Over-Voltage Protection Load Switch with Surge Protection

Features

- Surge protection
  - IEC 61000-4-5: ±200V
- Integrated low R_{dson} nFET switch: typical 33mΩ
- 4.5A continuous current capability
- Default Over-Voltage Protection (OVP) threshold
  - AW32601: 5.95V
  - AW32605: 6.8V
  - AW32610: 10.5V
- OVP threshold adjustable range: 4V to 20V
- System ESD protection on IN pin
  - IEC 61000-4-2 Contact discharge: ±8kV
  - IEC 61000-4-2 Air gap discharge: ±15kV
- Input maximum voltage rating: $29V_{DC}$
- Fast turn-off response: typical 50ns
- Over-Temperature Protection (OTP)
- Under-Voltage Lockout (UVLO)
- WLCSP 1.288mm × 1.988mm-12B package

Applications

- Smartphones
- Tablets
- Charging Ports

General Description

The AW326XX family OVP load switch features surge protection, an internal clamp circuit protects the device from surge voltages up to ±200V.

The AW326XX features an ultra-low 33mΩ (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 $29V_{DC}$.

The default OVP threshold is 5.95V (AW32601), 6.8V (AW32605) and 10.5V (AW32610), 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.

Typical Application Circuit

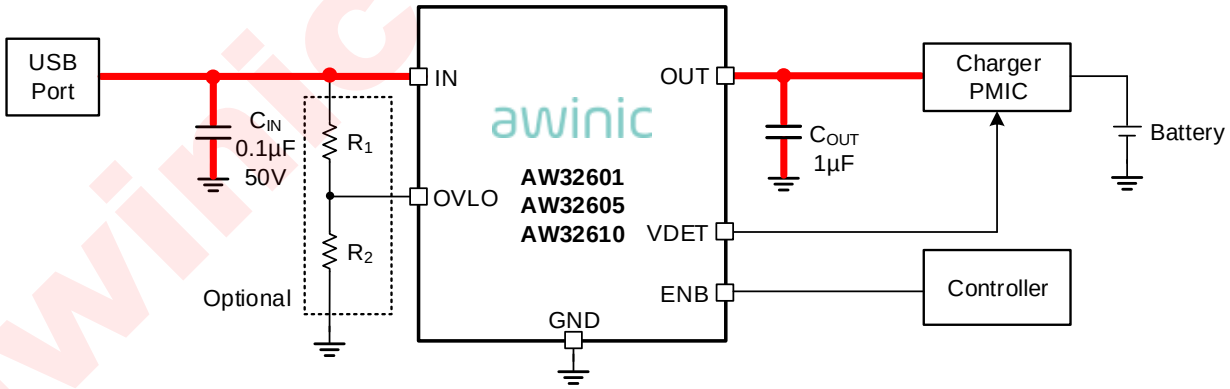

Figure 1 AW326XX typical application circuit

R_1 and R_2 are used for OVP threshold adjustment, to use default OVP threshold, connect OVLO to ground.

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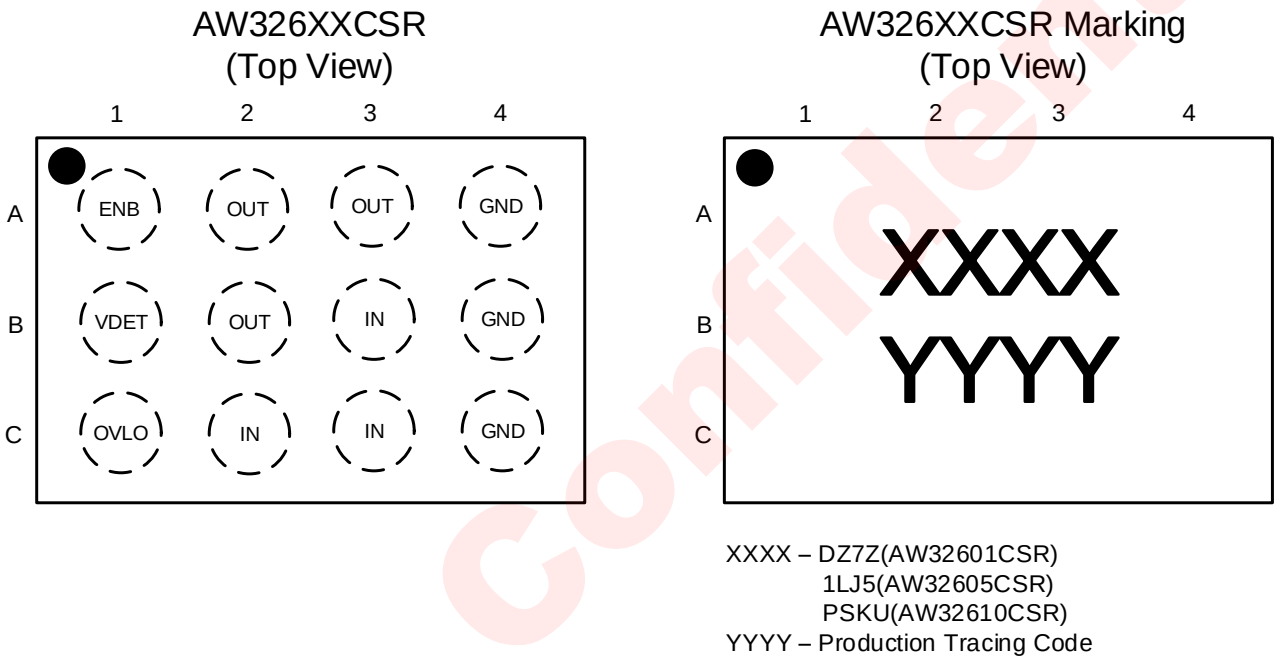
Device Comparison Table

Device	V_{IN_OVLO} (V)				V_{IN_OVLO} hysteresis (mV)
	Condition	Min.	Typ.	Max.	
AW32601	V_{IN} rising	5.83	5.95	6.07	130
AW32605	V_{IN} rising	6.66	6.80	6.94	140
AW32610	V_{IN} rising	10.29	10.50	10.71	210

Pin Configuration and Top Mark



XXXX – DZ7Z(AW32601CSR)
1LJ5(AW32605CSR)
PSKU(AW32610CSR)
YYYY – Production Tracing Code

Figure 2 Pin Configuration and Top Mark

Pin Definition

Pin	Name	Description
A1	ENB	Enable pin, active low
B1	VDET	Clamped output from IN pin
C1	OVLO	OVP threshold adjustment pin
B3, C2, C3	IN	Switch input and device power supply
A2, A3, B2	OUT	Switch output
A4, B4, C4	GND	Device ground

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Functional Block Diagram

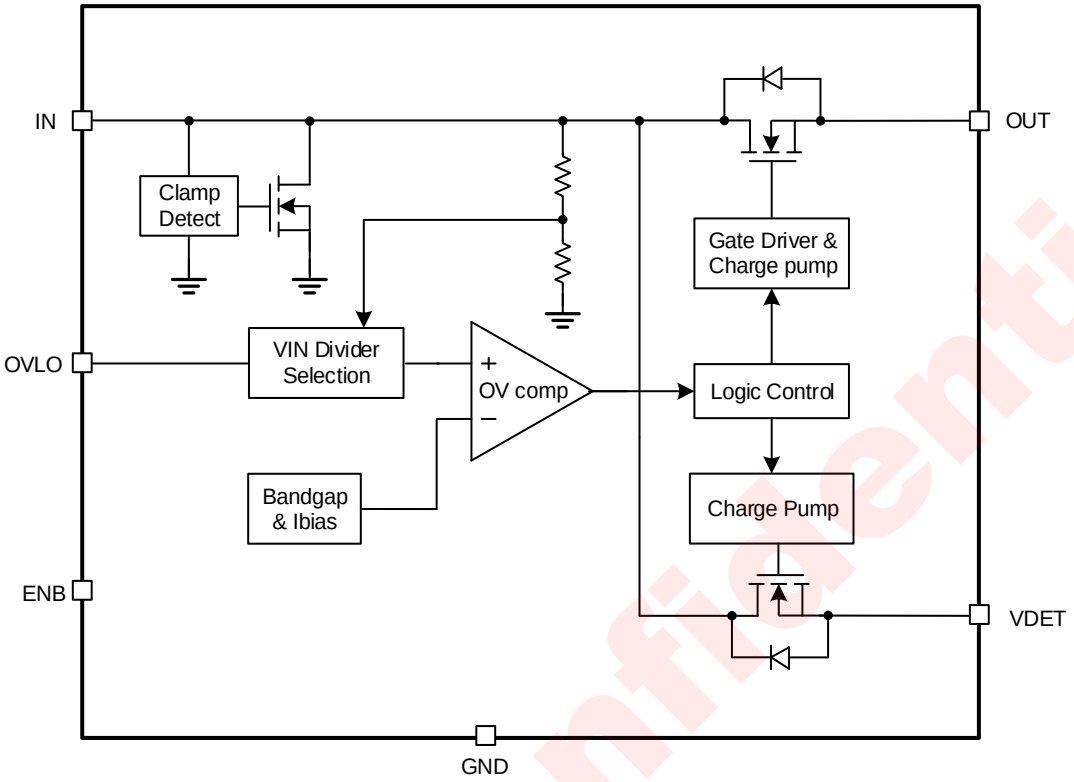

Figure 3 Functional Block Diagram

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Typical Application Circuits

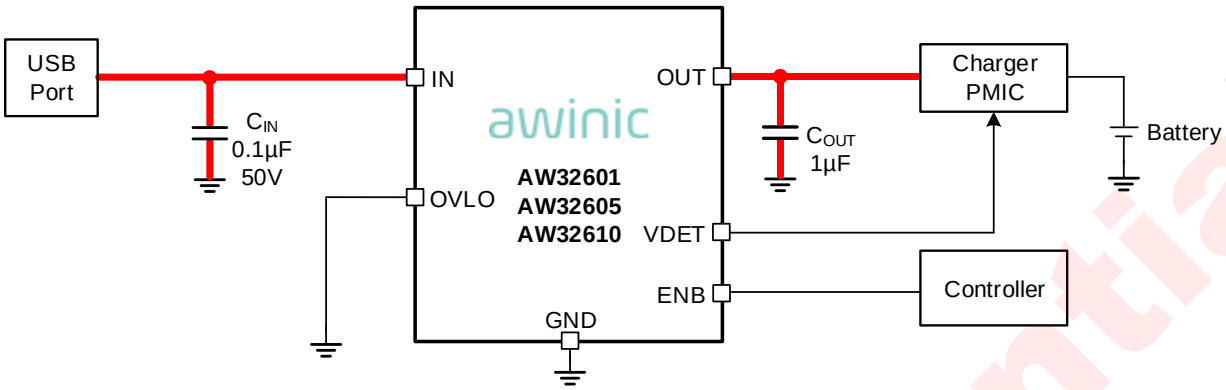

Figure 4 AW326XX typical application circuit(using default OVP threshold)

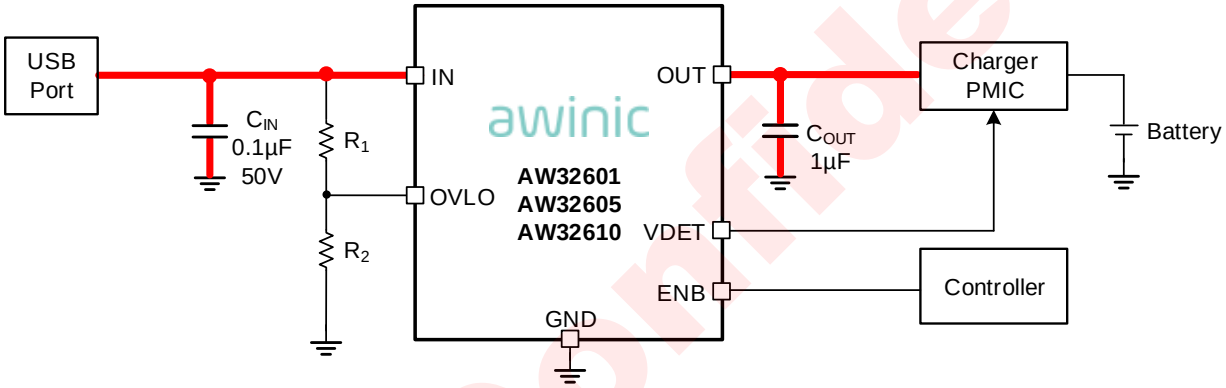

Figure 5 AW326XX typical application circuit(using external OVP threshold)

Notice for Typical Application Circuits:

1. When the default OVP threshold is used, connect OVLO pin to GND directly or through a 0Ω 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} = 0.1µF is recommended for typical application, larger C_{IN} is also acceptable. The rated voltage of C_{IN} should be 50V.
4. C_{OUT} = 1µF 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.

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Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW32601CSR	-40°C ~ 85°C	WLCSP 1.288mm × 1.988mm -12B	DZ7Z	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW32605CSR	-40°C ~ 85°C	WLCSP 1.288mm × 1.988mm -12B	1LJ5	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW32610CSR	-40°C ~ 85°C	WLCSP 1.288mm × 1.988mm -12B	PSKU	MSL1	ROHS+HF	3000 units/ Tape and Reel

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Absolute Maximum Ratings (NOTE 1)

Symbol	Parameter	Condition	Min.	Max.	Unit
V_{IN}	Input voltage		-0.3	29	V
V_{OUT}	Output voltage		-0.3	See(NOTE 2)	V
V_{OVLO}	OVLO voltage		-0.3	6	V
V_{VDET}	VDET voltage		-0.3	7	V
V_{ENB}	ENB voltage		-0.3	6	V
I_{SW}	Continuous current of switch IN-OUT(NOTE 3)	Continuous current on IN and OUT pin		4.5	A
I_{PEAK}	Peak current	Peak input and output current on IN and OUT pin(10ms pulse width)		7	A
I_{DIODE}	Continuous diode current	Continuous forward current through the nFET body diode		1.5	A
T_A	Ambient temperature		-40	85	°C
T_J	Junction temperature		-40	150	°C
T_{STG}	Storage temperature		-65	150	°C
T_{LEAD}	Soldering temperature	At leads, 10 seconds		260	°C
Surge	Input surge protection	IEC61000-4-5 test with 2Ω equivalent series resistance	-200	+200	V

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_{IN}+0.3V, whichever is smaller.*

NOTE3: *Limited by thermal design.*

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Thermal Information

Symbol	Parameter	Condition	Value	Unit
$R_{\theta JA}$	Thermal resistance from junction to ambient (NOTE 1)	In free air	80	°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_{ESD}	IEC61000-4-2 system ESD on IN pin(NOTE 1)	Contact discharge	±8	kV
		Air gap discharge	±15	kV
	Human Body Model	ANSI/ESDA/JEDEC JS-001	±2	kV
	Charged Device Model	JESD22-C101	±1.5	kV
$I_{Latch-up}$	Latch-up	JEDEC78	±200	mA

NOTE1: system ESD test board is based on figure 4.

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IN}	Input DC voltage	2.3		28	V
C_{IN}	Input capacitance		0.1		μF
C_{OUT}	Output load capacitance		1	100	μF

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Electrical Characteristics

T_A = -40°C to 85°C unless otherwise noted. Typical values are guaranteed for VIN = 5V, CIN = 0.1μF, IIN≤ 4.5A and T_A = 25°C.

Symbol	Description	Test Conditions		Min.	Typ.	Max.	Units
V_{IN_CLAMP}	Input clamp voltage	I_{IN} = 10mA, T_A = 25°C			30.6		V
R_{dson}	Switch on resistance	V_{IN} = 5V, I_{OUT} = 1A, T_A = 25°C			33	45	mΩ
I_Q	Input quiescent current	V_{IN} = 5V, V_{OVLO}=0V,I_{OUT} = 0A			80	150	μA
I_{IN_OVLO}	Input current at over-voltage condition	V_{IN} = 5V, V_{OVLO}=3V,V_{OUT} = 0V			77	150	μA
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_{OUT_LEAK}	OUT leakage current	VIN > V_{IN_OVLO},V_{OUT} = 5V			10	30	μA
I_{OVLO}	OVLO pin leakage current	V_{OVLO} = V_{OVLO_TH}		-0.2		0.2	μA
Protection							
V_{IN_OVLO}	OVP trip level	AW32601	V_{IN} rising	5.83	5.95	6.07	V
			Hysteresis		0.13		
		AW32605	V_{IN} rising	6.66	6.80	6.94	
			Hysteresis		0.14		
		AW32610	V_{IN} rising	10.29	10.50	10.71	
			Hysteresis		0.21		
V_{IN_UVLO}	UVLO trip level	V_{IN} rising			2.2	2.3	V
		Hysteresis			0.1		
T_{SDN}	Shutdown temperature				150		°C
T_{SDN_HYS}	Shutdown temperature hysteresis				20		°C

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Electrical Characteristics (continued)

T_A = -40°C to 85°C unless otherwise noted. Typical values are guaranteed for VIN = 5V, CIN = 0.1μF, IIN≤ 4.5A and T_A = 25°C.

Symbol	Description	Test Conditions	Min.	Typ.	Max.	Units
VDET						
R_{VDET}	VDET switch on-resistance	V_{IN} =4.5V to 5.5V, V_{ENB} =0V, I_{IDET} =1mA		33	55	Ω
V_{VDET_OUT}	VDET clamp voltage	V_{IN} =20V, V_{ENB} =0V, VDET no load		6.6		V
I_{VDET_LIM}	VDET current limit			28	45	mA
Digital Logical Interface						
V_{IH}	ENB input high voltage		1.4			V
V_{IL}	ENB input low voltage				0.4	V
I_{ENB_H}	ENB input high current	IN unconnected, V_{ENB} =3V, VDET=2.5V		0.5	2	μA
I_{ENB_L}	ENB input low current	V_{ENB} =0V	-1	0	1	μA
Timing Characteristics (Figure 6)						
t_{DEB}	Debounce time	From V_{IN} > V_{IN_UVLO} to 10% V_{OUT}		15		ms
t_{ON}	Switch turn-on time	R_{OUT} = 100Ω, C_{OUT} = 22μF, V_{OUT} from 10% V_{IN} to 90% V_{IN}		1		ms
t_{OFF}	Switch turn-off time	C_{IN} = 0μF, R_{OUT} = 100Ω, V_{IN} > V_{IN_OVLO} to V_{OUT} stop rising, V_{IN} rise at 10V/μs		50		ns

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Timing Diagram

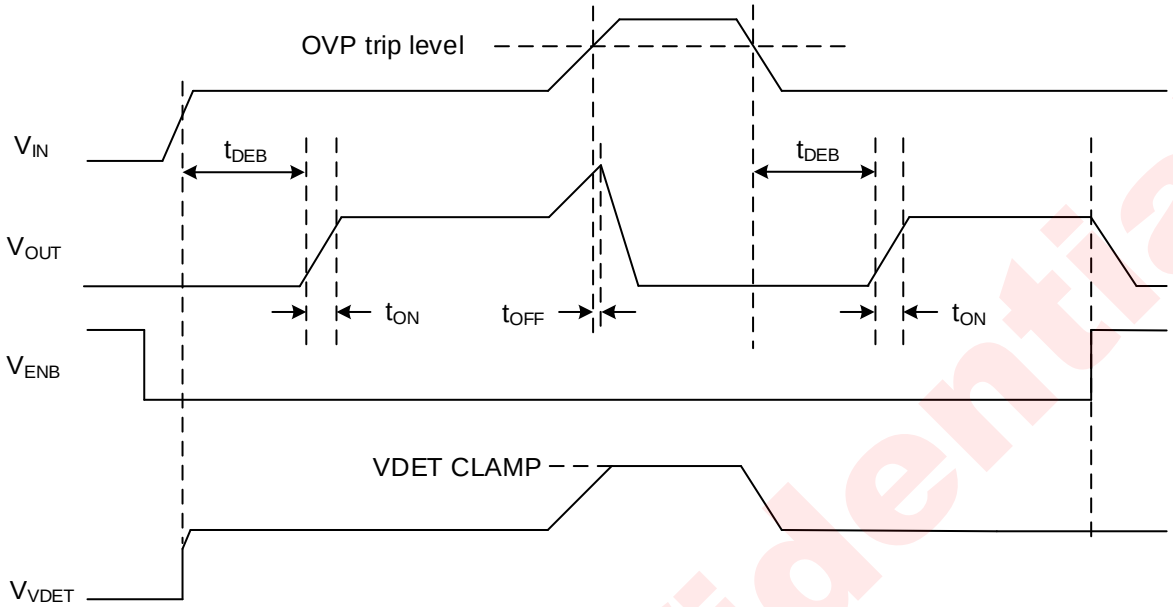

Figure 6 Timing Diagram

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Typical characteristics

V_{IN} = 5V, V_{ENB} = 0V, V_{OVLO} = 0V, C_{IN} = 0.1μF, C_{OUT} = 1μF, and T_A = 25°C unless otherwise specified.

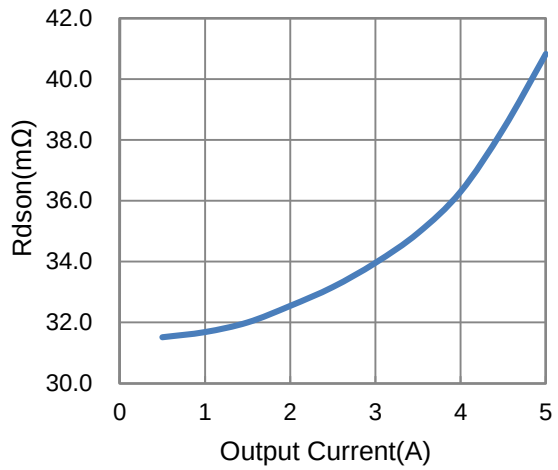

Figure 7 R_{dson} vs. Output Current

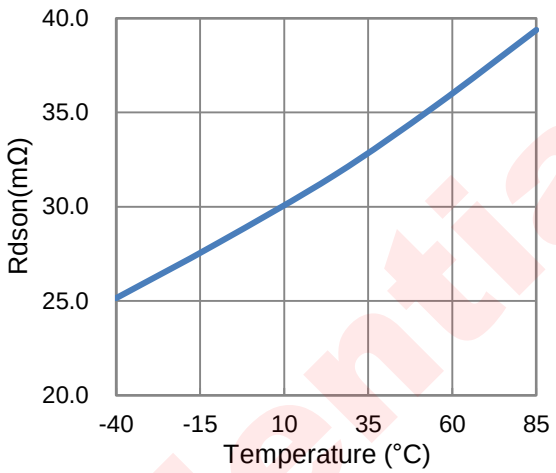

Figure 8 R_{dson} vs. Temp. (I_{OUT} = 1A)

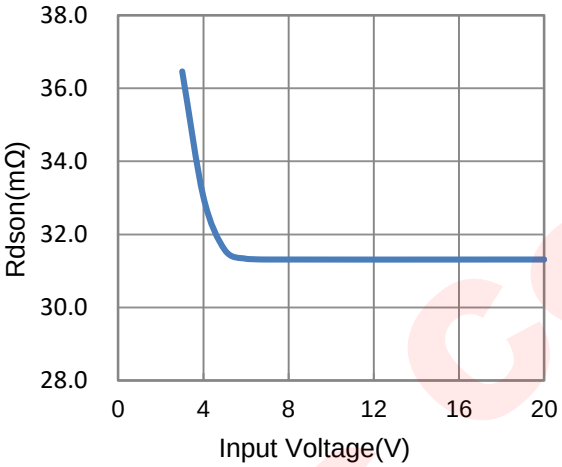

Figure 9 R_{dson} vs. Input Voltage (I_{OUT} = 1A)

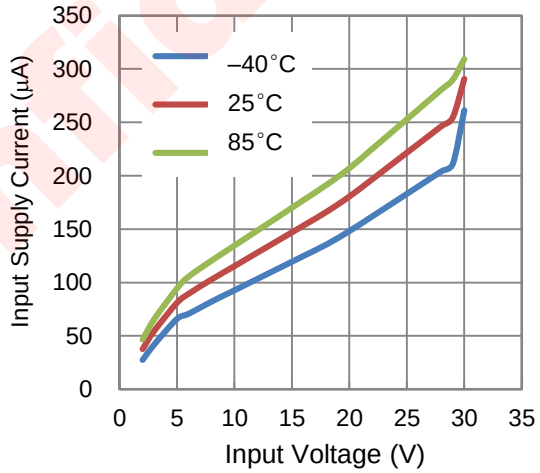

Figure 10 Input Supply Current vs. Supply Voltage

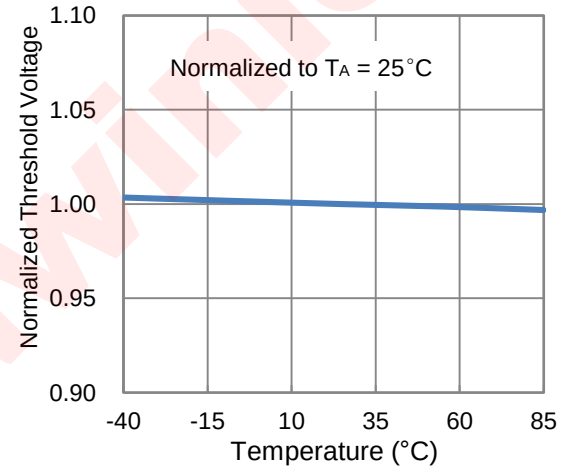

Figure 11 Normalized Internal OVP Threshold vs. Temp.

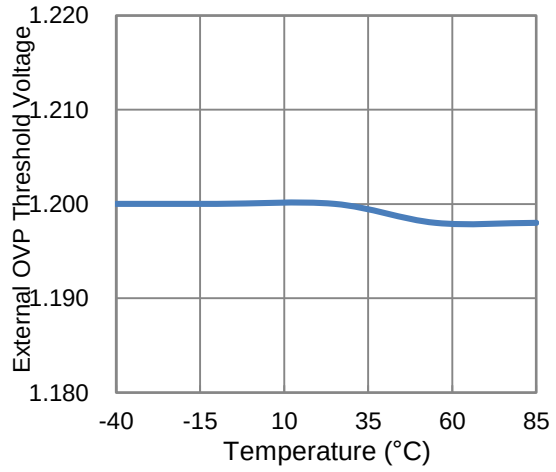

Figure 12 OVLO set threshold vs. Temp.

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Typical characteristics (continued)

V_{IN} = 5V, V_{ENB} = 0V, V_{OVLO} = 0V, C_{IN} = 0.1μF, C_{OUT} = 1μF, and T_A = 25°C unless otherwise specified.

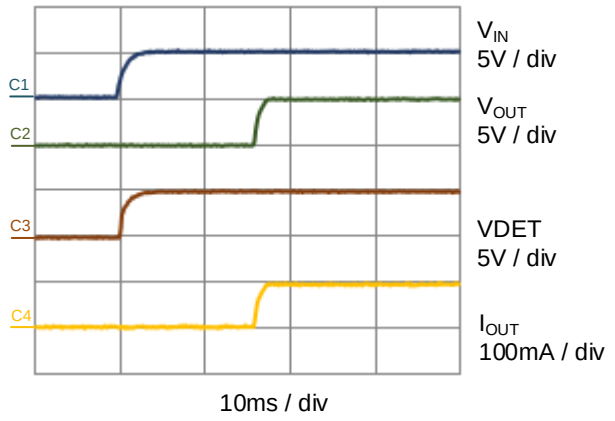

Figure 13 Power-up (C_{IN} = 1μF, C_{OUT} = 1μF, 100mA load)

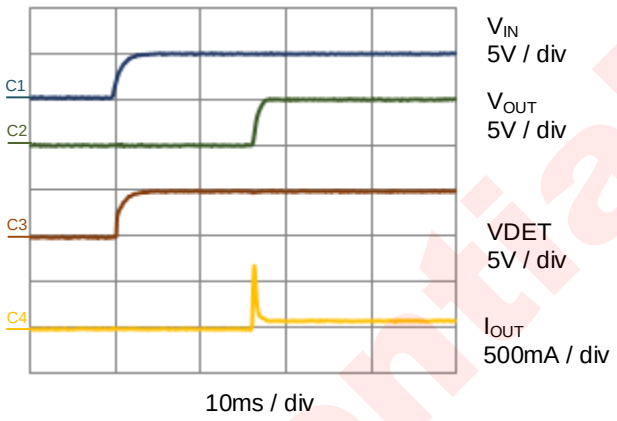

Figure 14 Power-up (C_{IN} = 1μF, C_{OUT} = 100μF, 100mA load)

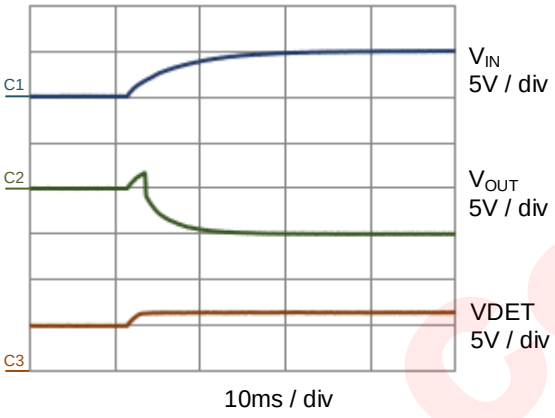

Figure 15 OVP Response (AW32605, C_{IN} = 1μF, C_{OUT} = 1μF, 5kΩ load)

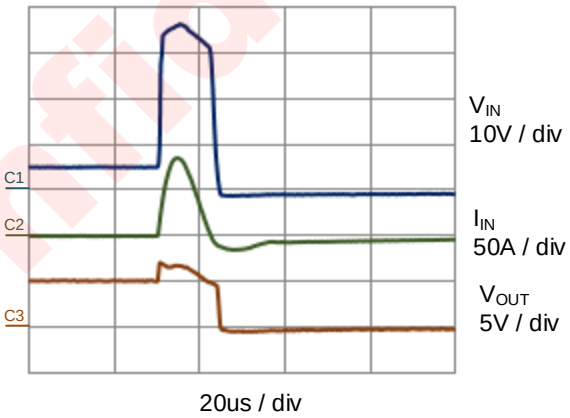

Figure 16 210V Surge Response (AW32605, C_{IN} = 1μF, C_{OUT} = 1μF)

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Detailed Functional Description

Device Operation

If the AW326XX is enabled and the input voltage is between UVLO and OVP threshold, the internal charge pump begins to work after 15ms debounce time, the gate of the nFET switch will be slowly charged high till the switch is fully on. The OVP switch features an ultra-low 33mΩ (typ.) on-resistance MOSFET and protects low-voltage system against voltage faults up to $29V_{DC}$. If the input voltage exceeds the OVP trip level, the switch will be turned off in about 50ns.

Surge Protection

The AW326XX integrates a clamp circuit to suppress input surge voltage. For surge voltages between V_{IN_OVLO} and V_{IN_CLAMP}, the switch will be turned off but the clamp circuit will not work. For surge voltages greater than V_{IN_CLAMP}, the internal clamp circuit will detect surge voltage level and discharge the surge energy to ground. The device can suppress surge voltages up to ±200V.

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:

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

For example, if we select R_1 = 510kΩ and R_2 = 51kΩ, then the new OVP threshold calculated from the above formula is 13.2V. The OVP threshold 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} (1.2V typical) to judge whether input supply is over-voltage.

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. It is recommend to pull ENB low in OTG mode, 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.

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PCB Layout Consideration

To make fully use of the performance of AW326XX, 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 AW326XX) and close to IN pin, and place the output capacitor C_{OUT} on the top layer (same layer as the AW326XX) and close to OUT pin.

2. 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.

3. The path from device ground pins to the system ground plane must be as short as possible.

4. The power trace from USB connector to AW326XX may suffer from ESD event, keep other traces away from it to minimize possible EMI and ESD coupling.

5. Use rounded corners on the power trace from USB connector to AW326XX to decrease EMI coupling.

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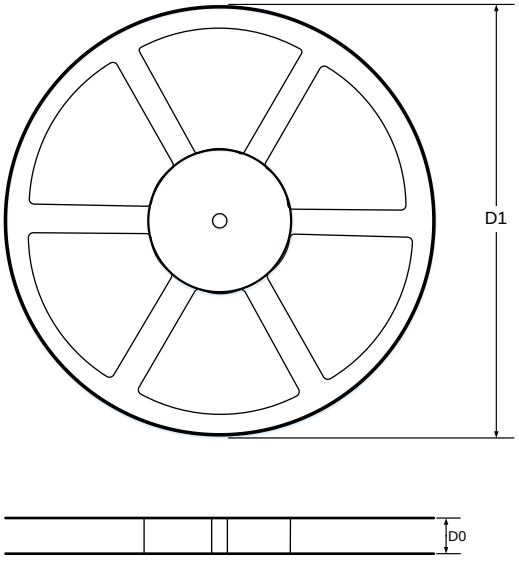
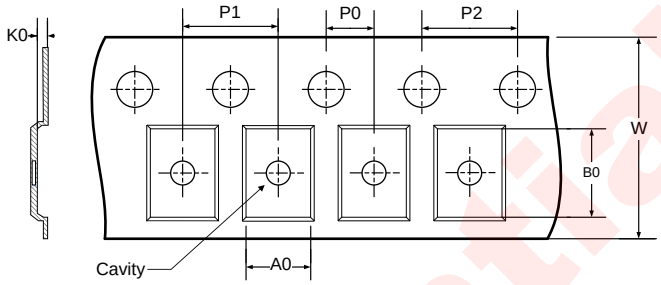
Tape and Reel Information

REEL DIMENSIONS

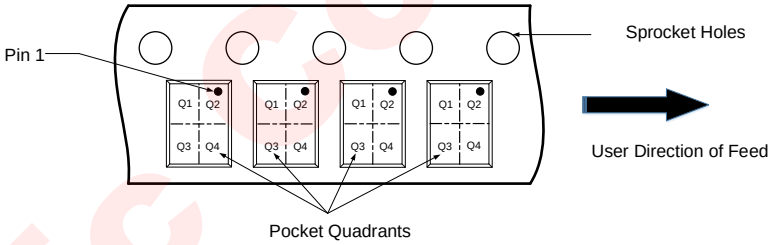


TAPE DIMENSIONS



A0：Dimension designed to accommodate the component width
B0：Dimension designed to accommodate the component length
K0：Dimension designed to accommodate the component thickness
W：Overall width of the carrier tape
P0：Pitch between successive cavity centers and sprocket hole
P1：Pitch between successive cavity centers
P2：Pitch between sprocket hole
D1：Reel Diameter
D0：Reel Width

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



All Dimensions are nominal

D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
179.00	9.00	1.40	2.10	0.76	2.00	4.00	4.00	8.00	Q2

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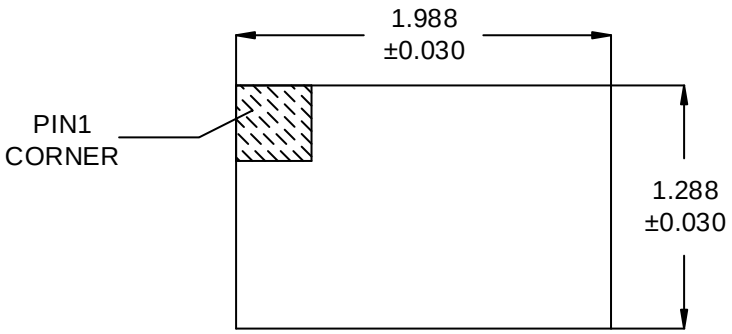
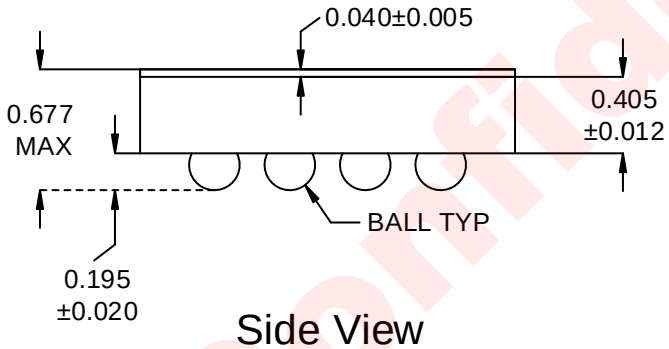
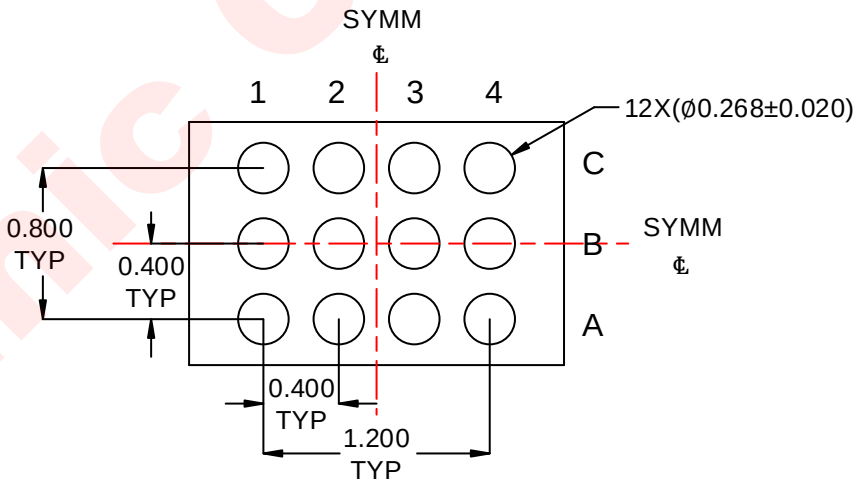
Package Description



Top View



Side View



Bottom View

Unit: mm

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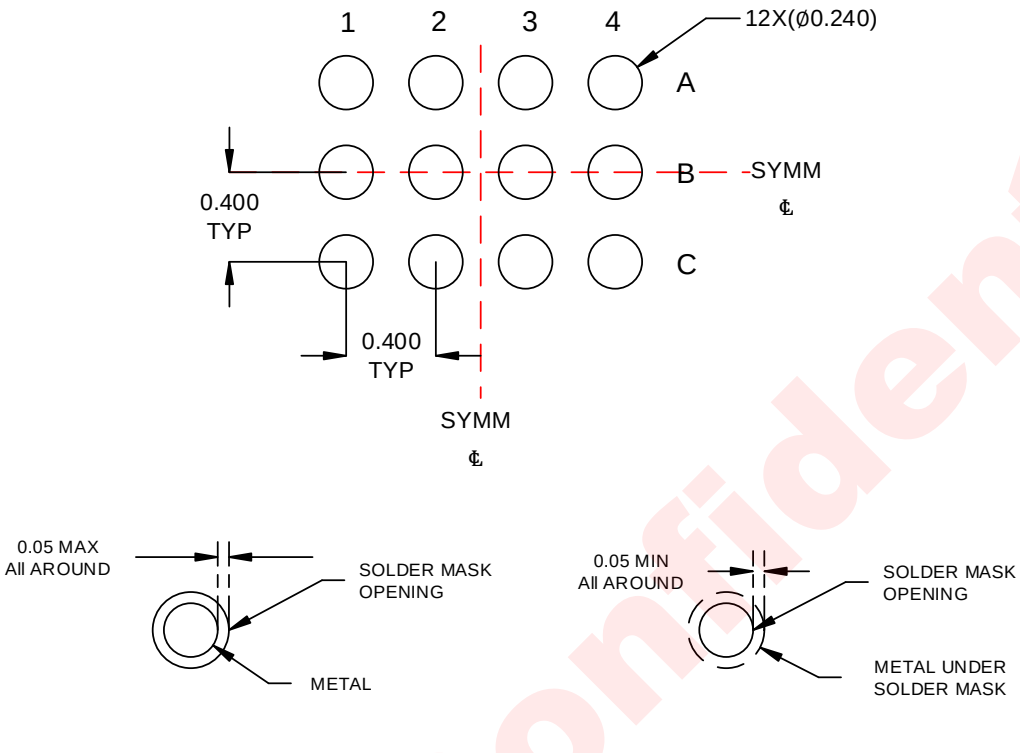
Land Pattern Data



NON SOLDER MASK DEFINED

SOLDER MASK DEFINED

Unit: mm

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Revision History

Version	Date	Change Record
V1.0	November 2018	Datasheet V1.0 Officially Released

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