

## Over-Voltage Protection Load Switch

### FEATURES

- Integrated low  $R_{\text{dson}}$  nFET switch: typical 29m $\Omega$
- 4.5A continuous current capability
- Default Over-Voltage Protection (OVP) threshold
  - AW33801: 5.95V
  - AW33802: 6.2V
  - AW33805: 6.8V
  - AW33809: 9.98V
  - AW33812: 14V
- OVP threshold adjustable range: 4V to 20V
- Input maximum voltage rating: 35V<sub>DC</sub>
- Fast turn-off response: typical 90ns
- Over-Temperature Protection (OTP)
- Under-Voltage Lockout (UVLO)
- 1.245mm × 1.245mm WLCSP-9 package

### APPLICATIONS

- Smartphones
- Tablets
- Charging Ports

### GENERAL DESCRIPTION

The AW338XX features an ultra-low 29m $\Omega$  (typ.)  $R_{\text{dson}}$  nFET load switch. When input voltage exceeds the OVP threshold, the switch is turned off very fast to prevent damage to the protected downstream devices. The IN pin is capable of withstanding fault voltages up to 35V<sub>DC</sub>.

The default OVP threshold is 5.95V (AW33801), 6.2V (AW33802), 6.8V (AW33805), 9.98V (AW33809) and 14V (AW33812). The OVP threshold can be adjusted from 4V to 20V through external OVLO pin.

This device features over-temperature protection that prevents itself from thermal damaging.

The AW338XX is available in a RoHS compliant 9-bump 1.245mm × 1.245mm WLCSP.

### TYPICAL APPLICATION CIRCUIT

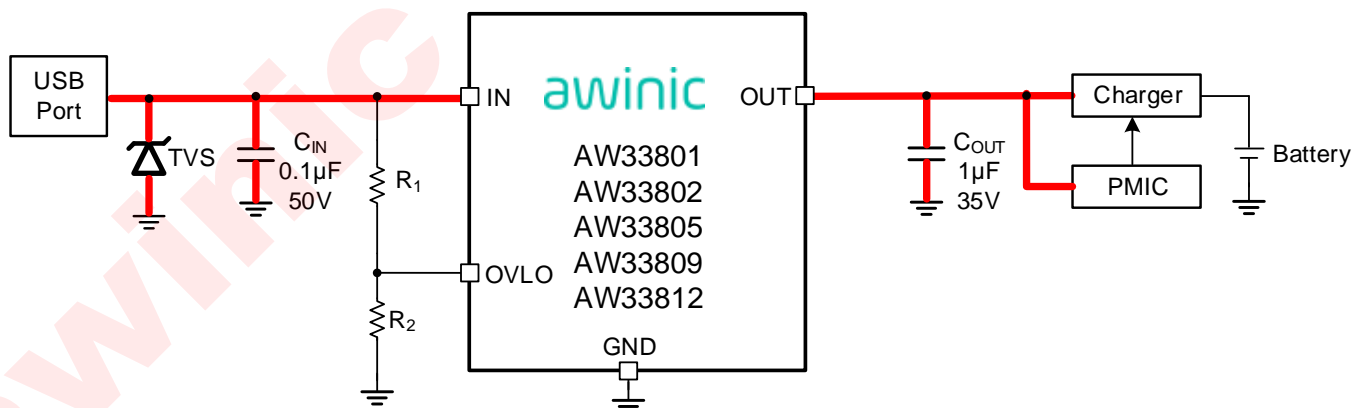


Figure 1 AW338XX typical application circuit

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## DEVICE COMPARISON TABLE

Device	$V_{IN\_OVLO}(V)$				$V_{IN\_OVLO}$ Hysteresis(mV)
	Condition	Min.	Typ.	Max.	
AW33801	$V_{IN}$ rising	5.83	5.95	6.07	100
AW33802	$V_{IN}$ rising	6.0	6.2	6.4	110
AW33805	$V_{IN}$ rising	6.66	6.80	6.94	150
AW33809	$V_{IN}$ rising	9.78	9.98	10.18	210
AW33812	$V_{IN}$ rising	13.7	14.0	14.3	300

## PIN CONFIGURATION AND TOP MARK

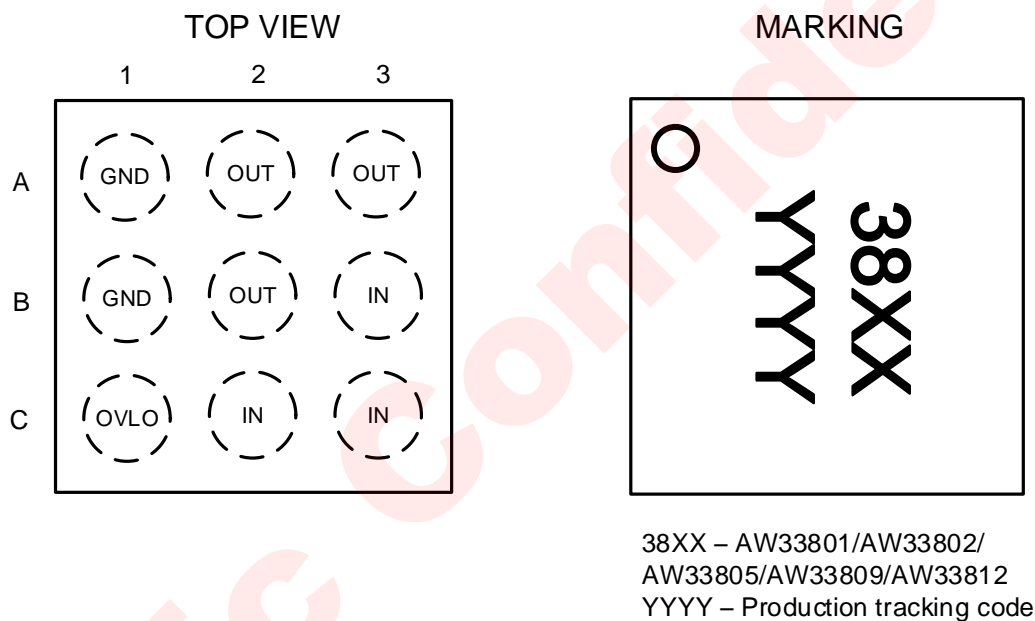


Figure 2 Pin Configuration and Top Mark

## PIN DEFINITION

Pin	Name	Description
B3,C2,C3	IN	Switch input and device power supply
A1,B1	GND	Device ground
C1	OVLO	OVP threshold adjustment pin
A2,A3,B2	OUT	Switch output

## FUNCTIONAL BLOCK DIAGRAM

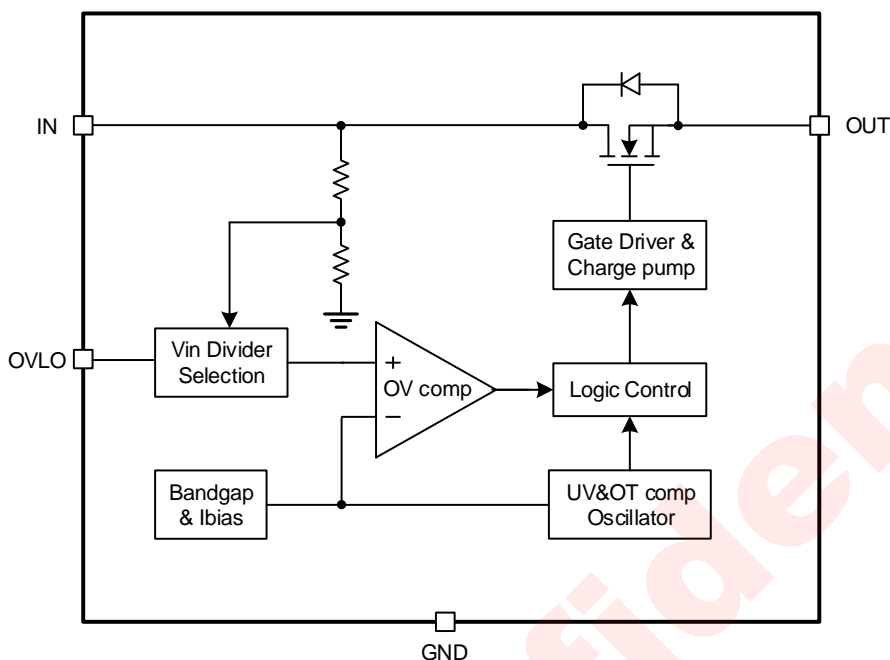


Figure 3 Functional Block Diagram

## TYPICAL APPLICATION CIRCUITS

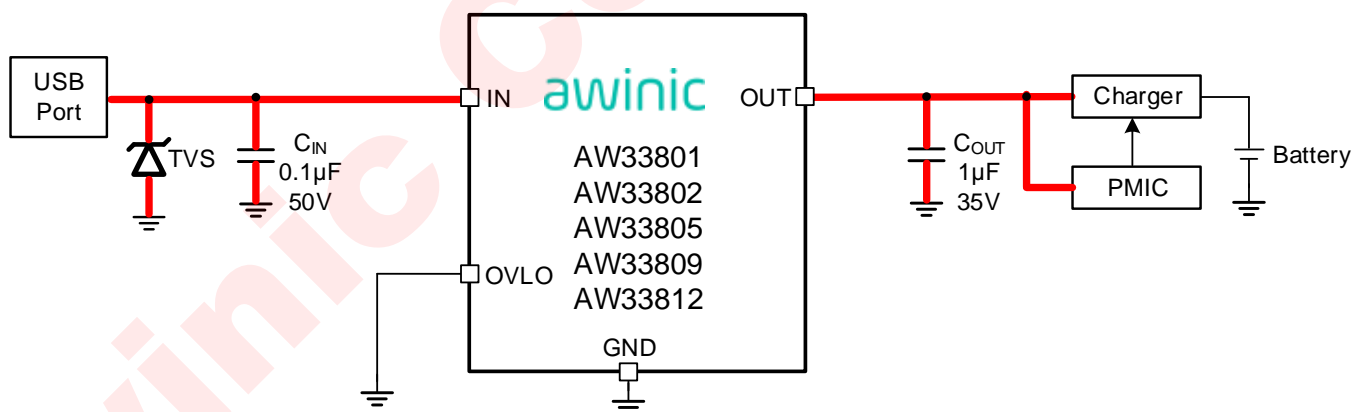


Figure 4 AW338XX typical application circuit(using default OVP threshold)

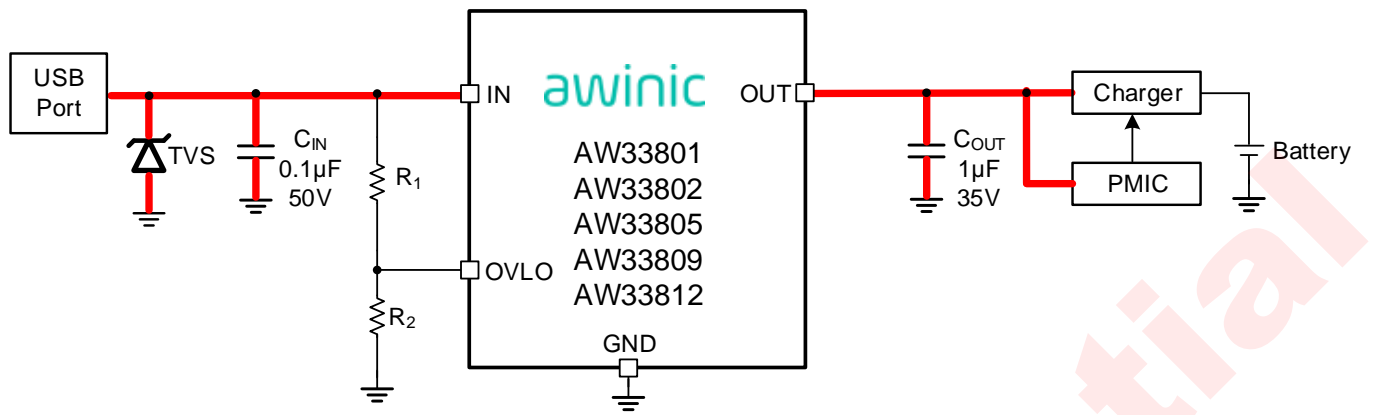
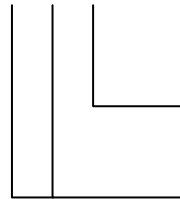


Figure 5 AW338XX typical application circuit(using external OVP threshold)

## ORDERING INFORMATION

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW33801CSR	-40°C – 85°C	1.245mm x 1.245mm x 0.597mm WLCSP-9	3801	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33802CSR	-40°C – 85°C	1.245mm x 1.245mm x 0.597mm WLCSP-9	3802	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33805CSR	-40°C – 85°C	1.245mm x 1.245mm x 0.597mm WLCSP-9	3805	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33809CSR	-40°C – 85°C	1.245mm x 1.245mm x 0.597mm WLCSP-9	3809	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33812CSR	-40°C – 85°C	1.245mm x 1.245mm x 0.597mm WLCSP-9	3812	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel

AW338XX □ □ □



Shipping  
R: Tape & Reel

Package Type  
CS: CSP

## ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Symbol	Parameter	Condition	Min.	Max.	Unit
V <sub>IN</sub>	Input DC voltage		-0.3	35	V
V <sub>IN_PUL</sub>	Input peak pulse voltage	20μs pulse width, repeat 100 times		45	V
V <sub>OUT</sub>	Output voltage		-0.3	See <sup>(NOTE 2)</sup>	V
V <sub>OVLO</sub>	OVLO voltage		-0.3	7	V
I <sub>IN</sub>	Switch current <sup>(NOTE 3)</sup>	Continuous current		4.5	A
T <sub>A</sub>	Ambient temperature		-40	85	°C
T <sub>J</sub>	Junction temperature		-40	150	°C
T <sub>STG</sub>	Storage temperature		-65	150	°C
T <sub>LEAD</sub>	Soldering temperature	At leads, 10 seconds		260	°C

NOTE1: Conditions out of those ranges listed in "absolute maximum ratings" may cause permanent damages to the device. In spite of the limits above, functional operation conditions of the device should within the ranges listed in "recommended operating conditions". Exposure to absolute-maximum-rated conditions for prolonged periods may affect device reliability.

NOTE2: 29V or V<sub>IN</sub>+0.3V, whichever is smaller.

NOTE3: Limited by thermal design.

## THERMAL INFORMATION

Symbol	Parameter	Condition	Value	Unit
R <sub>θJA</sub>	Thermal resistance from junction to ambient <sup>(NOTE 1)</sup>	In free air	85	°C/W

NOTE1: Thermal resistance from junction to ambient is highly dependent on PCB layout.

## ESD AND LATCH-UP RATINGS

Symbol	Parameter	Condition	Value	Unit
V <sub>ESD</sub>	Human Body Model	All pins, per MIL-STD-883J Method 3015.9	±3	kV
	Charged Device Model	All pins, per JEDEC EIA/JESD22-C101F	±2	kV
	Machine Model	All pins, per JEDEC EIA/JESD22-A115	±200	V
I <sub>Latch-up</sub>	Latch-up	All pins, per JEDEC STANDARD NO.78E SEPTEMBER 2016, I Trigger	±800	mA

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min.	Typ.	Max.	Unit
V <sub>IN</sub>	Input DC voltage	2.5		30	V
C <sub>IN</sub>	Input capacitance		0.1		μF
C <sub>OUT</sub>	Output load capacitance		1	100	μF

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## ELECTRICAL CHARACTERISTICS

T<sub>A</sub> = -40°C to 85°C unless otherwise noted. Typical values are guaranteed for V<sub>IN</sub> = 5V, C<sub>IN</sub> = 0.1μF, I<sub>IN</sub> ≤ 4.5A and T<sub>A</sub> = 25°C.

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units	
R <sub>dson</sub>	Switch on resistance	V <sub>IN</sub> = 5V, I <sub>OUT</sub> = 1A, T <sub>A</sub> = 25°C		29	39	mΩ	
I <sub>Q</sub>	Input quiescent current	V <sub>IN</sub> = 5V, V <sub>OVLO</sub> = 0V, I <sub>OUT</sub> = 0A		78	120	μA	
I <sub>IN_OVLO</sub>	Input current at over-voltage condition	V <sub>IN</sub> = 5V, V <sub>OVLO</sub> = 3V, V <sub>OUT</sub> = 0V		71	110	μA	
V <sub>OVLO_TH</sub>	OVLO set threshold	AW33801/AW33805/ AW33809/AW33812	1.16	1.20	1.24	V	
		AW33802	1.17	1.23	1.29		
V <sub>OVLO_RNG</sub>	OVP threshold adjustable range		4		20	V	
V <sub>OVLO_SEL</sub>	External OVLO select threshold	OVLO rising	0.19	0.26	0.33	V	
		Hysteresis		0.06			
I <sub>OVLO</sub>	OVLO pin leakage current	V <sub>OVLO</sub> = V <sub>OVLO_TH</sub>	-0.1		0.1	μA	
<b>Protection</b>							
V <sub>IN_OVLO</sub>	OVP trip level	AW33801	V <sub>IN</sub> rising	5.83	5.95	6.07	V
			Hysteresis		0.10		
		AW33802	V <sub>IN</sub> rising	6.0	6.2	6.4	
			Hysteresis		0.11		
		AW33805	V <sub>IN</sub> rising	6.66	6.80	6.94	
			Hysteresis		0.15		
		AW33809	V <sub>IN</sub> rising	9.78	9.98	10.18	
			Hysteresis		0.21		
		AW33812	V <sub>IN</sub> rising	13.7	14.0	14.3	
			Hysteresis		0.3		
V <sub>IN_UVLO</sub>	UVLO trip level	AW33801/ AW33805/ AW33809/ AW33812	V <sub>IN</sub> rising		2.2	2.4	V
			Hysteresis		0.08		
		AW33802	V <sub>IN</sub> rising		2.3	2.5	
			Hysteresis		0.13		
T <sub>SDN</sub>	Shutdown temperature	AW33801/AW33805/ AW33809/AW33812		150		°C	
		AW33802		140			
T <sub>SDN_HYS</sub>	Shutdown temperature hysteresis			20		°C	
<b>Timing Characteristics (Figure 6)</b>							
t <sub>DEB</sub>	Debounce time	From V <sub>IN</sub> > V <sub>IN_UVLO</sub> to 10% V <sub>OUT</sub>		15		ms	



Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
$t_{ON}$	Switch turn-on time	$R_L = 100\Omega, C_L = 22\mu F, V_{OUT}$ from 10% $V_{IN}$ to 90% $V_{IN}$		2		ms
$t_{OFF}$	Switch turn-off time	$R_L = 100\Omega, C_L = 0\mu F, V_{IN} >$ $V_{IN\_OVLO}$ to $V_{OUT}$ stop rising, $V_{IN}$ rise at $10V/\mu s$		90		ns

## TIMING DIAGRAM

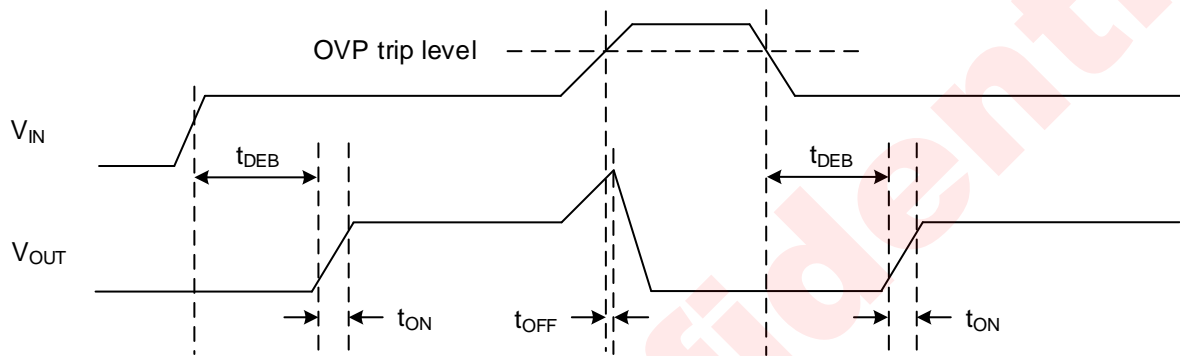


Figure 6 Timing diagram

## TYPICAL CHARACTERISTICS

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$V_{IN} = 5V$ ,  $V_{OVLO} = 0V$ ,  $C_{IN} = 0.1\mu F$ ,  $C_{OUT} = 1\mu F$ , and  $T_A = 25^\circ C$  unless otherwise specified.

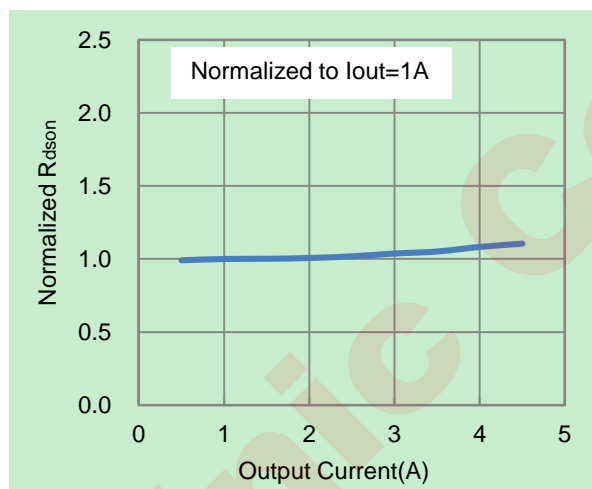


Figure 7 Normalized  $R_{ds(on)}$  vs. Output Current

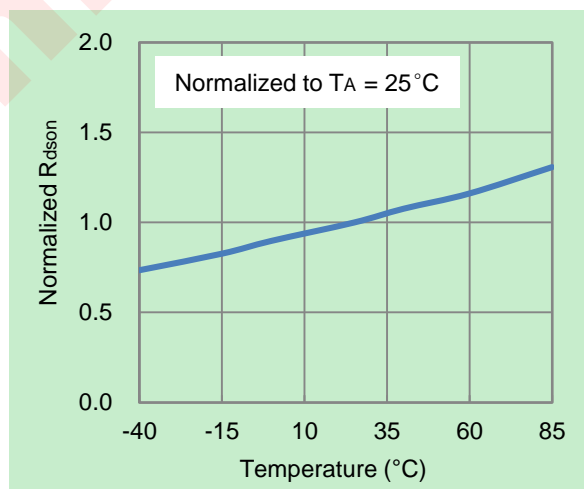


Figure 8 Normalized  $R_{ds(on)}$  vs. Temp. ( $I_{OUT} = 1A$ )

## TYPICAL CHARACTERISTICS (CONTINUED)

$V_{IN} = 5V$ ,  $V_{OVLO} = 0V$ ,  $C_{IN} = 0.1\mu F$ ,  $C_{OUT} = 1\mu F$ , and  $T_A = 25^\circ C$  unless otherwise specified.

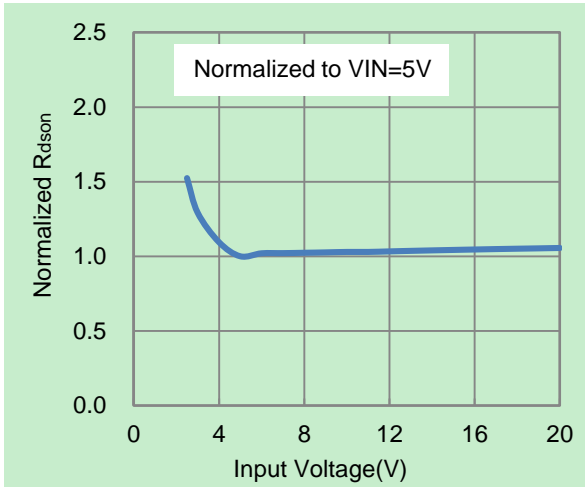


Figure 9 Normalized  $R_{ds(on)}$  vs. Input Voltage ( $I_{OUT} = 1A$ )

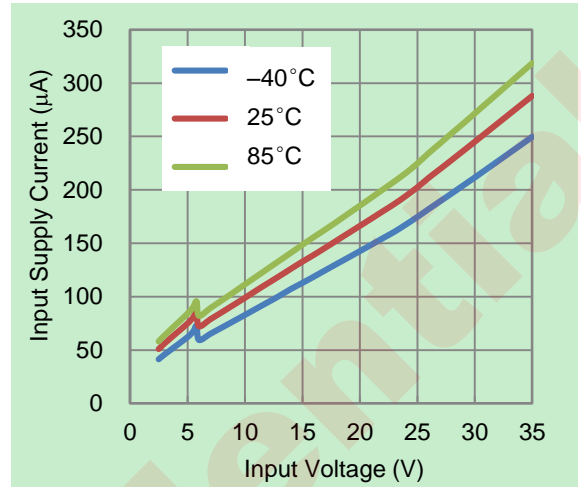


Figure 10 Input Supply Current vs. Supply Voltage

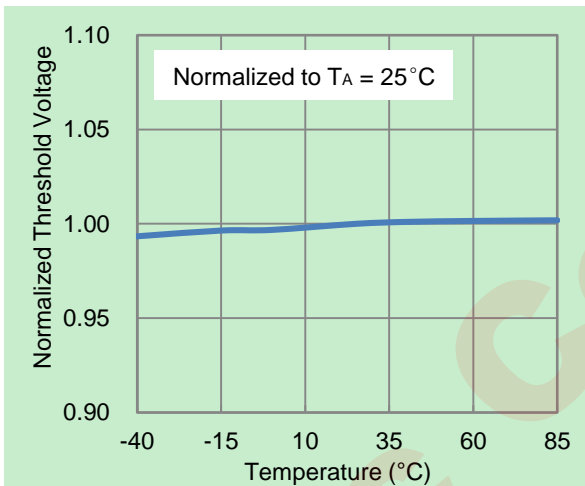


Figure 11 Normalized Internal OVP Threshold

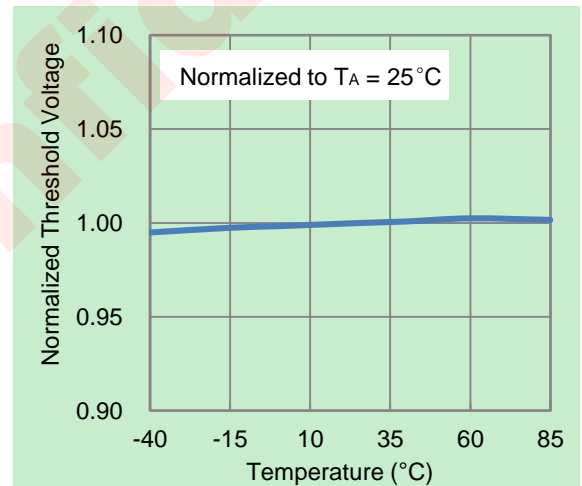


Figure 12 Normalized External OVP Threshold

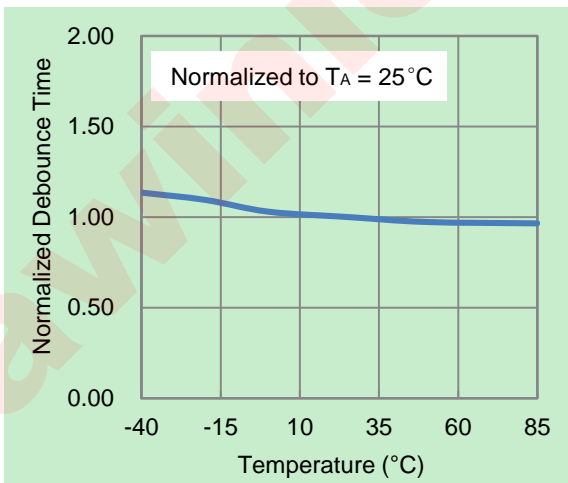


Figure 13 Normalized Debounce Time vs. Temp.

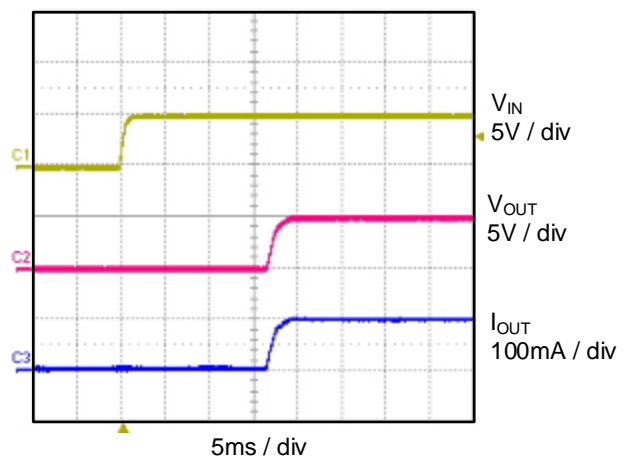
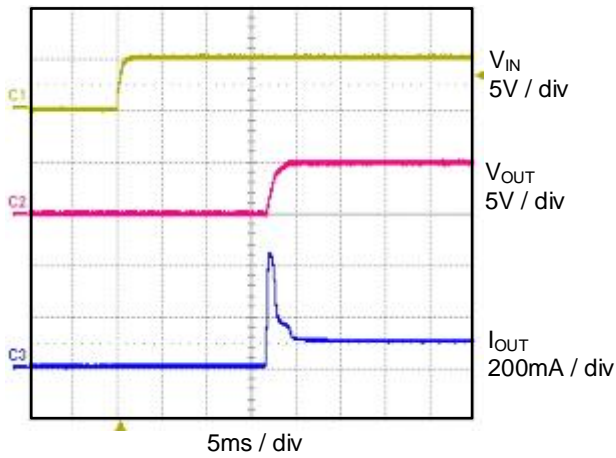


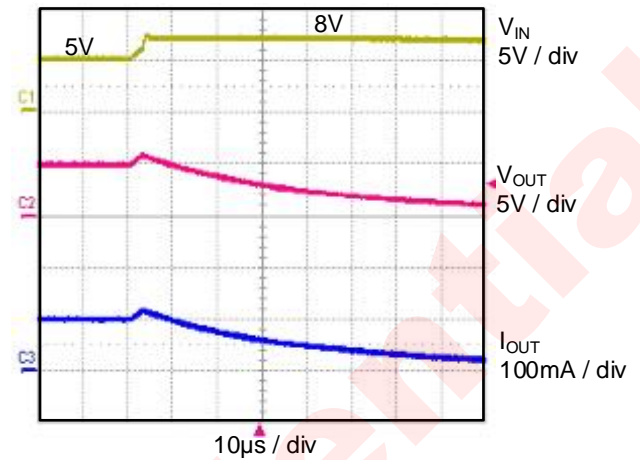
Figure 14 Power-up ( $C_{OUT} = 1\mu F$ , 100mA load)

## TYPICAL CHARACTERISTICS (CONTINUED)

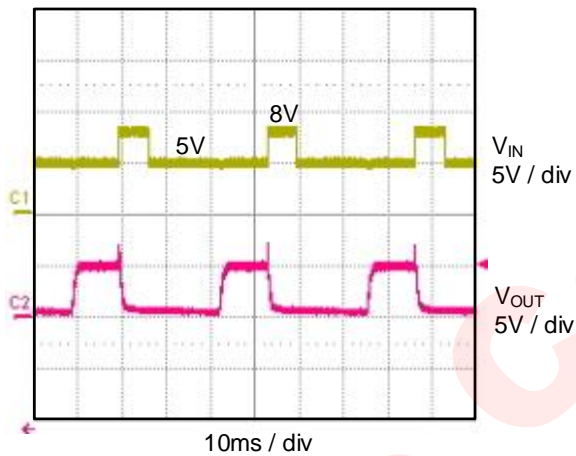
$V_{IN} = 5V$ ,  $V_{OVLO} = 0V$ ,  $C_{IN} = 0.1\mu F$ ,  $C_{OUT} = 1\mu F$ , and  $T_A = 25^\circ C$  unless otherwise specified.



**Figure 15** Power-up ( $C_{OUT} = 100\mu F$ , 100mA load)



**Figure 16** OVP Response (AW33801)



**Figure 17** Recovery from OVP(AW33801)

## FUNCTIONAL DESCRIPTION

### Device Operation

If the input voltage is between UVLO and OVP threshold, the internal charge pump begins to work after debounce time, the gate of the nFET switch will be slowly charged high till the switch is fully on. If the input voltage exceeds the OVP trip level, the switch will be turned off in about 90ns. If input voltage falls below UVLO threshold, or over-temperature happens, the switch will also be turned off.

### Over-Voltage Protection

If the input voltage exceeds the OVP rising trip level, the switch will be turned off in about 90ns. The switch will remain off until  $V_{IN}$  falls below the OVP falling trip level.

### OVP Threshold Adjustment

If OVLO pin is not grounded, and by connecting external resistor divider to OVLO pin as shown in the typical application circuit, between IN and GND, the OVP threshold can be adjusted as following:

$$V_{IN\_OVLO} = \frac{R_1 + R_2}{R_2} V_{OVLO\_TH}$$

The adjustment range is 4V to 20V. When the OVLO pin voltage  $V_{OVLO}$  exceeds  $V_{OVLO\_SEL}$  (0.26V typical),  $V_{OVLO}$  is compared with the reference voltage  $V_{OVLO\_TH}$  (1.20V typical for AW33801/AW33805/AW33809/AW33812, 1.23V typical for AW33802) to judge whether input supply is over-voltage. Take AW33801 for example, if we select  $R_1 = 51k\Omega$  and  $R_2 = 12.4k\Omega$ , then the new OVP threshold calculated from the above formula is 6.14V.

### USB On-The-Go (OTG) Operation

If  $V_{IN} = 0V$  and OUT is supplied by OTG voltage, the body diode of the load switch conducts current from OUT to IN and the voltage drop from OUT to IN is approximately 0.7V. When  $V_{IN} > V_{IN\_UVLO}$ , internal charge pump begins to open the load switch after debounce time. After switch is fully on, current is supplied through switch channel and the voltage drop from OUT to IN is minimum.

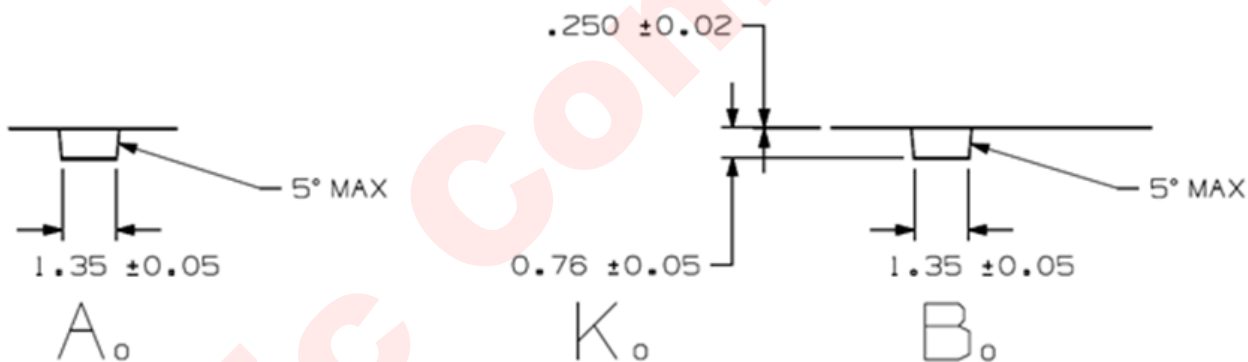
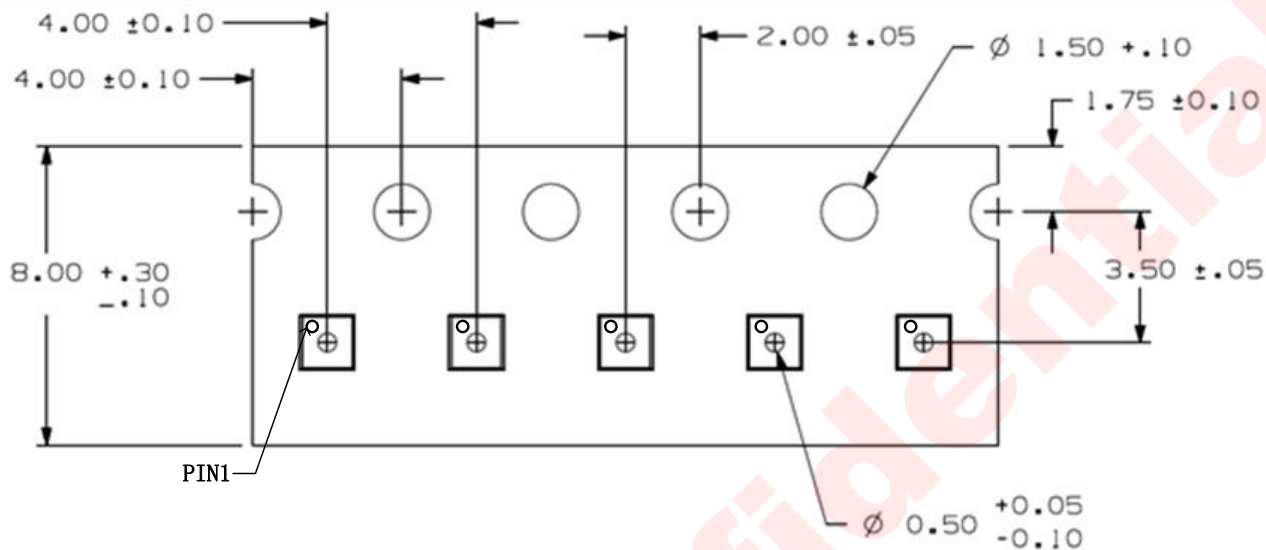
## PCB LAYOUT CONSIDERATION

To make fully use of the performance of AW338XX, the guidelines below should be followed.

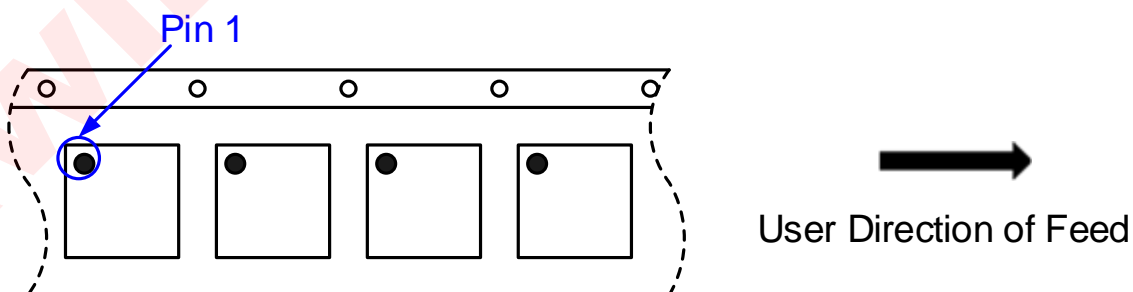
1. All the peripherals should be placed as close to the device as possible. Place the input capacitor  $C_{IN}$  on the top layer (same layer as the AW338XX) and close to IN pin, and place the output capacitor  $C_{OUT}$  on the top layer (same layer as the AW338XX) and close to OUT pin.
2. Route the power line (shown in Figure 1) as widely and shortly as possible to reduce parasitic impedance.

## TAPE AND REEL INFORMATION

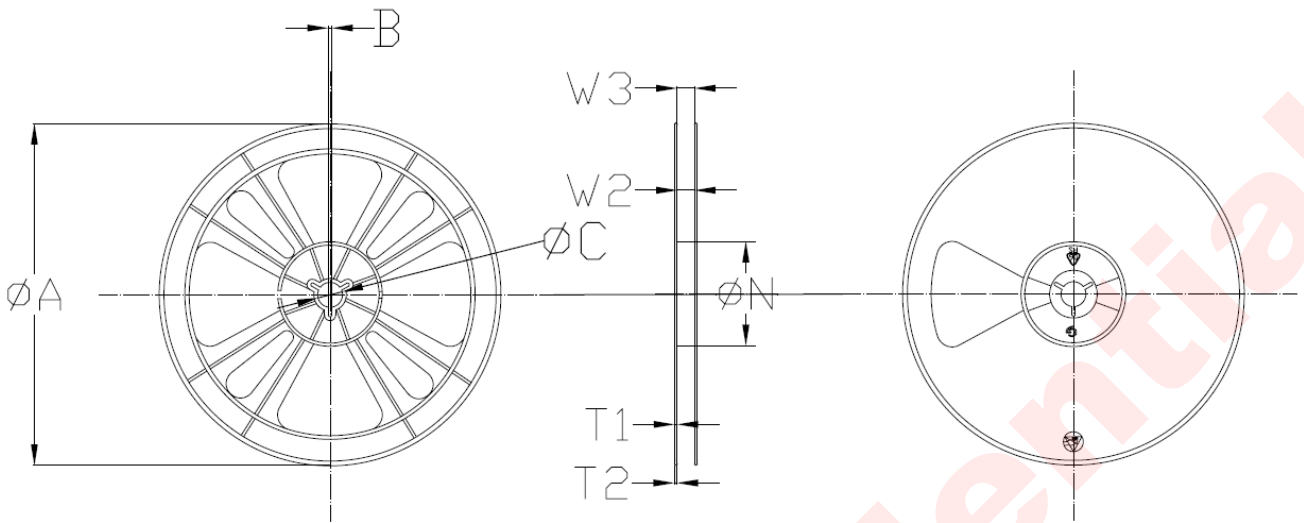
### CARRIER TAPE



### Pin 1 direction



REEL

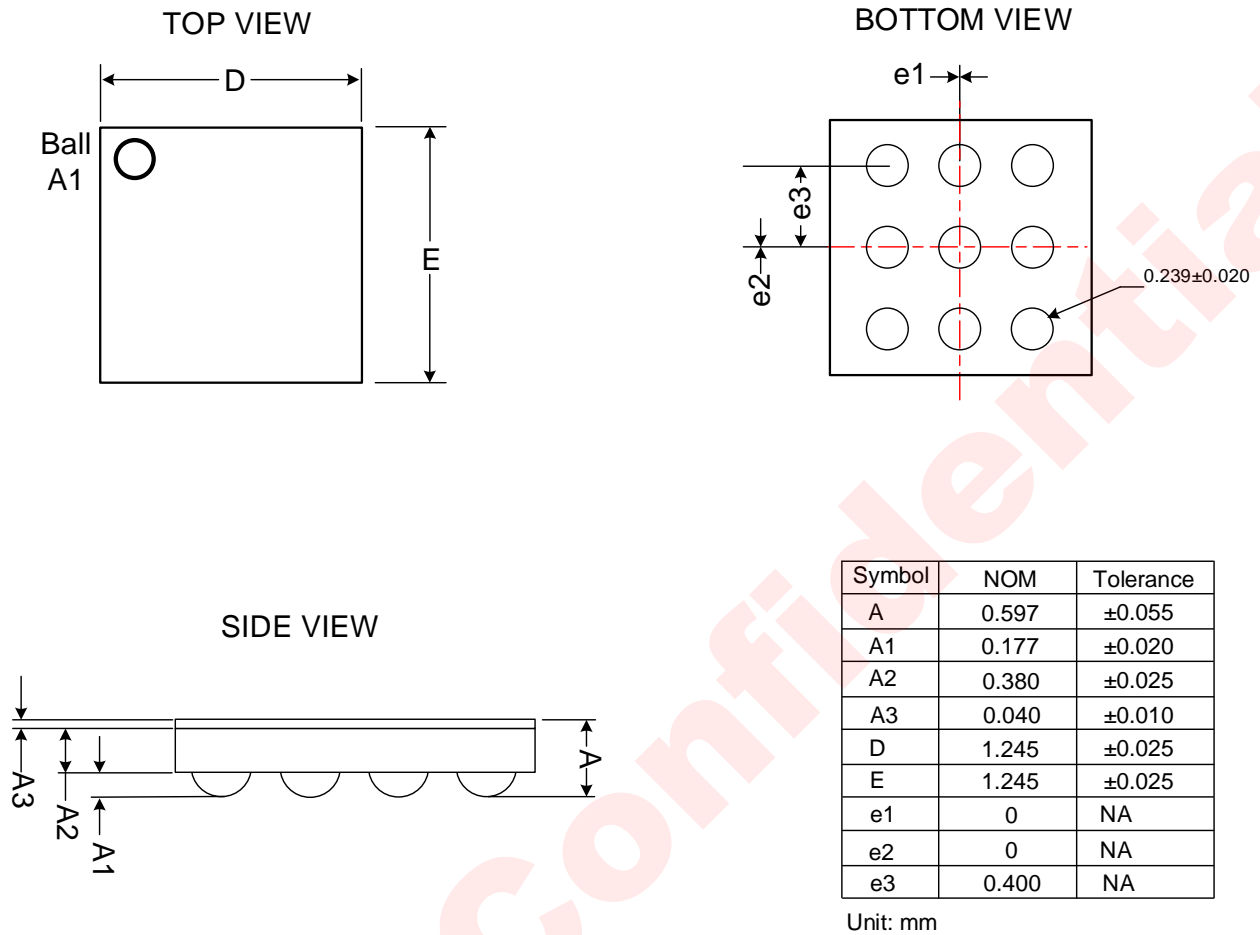


Item	Value&Tolerance
A	179±1.0
B	2.0±0.1
C	13.5±0.2
N	54.8±0.2
W2	9.0±0.2
W3	9.2±1.0
T1	1.2±0.2
T2	1.5±0.2

NOTE:

1. Unit: mm;
2. Surface resistivity:  $10^5$  to  $10^{11}$  ohms/sq;
3. Restriction criterion of hazardous substance for packing material follow GP-M001.

## PACKAGE DESCRIPTION



### NOTE:

1. AW338XX is compatible with the current **RoHS** requirements and adopts **Halogen-Free** assembly;
2. AW338XX is produced based on **MSL level-1** according to the JEDEC industry standard classification.



## REFLOW

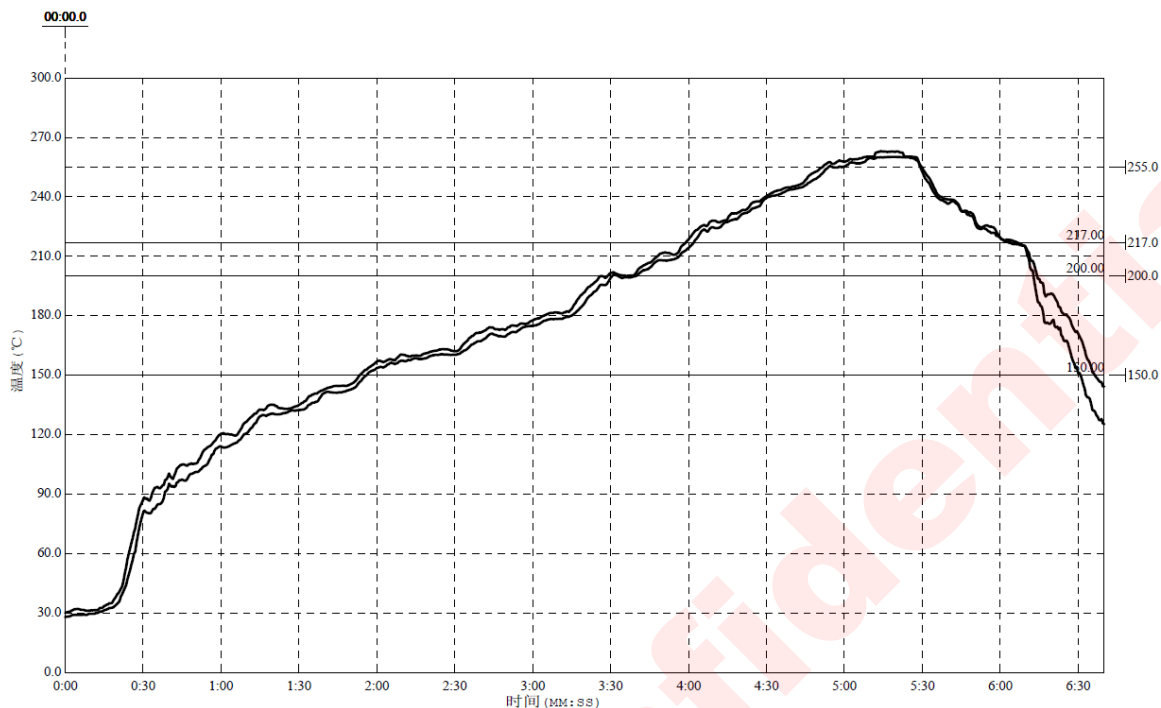


Figure 15 Package Reflow Oven Thermal Profile

Reflow Note	Spec
Average ramp-up rate (217°C to Peak)	Max. 3°C /sec
Time of Preheat temp.(from 150°C to 200°C)	60-120 sec
Time to be maintained above 217°C	60-150 sec
Peak Temperature	>260°C
Time within 5°C of actual peak temp	20-40 sec
Ramp-down rate	Max. 6°C /sec
Time from 25°C to peak temp	Max. 8min

## REVISION HISTORY

Vision	Date	Change Record
V0.9	January 2017	Datasheet V0.9 Released
V1.0	March 2017	Added Typical Characteristics
V1.1	April 2017	1. Added PCB Layout Consideration. 2. Added ROHS and MSL Statements. 3. Added Reflow Information.
V1.2	January 2018	Added Land Pattern Data
V1.3	September, 2018	Storage Temperature Modified

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