

## Over-Voltage Protection Load Switch

### Features

- Highly reliable FCQFN 1.2mm×1.2mm-9L package
- Integrated low  $R_{dson}$  nFET switch: typical 30mΩ
- 5A continuous current capability
- Default Over-Voltage Protection (OVP) threshold
  - AW33901: 5.95V
  - AW33902: 6.2V
  - AW33905: 6.8V
  - AW33909: 9.98V
  - AW33910: 10.5V
- OVP threshold adjustable range: 4V to 20V
- Input maximum voltage rating: 32V<sub>DC</sub>
- Fast turn-off response: typical 50ns
- Over-Temperature Protection (OTP)
- Under-Voltage Lockout (UVLO)

### Applications

- Smartphones
- Tablets
- Charging Ports

### General Description

The AW339XX features an ultra-low 30mΩ (typ.)  $R_{dson}$  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 32V<sub>DC</sub>.

The default OVP threshold is 5.95V (AW33901), 6.2V (AW33902), 6.8V (AW33905), 9.98V (AW33909) and 10.5V (AW33910). The OVP threshold can be adjusted from 4V to 20V through external OVLO pin.

The device features an open-drain output  $\overline{ACOK}$ , when  $V_{IN\_UVLO} < V_{IN} < V_{IN\_OVLO}$  and the switch is on,  $\overline{ACOK}$  will be driven low to indicate a good power input, otherwise it is in high impedance mode (HiZ).

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

### Typical Application Circuit

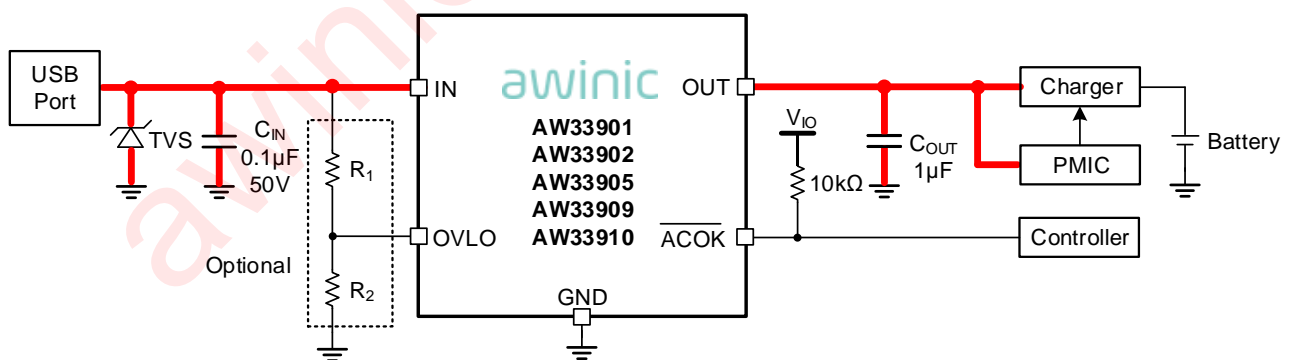


Figure 1 AW339XX typical application circuit

Note: when using default OVP threshold,  $R_1$  and  $R_2$  are not required, and connect OVLO pin to ground.

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## Device Comparison Table

Device	$V_{IN\_OVLO}(V)$				$V_{IN\_OVLO}$ Hysteresis(mV)
	Condition	Min.	Typ.	Max.	
AW33901	$V_{IN}$ rising	5.83	5.95	6.07	130
AW33902	$V_{IN}$ rising	6.08	6.20	6.32	130
AW33905	$V_{IN}$ rising	6.66	6.80	6.94	140
AW33909	$V_{IN}$ rising	9.78	9.98	10.18	210
AW33910	$V_{IN}$ rising	10.29	10.50	10.71	210

## Pin Configuration and Top Mark

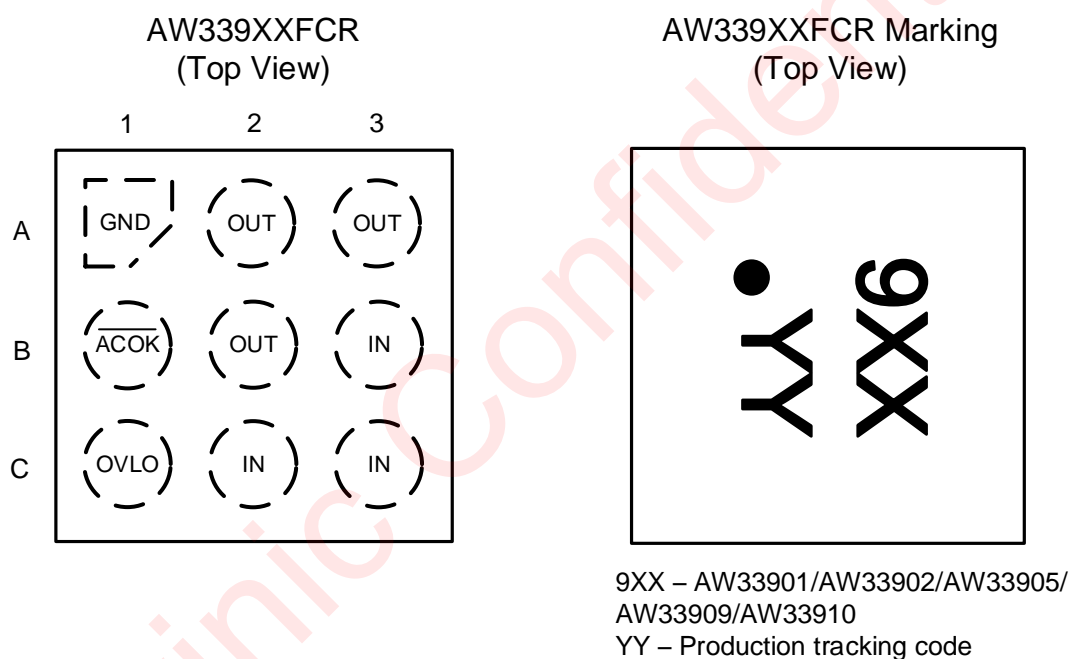


Figure 2 Pin Configuration and Top Mark

## Pin Definition

Pin	Name	Description
B3,C2,C3	IN	Switch input and device power supply
A1	GND	Device ground
C1	OVLO	OVP threshold adjustment pin
A2,A3,B2	OUT	Switch output
B1	$\overline{ACOK}$	Power good flag, active-low, open-drain. When $V_{IN\_UVLO} < V_{IN} < V_{IN\_OVLO}$ , $\overline{ACOK}$ is pulled low, otherwise it's Hi-Z state, and can be pulled high by external pull-up resistor

Functional Block Diagram

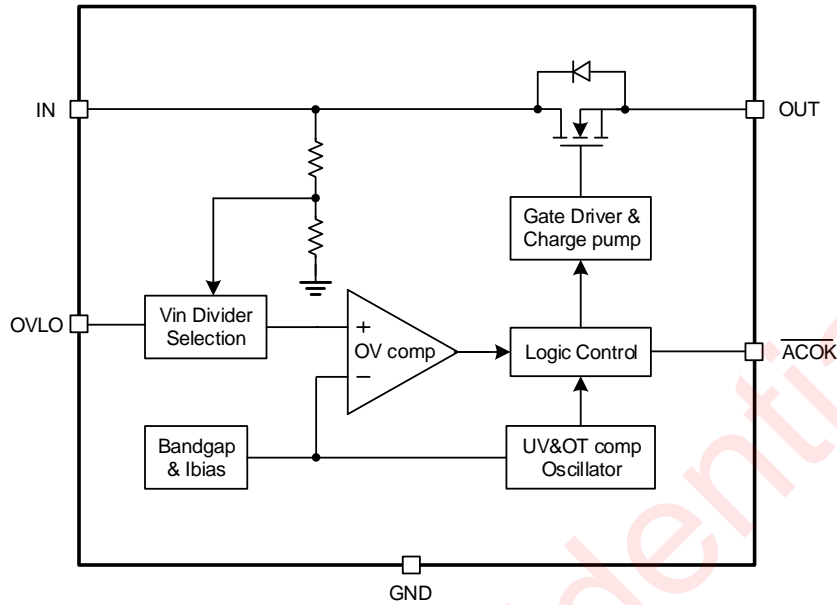


Figure 3 Functional Block Diagram

Typical Application Circuits

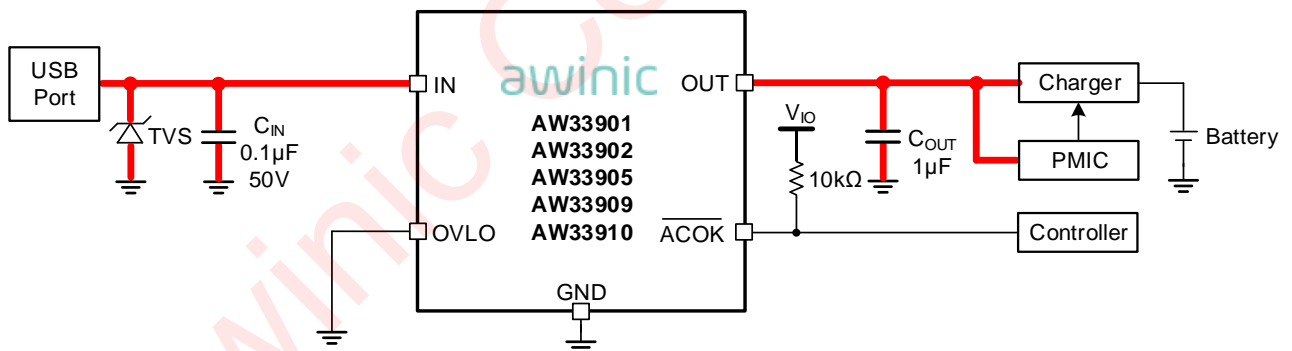


Figure 4 AW339XX typical application circuit(using default OVP threshold)

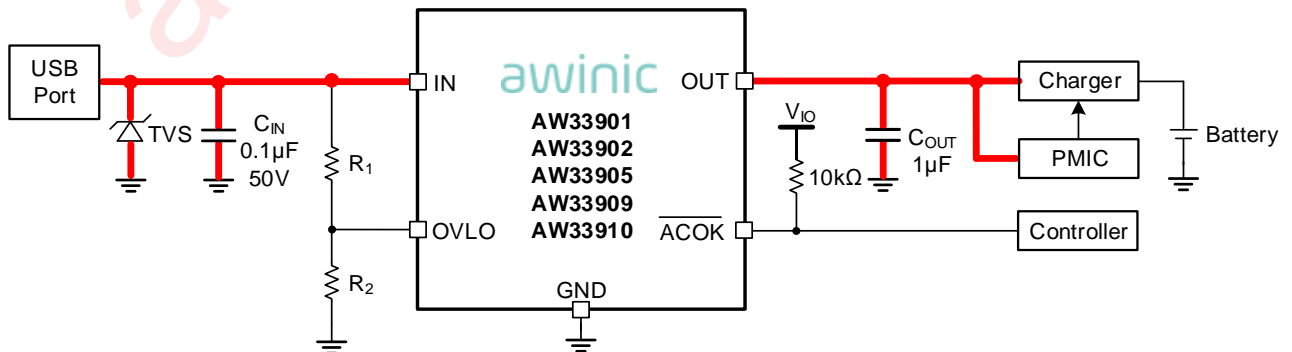


Figure 5 AW339XX typical application circuit(using external OVP threshold)

**Notice for Typical Application Circuits:**

1. When the default OVP threshold is used, connect OVLO pin to GND directly or through a  $0\Omega$  resistor. OVLO pin cannot be left floating.
2. If  $R_1$  and  $R_2$  are used to adjust the OVP threshold, it is better to use 1% precision resistors to improve the OVP threshold precision.
3.  $C_{IN} = 0.1\mu F$  is recommended for typical application, larger  $C_{IN}$  is also acceptable. The rated voltage of  $C_{IN}$  should be larger than the TVS maximum clamping voltage, if no TVS is applied and only AW339XX is used, the rated voltage of  $C_{IN}$  should be 50V.
4.  $C_{OUT} = 1\mu F$  is recommended for typical application, larger  $C_{OUT}$  is also acceptable. The rated voltage of  $C_{OUT}$  should be larger than the OVP threshold. For example, if the OVP threshold is 6.8V, the rated voltage of  $C_{OUT}$  should be 10V or higher.
5. Unidirectional TVS is suggested to use on VBUS port to withstand surge voltage, the maximum clamping voltage of the TVS should be below 35V.
6. If  $\overline{ACOK}$  is not used, it can be left floating, or short to GND.

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## Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW33901FCR	-40°C – 85°C	FCQFN 1.2mm×1.2mm -9L	901	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33902FCR	-40°C – 85°C	FCQFN 1.2mm×1.2mm -9L	902	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33905FCR	-40°C – 85°C	FCQFN 1.2mm×1.2mm -9L	905	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33909FCR	-40°C – 85°C	FCQFN 1.2mm×1.2mm -9L	909	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33910FCR	-40°C – 85°C	FCQFN 1.2mm×1.2mm -9L	910	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel

## Absolute Maximum Ratings (NOTE1)

Symbol	Parameter	Condition	Min.	Max.	Unit
V <sub>IN</sub>	Input DC voltage		-0.3	32	V
V <sub>IN_PUL</sub>	Input peak pulse voltage	20μs pulse width, repeat 100 times		40	V
V <sub>OUT</sub>	Output voltage		-0.3	See <sup>(NOTE 2)</sup>	V
V <sub>ACOK</sub>	ACOK voltage		-0.3	7	V
V <sub>OVLO</sub>	OVLO voltage		-0.3	7	V
I <sub>SW</sub>	Continuous current of switch IN-OUT <sup>(NOTE 3)</sup>	Continuous current on IN and OUT pin		5	A
I <sub>PEAK</sub>	Peak current	Peak input and output current on IN and OUT pin(10ms)		8	A
I <sub>DIODE</sub>	Continuous diode current	Continuous forward current through the nFET body diode		1.5	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	70	°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	±6.5	kV
	Charged Device Model	All pins, per ESDA/JEDEC JS-002-2014	±2	kV
	Machine Model	All pins, per JESD22-A115C	±450	V
I <sub>Latch-up</sub>	Latch-up	All pins, per JESD78D, I Trigger	±800	mA

## Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V <sub>IN</sub>	Input DC voltage	3		30	V
C <sub>IN</sub>	Input capacitance		0.1		μF
C <sub>OUT</sub>	Output load capacitance		1		μF

## Electrical Characteristics

$T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  unless otherwise noted. Typical values are guaranteed for  $V_{IN} = 5\text{V}$ ,  $C_{IN} = 0.1\mu\text{F}$ ,  $I_{IN} \leq 5\text{A}$  and  $T_A = 25^{\circ}\text{C}$ .

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units			
$R_{dson}$	Switch on resistance	$V_{IN} = 5\text{V}$ , $I_{OUT} = 1\text{A}$ , $T_A = 25^{\circ}\text{C}$		30	41	$\text{m}\Omega$			
$I_Q$	Input quiescent current	$V_{IN} = 5\text{V}$ , $V_{OVLO} = 0\text{V}$ , $I_{OUT} = 0\text{A}$		80	150	$\mu\text{A}$			
$I_{IN\_OVLO}$	Input current at over-voltage condition	$V_{IN} = 5\text{V}$ , $V_{OVLO} = 3\text{V}$ , $V_{OUT} = 0\text{V}$		78	150	$\mu\text{A}$			
$V_{OVLO\_TH}$	OVLO set threshold		1.16	1.20	1.24	V			
$V_{OVLO\_RNG}$	OVP threshold adjustable range		4		20	V			
$V_{OVLO\_SEL}$	External OVLO select threshold	OVLO rising	0.19	0.26	0.33	V			
		Hysteresis		0.06		V			
$I_{OVLO}$	OVLO pin leakage current	$V_{OVLO} = V_{OVLO\_TH}$	-0.2		0.2	$\mu\text{A}$			
<b>Protection</b>									
$V_{IN\_OVLO}$	OVP trip level	AW33901	$V_{IN}$ rising	5.83	5.95	6.07	V		
			Hysteresis		0.13				
		AW33902	$V_{IN}$ rising	6.08	6.20	6.32			
			Hysteresis		0.13				
		AW33905	$V_{IN}$ rising	6.66	6.80	6.94			
			Hysteresis		0.14				
		AW33909	$V_{IN}$ rising	9.78	9.98	10.18			
			Hysteresis		0.21				
		AW33910	$V_{IN}$ rising	10.29	10.50	10.71			
			Hysteresis		0.21				
		$V_{IN\_UVLO}$	UVLO trip level	$V_{IN}$ rising		2.9		3.0	V
				Hysteresis		0.1			



## Electrical Characteristics (Continued)

$T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  unless otherwise noted. Typical values are guaranteed for  $V_{IN} = 5\text{V}$ ,  $C_{IN} = 0.1\mu\text{F}$ ,  $I_{IN} \leq 5\text{A}$  and  $T_A = 25^{\circ}\text{C}$ .

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
<b>Protection(continued)</b>						
$T_{SDN}$	Shutdown temperature			150		$^{\circ}\text{C}$
$T_{SDN\_HYS}$	Shutdown temperature hysteresis			20		$^{\circ}\text{C}$
$R_{DCHG}$	Output resistance discharge	$V_{OUT}=7\text{V}, V_{OVLO}=3\text{V}$		50		$\Omega$
<b>Digital Logical Interface</b>						
$V_{OL}$	$\overline{\text{ACOK}}$ output low voltage	$I_{SINK}=1\text{mA}$			0.4	V
$I_{LEAK\_ACOK}$	$\overline{\text{ACOK}}$ leakage current	$V_{IO}=5\text{V}, \overline{\text{ACOK}}$ de-asserted	-0.5		0.5	$\mu\text{A}$
<b>Timing Characteristics (Figure 6)</b>						
$t_{DEB}$	Debounce time	From $V_{IN} > V_{IN\_UVLO}$ to 10% $V_{OUT}$		15		ms
$t_{START}$	Start-up time	From $V_{IN} > V_{IN\_UVLO}$ to $\overline{\text{ACOK}}$ low		30		ms
$t_{ON}$	Switch turn-on time	$R_L = 100\ \Omega$ , $C_L = 22\ \mu\text{F}$ , $V_{OUT}$ from 10% $V_{IN}$ to 90% $V_{IN}$		2		ms
$t_{OFF}$	Switch turn-off time	$C_L = 0\mu\text{F}$ , $R_L = 100\Omega$ , $V_{IN} > V_{IN\_OVLO}$ to $V_{OUT}$ stop rising, $V_{IN}$ rise at $10\text{V}/\mu\text{s}$		50		ns

## Timing Diagram

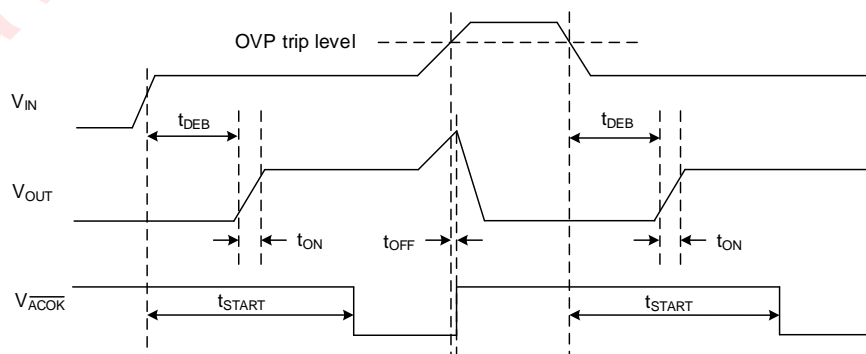


Figure 6 Timing diagram

### Typical Characteristics

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

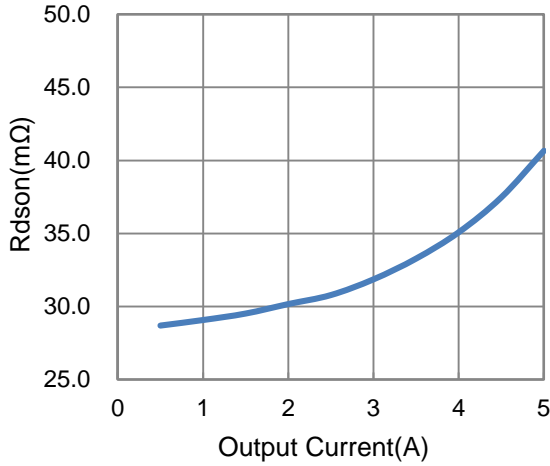


Figure 7  $R_{ds(on)}$  vs. Output Current

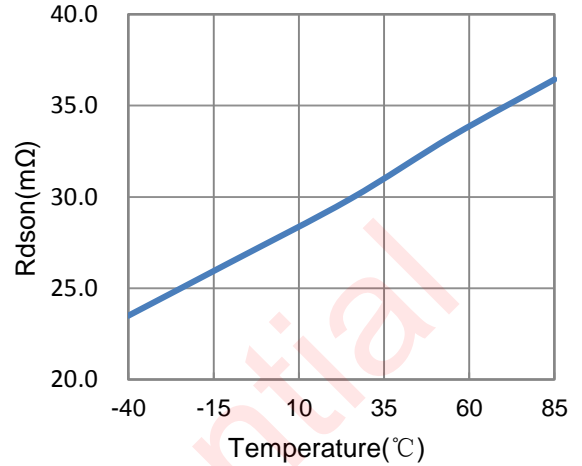


Figure 8  $R_{ds(on)}$  vs. Temp. ( $I_{OUT} = 1A$ )

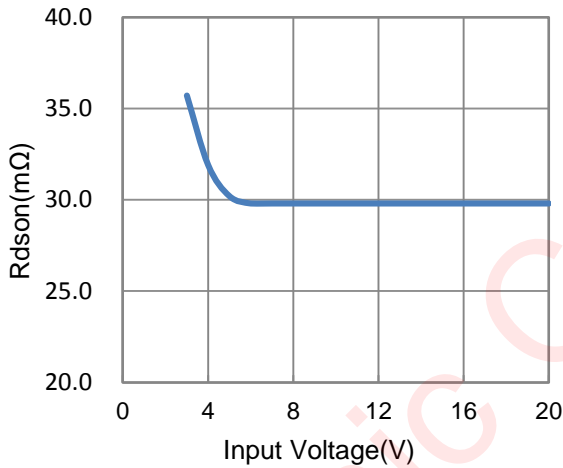


Figure 9  $R_{ds(on)}$  vs. Input Voltage ( $I_{OUT} = 1A$ )

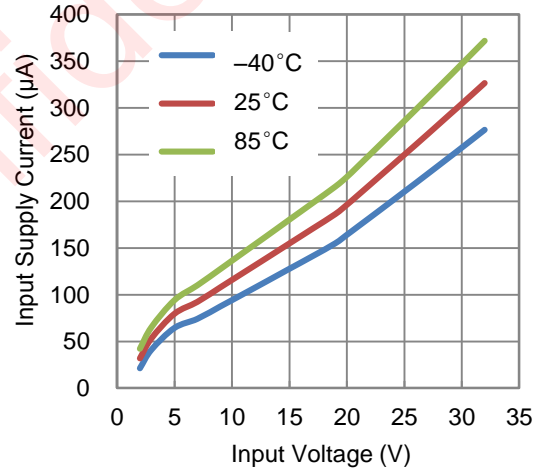


Figure 10 Input Supply Current vs. Supply Voltage

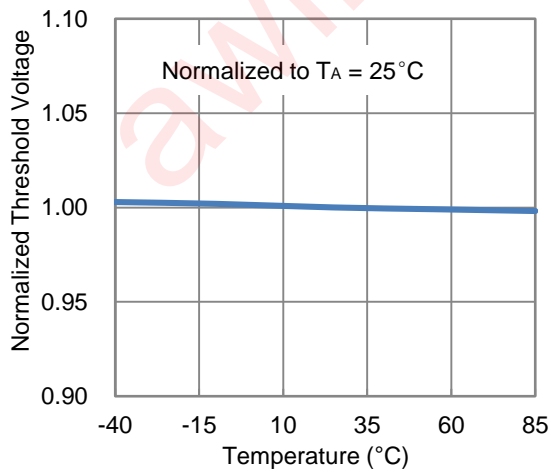


Figure 11 Normalized Internal OVP Threshold

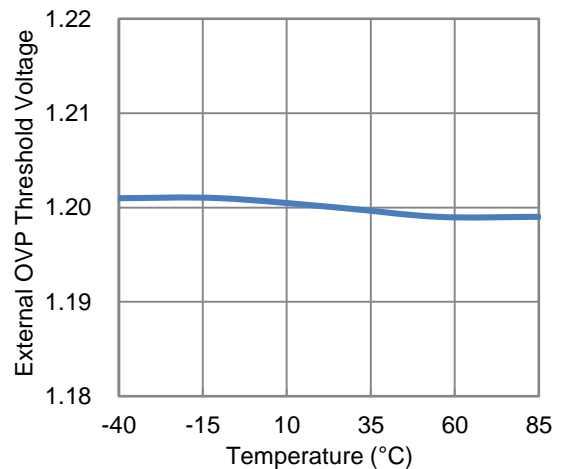


Figure 12 External OVP Threshold

## 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.

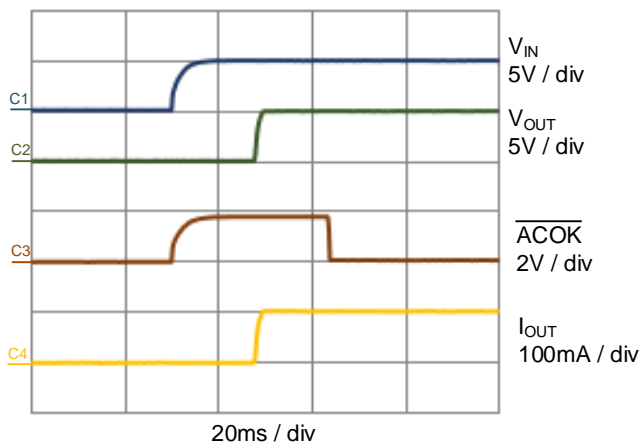


Figure 13 Power-up ( $C_{OUT} = 1\mu F$ , 100mA load).

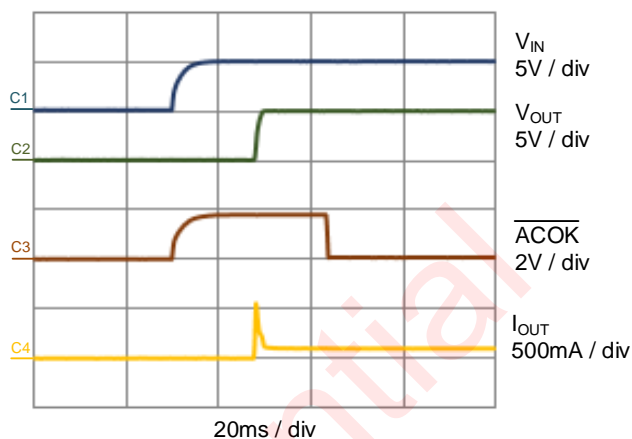


Figure 14 Power-up ( $C_{OUT} = 100\mu F$ , 100mA load)

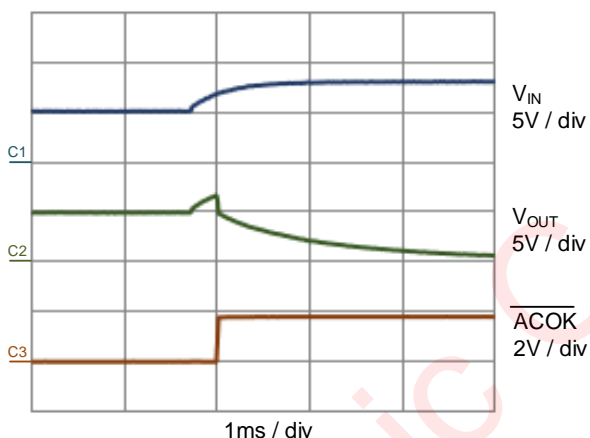


Figure 15 OVP Response (AW33905)

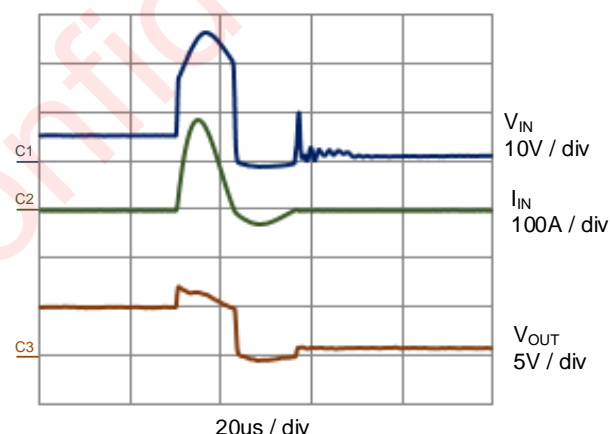


Figure 16 400V Surge Response (AW33905 with 12V TVS)

## Detailed 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.  $\overline{ACOK}$  will be driven low about 30ms after  $V_{IN}$  valid, indicating the switch is on with a good power input. If the input voltage exceeds the OVP trip level, the switch will be turned off in about 50ns. 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 50ns. The switch will remain off until  $V_{IN}$  falls below the OVP falling trip level.

### OVP Threshold Adjustment

If the default OVP threshold is used, OVLO pin must be grounded. 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:

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

For example, if we select  $R_1 = 1M\Omega$  and  $R_2 = 100k\Omega$ , then the new OVP threshold calculated from the above formula is 13.2V. The OVP threshold adjustment range is from 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  $V_{OVLO\_TH}$  (1.2V typical) to judge whether input supply is over-voltage.

### $\overline{ACOK}$ Output

The device features an open-drain output  $\overline{ACOK}$ , it should be connected to the system I/O rail through a pull-up resistor. If the device is enabled and  $V_{IN\_UVLO} < V_{IN} < V_{IN\_OVLO}$ ,  $\overline{ACOK}$  will be driven low indicating the switch is on with a good power input. If OVP, UVLO, or OT occurs, the switch will be turned off and  $\overline{ACOK}$  will be pulled high. If this function is not needed,  $\overline{ACOK}$  pin can be floating or grounded.

### 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 (15ms typical). After switch is fully on, current is supplied through switch channel and the voltage drop from OUT to IN is minimum.

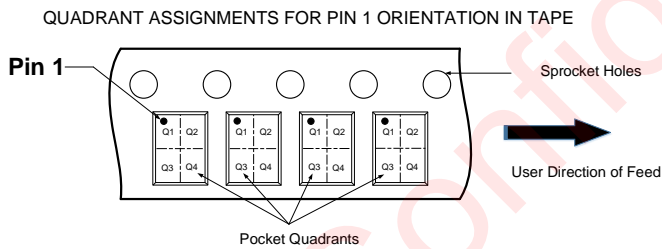
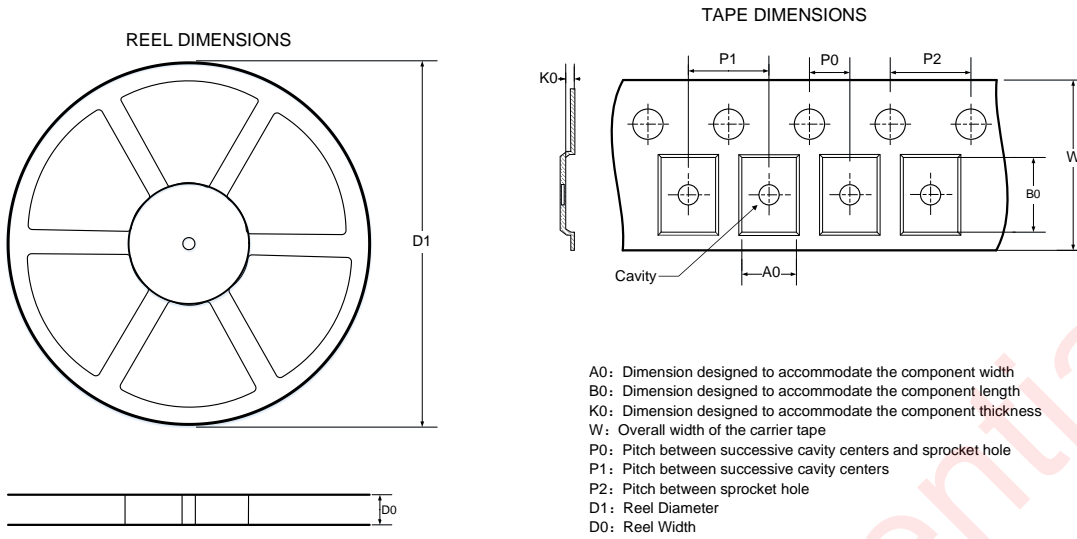
## PCB Layout Consideration

To make fully use of the performance of AW339XX, 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 AW339XX) and close to IN pin, and place the output capacitor  $C_{OUT}$  on the top layer (same layer as the AW339XX) and close to OUT pin.
2. IN pin routing passes through the external TVS firstly, and then connect AW339XX.
3. Red bold paths on figure 4 and 5 are power lines that will flow large current, please route them on PCB as straight, wide and short as possible.
4. If  $R_1$  and  $R_2$  are used, route OVLO line on PCB as short as possible to reduce parasitic capacitance.
5. The power trace from USB connector to AW339XX may suffer from ESD event, keep other traces away from it to minimize possible EMI and ESD coupling.
6. Use rounded corners on the power trace from USB connector to AW339XX to decrease EMI coupling.

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## Tape and Reel Information

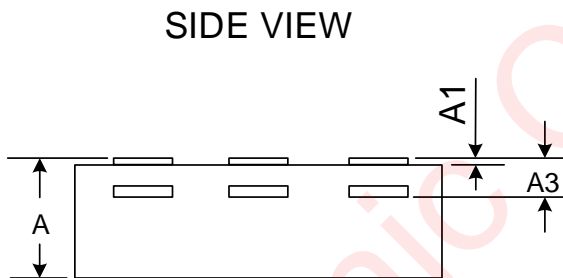
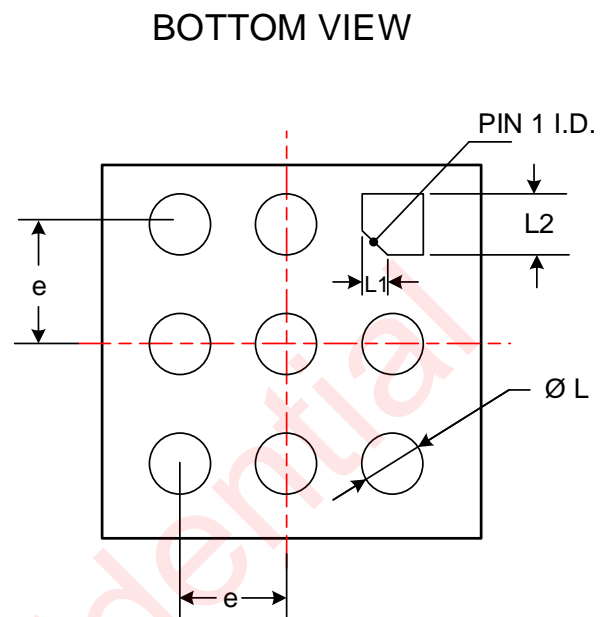
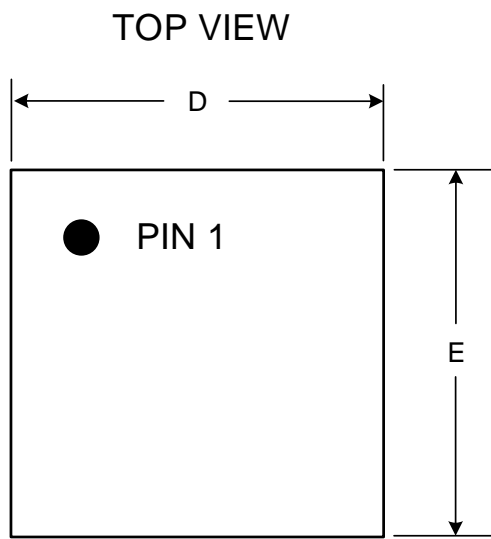


**DIMENSIONS AND PIN1 ORIENTATION**

D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178	8.4	1.38	1.38	0.75	2	4	4	8	Q1

All dimensions are nominal

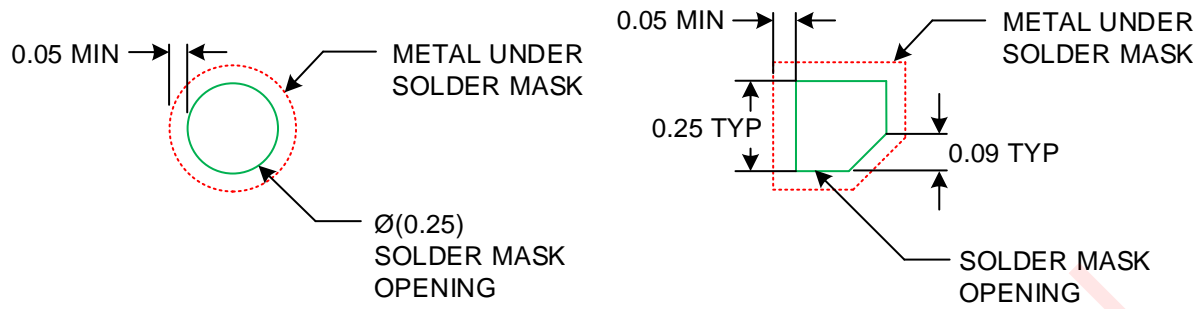
## Package Description



SYMBOL	MIN	NOM	MAX
A	0.50	0.55	0.60
A1	0.00	0.02	0.05
A3	0.152REF.		
D	1.10	1.20	1.30
E	1.10	1.20	1.30
e	0.400REF.		
L	0.18	0.25	0.30
L1	0.090REF.		
L2	0.250REF.		

Unit: mm

## Solder Mask Details



SOLDER MASK DETAILS  
NOT TO SCALE

NOTE:

Unit: mm.

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## Revision History

Version	Date	Change Record
V1.0	December, 2017	Officially released.
V1.1	February, 2018	<ol style="list-style-type: none"> <li>1. Modified Reel information.</li> <li>2. Modified POD information.</li> <li>3. Modified Solder Mask Details.</li> </ol>
V1.2	September, 2018	Storage Temperature Modified
V1.3	February, 2020	<ol style="list-style-type: none"> <li>1. Modified package description in features and ordering Information, and removed it from general description. (P1 and P5)</li> <li>2. Modified <math>\overline{ACOK}</math> pin description. (P2)</li> <li>3. Added item 5 and 6 of notice for typical application circuits. (P4)</li> <li>4. Deleted table 1 table of figures. (P11)</li> <li>5. Modified OVP threshold adjustment description. (P12)</li> <li>6. Reflow curve deleted. Deleted figure 17 package reflow oven thermal profile and table 2 package reflow standard.</li> <li>7. Update tape and reel information.</li> </ol>

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