (t_L)	60-150 seconds		60-150 seconds	
Peak Temperature(T_P)	225 +0/-5°C	240 +0/-5°C	245 +0/-5°C	250 +0/-5°C
Time within 5°C of actual Peak Temperature(t_p)	10-30 seconds	10-30 seconds	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max.		6°C/second max.	
Time 25°C to Peak Temperature	6 minutes max.		8 minutes max.	

Note: All temperatures refer to topside of the package. Measured on the body surface.

Reliability test program

Test item	Method	Description
SOLDERABILITY	MIL-STD-883D-2003	245°C , 5 SEC
HOLT	MIL-STD-883D-1005.7	1000 Hrs Bias @ 125 °C
PCT	JESD-22-B, A102	168 Hrs, 100 % RH , 121°C
TST	MIL-STD-883D-1011.9	-65°C ~ 150°C, 200 Cycles
ESD	MIL-STD-883D-3015.7	VHBM > 2KV, VMM > 200V
Latch-Up	JESD 78	10ms , $I_{tr} > 100mA$

Carrier Tape & Reel Dimensions



Application	A	B	C	J	T1	T2	W	P	E
SOP-8	330±1	62 ± 1.5	12.75 + 0.1 5	2 + 0.5	12.4 +0.2	2± 0.2	12 + 0.3 - 0.1	8± 0.1	1.75± 0.1
Application	F	D	D1	Po	P1	Ao	Bo	Ko	t
SOP-8	5.5 ± 0.1	1.55±0.1	1.5+ 0.25	4.0 ± 0.1	2.0 ± 0.1	6.4 ± 0.1	5.2± 0.1	2.1± 0.1	0.3±0.013

(mm)

Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOP- 8	12	9.3	2500

Customer Service

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