Over-Voltage Protection Load Switch

FEATURES

- Integrated low R_{dson} nFET switch: typical 29mΩ
- 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: $35V_{DC}$
- 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 29mΩ (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 $35V_{DC}$.

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

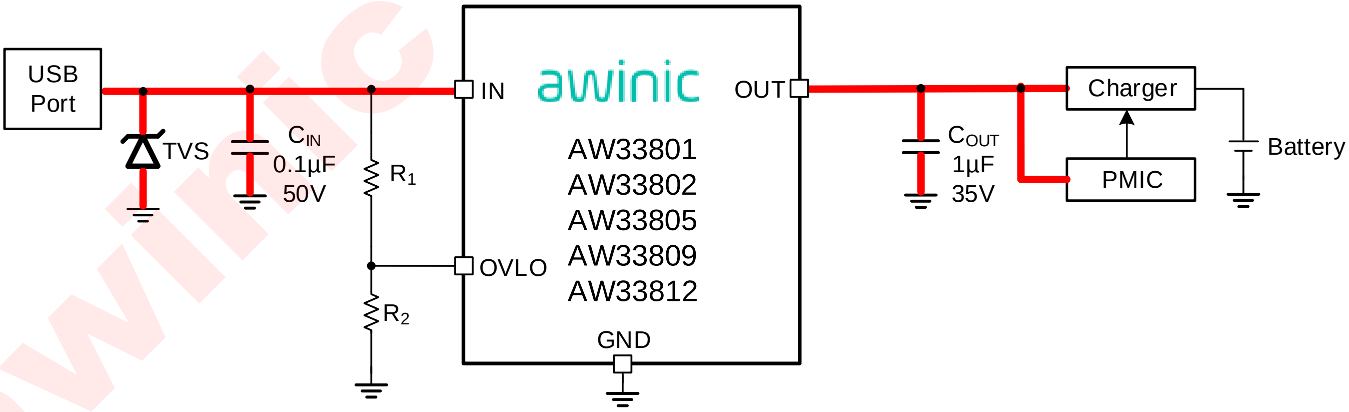


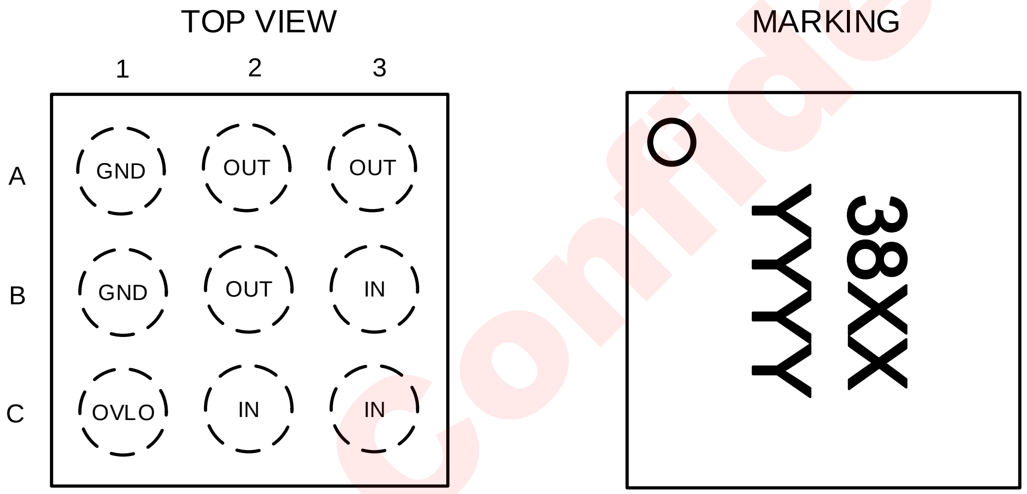
Figure 1 AW338XX typical application circuit

All the trademarks mentioned in the document are the property of their owners.

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



38XX – AW33801/AW33802/
AW33805/AW33809/AW33812
YYYY – Production tracking code

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

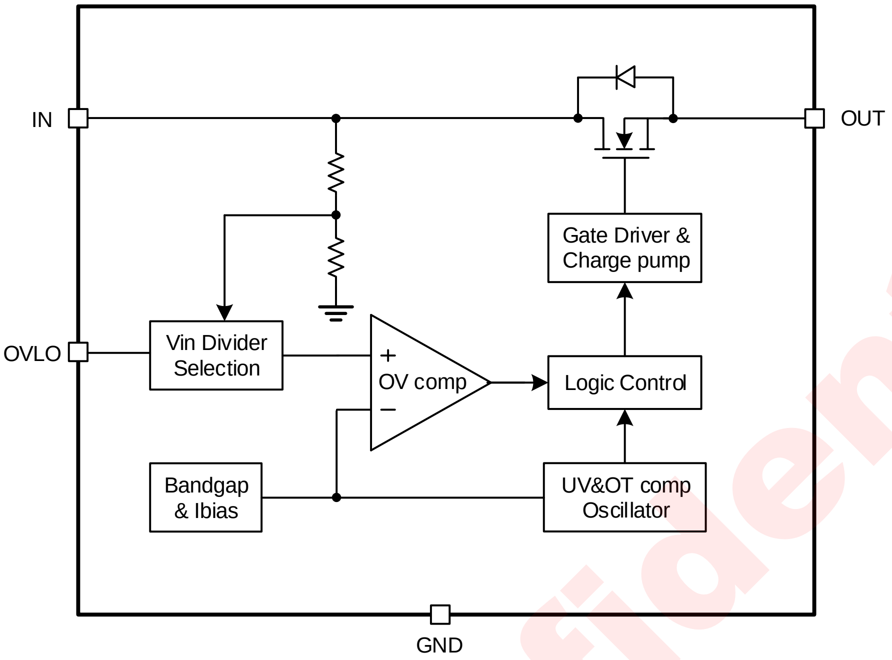

IN
OUT
OVLO
GND
Gate Driver & Charge pump
Vin Divider Selection
+
OV comp
−
Logic Control
Bandgap & Ibias
UV&OT comp Oscillator

Figure 3 **Functional Block Diagram**

TYPICAL APPLICATION CIRCUITS

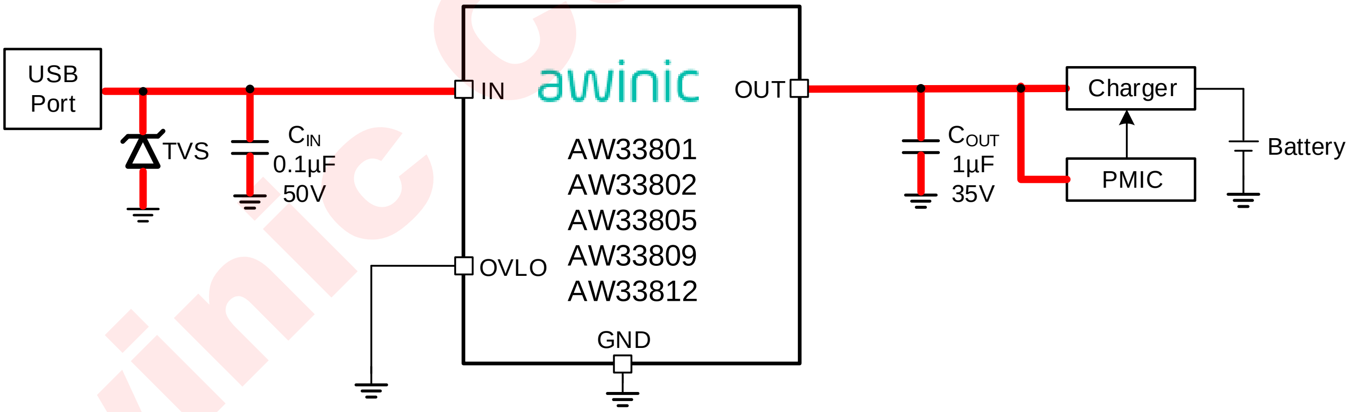

USB Port
TVS
C_{IN}
0.1µF
50V
IN
awinic
OUT
AW33801
AW33802
AW33805
AW33809
AW33812
OVLO
GND
C_{OUT}
1µF
35V
Charger
PMIC
Battery

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

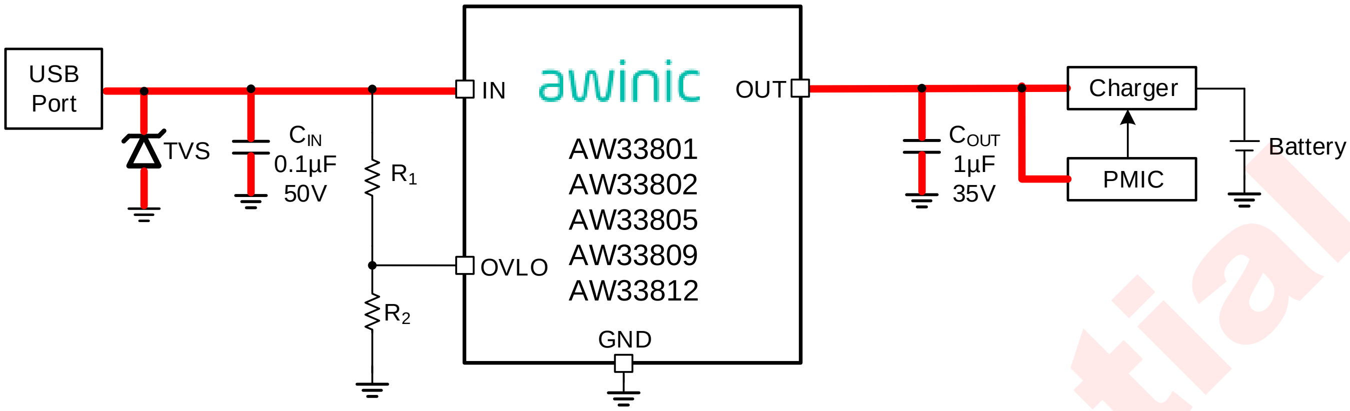
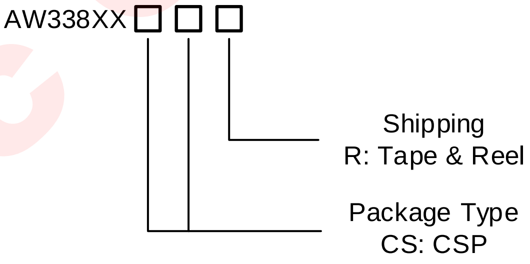

USB
Port
TVS
C_IN
0.1µF
50V
R1
R2
IN
OVLO
awinic
AW33801
AW33802
AW33805
AW33809
AW33812
GND
OUT
C_OUT
1µF
35V
Charger
PMIC
Battery

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 × 1.245mm × 0.597mm WLCSP-9	3801	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33802CSR	-40°C – 85°C	1.245mm × 1.245mm × 0.597mm WLCSP-9	3802	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33805CSR	-40°C – 85°C	1.245mm × 1.245mm × 0.597mm WLCSP-9	3805	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33809CSR	-40°C – 85°C	1.245mm × 1.245mm × 0.597mm WLCSP-9	3809	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel
AW33812CSR	-40°C – 85°C	1.245mm × 1.245mm × 0.597mm WLCSP-9	3812	MSL1	ROHS+HF	Tape and Reel 3000pcs/Reel



ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Symbol	Parameter	Condition	Min.	Max.	Unit
V_{IN}	Input DC voltage		-0.3	35	V
V_{IN_PUL}	Input peak pulse voltage	20μs pulse width, repeat 100 times		45	V
V_{OUT}	Output voltage		-0.3	See(NOTE 2)	V
V_{OVLO}	OVLO voltage		-0.3	7	V
I_{IN}	Switch current(NOTE 3)	Continuous current		4.5	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

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 VIN+0.3V, whichever is smaller.

NOTE3: Limited by thermal design.

THERMAL INFORMATION

Symbol	Parameter	Condition	Value	Unit
$R_{\theta JA}$	Thermal resistance from junction to ambient (NOTE 1)	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_{ESD}	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
$I_{Latch\text{-}up}$	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_{IN}	Input DC voltage	2.5		30	V
C_{IN}	Input capacitance		0.1		μF
C_{OUT}	Output load capacitance		1	100	μF

ELECTRICAL CHARACTERISTICS

T_A = -40°C to 85°C unless otherwise noted. Typical values are guaranteed for V_{IN} = 5V, C_{IN} = 0.1µF, I_{IN}≤ 4.5A and T_A = 25°C.

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

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

TIMING DIAGRAM

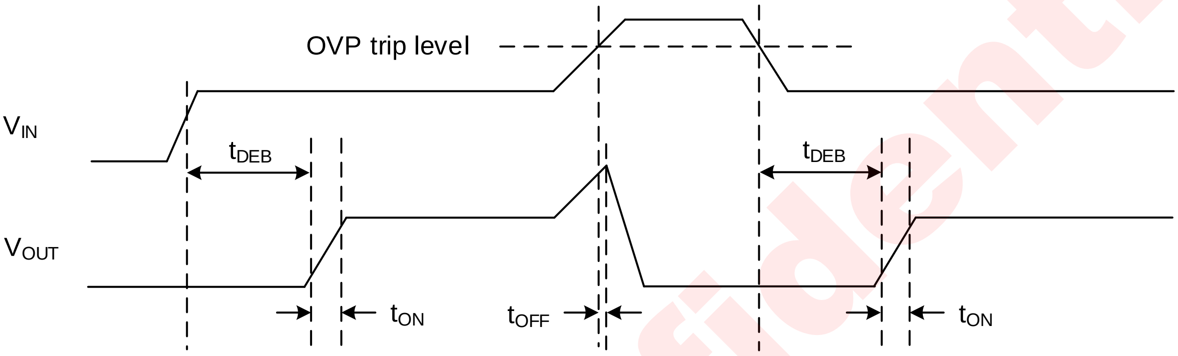


Figure 6 Timing diagram

TYPICAL CHARACTERISTICS

Table 1 Table of Figures

INDEX	Figure No
Normalized R_{dson} vs. Output Current	**FIGURE 7**
Normalized R_{dson} vs. Temp. (I_{OUT} = 1A)	**FIGURE 8**
Normalized R_{dson} vs. Input Voltage (I_{OUT} = 1A)	**FIGURE 9**
Input Supply Current vs. Supply Voltage	**FIGURE 10**
Normalized Internal OVP Threshold	**FIGURE 11**
Normalized External OVP Threshold	**FIGURE 12**
Normalized Debounce Time vs. Temp	**FIGURE 13**
Power-up (C_{OUT} = 1μF, 100mA load)	**FIGURE 14**
Power-up (C_{OUT} = 100μF, 100mA load)	**FIGURE 15**
OVP Response (AW33801)	**FIGURE 16**
Recovery from OVP(AW33801)	**FIGURE 17**

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

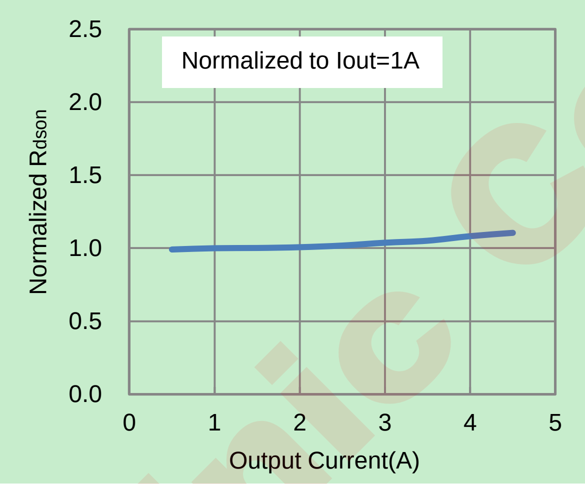


Figure 7 Normalized R_{dson} vs. Output Current

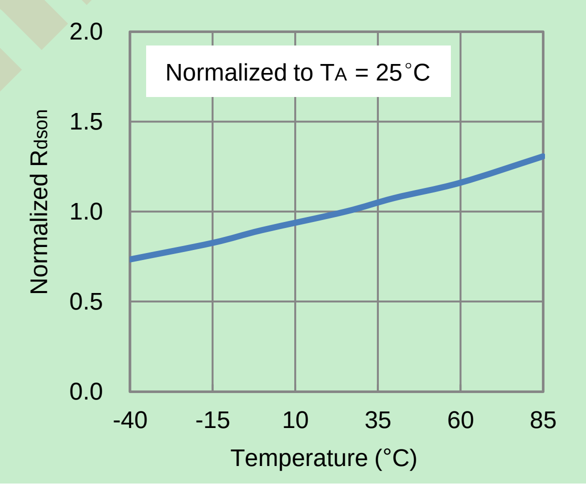


Figure 8 Normalized R_{dson} vs. Temp. (I_{OUT} = 1A)

TYPICAL CHARACTERISTICS (CONTINUED)

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

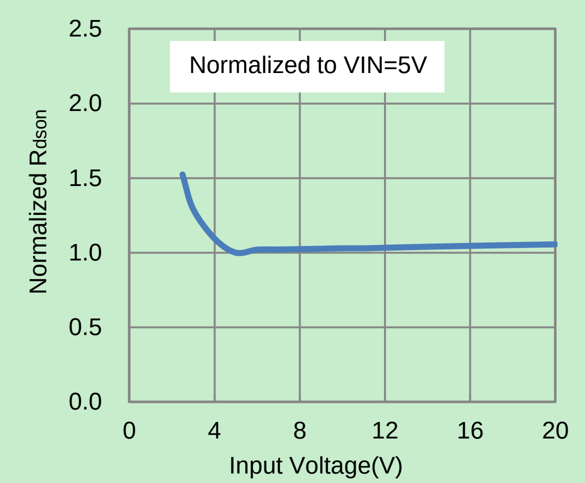


Figure 9 Normalized R_{dson} vs. Input Voltage (I_{OUT} = 1A)

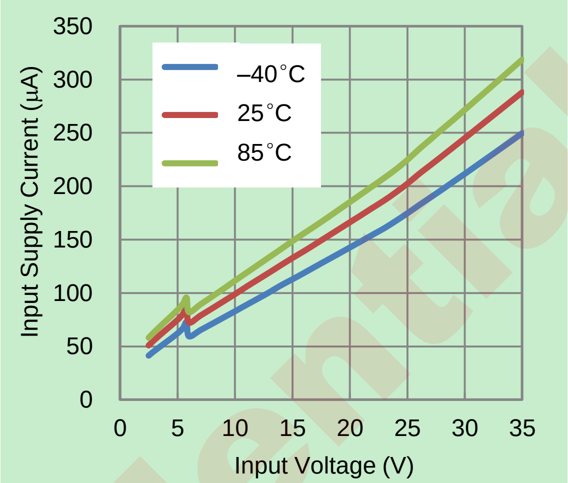


Figure 10 Input Supply Current vs. Supply Voltage

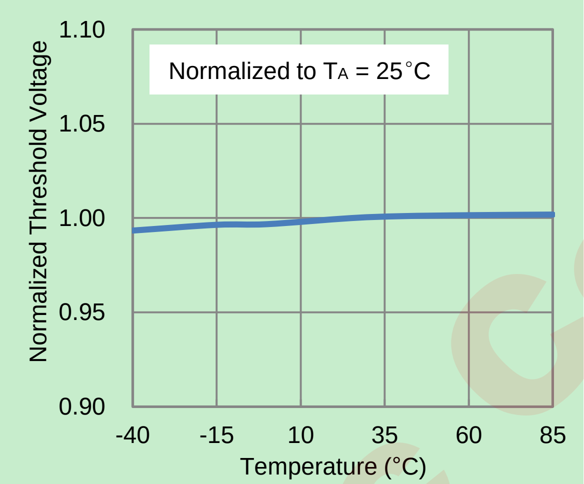


Figure 11 Normalized Internal OVP Threshold

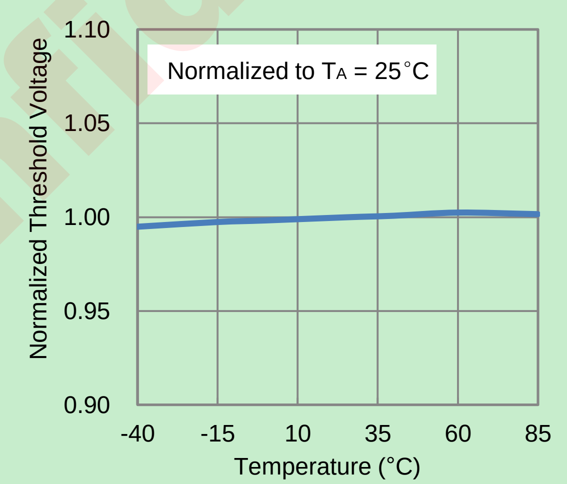


Figure 12 Normalized External OVP Threshold

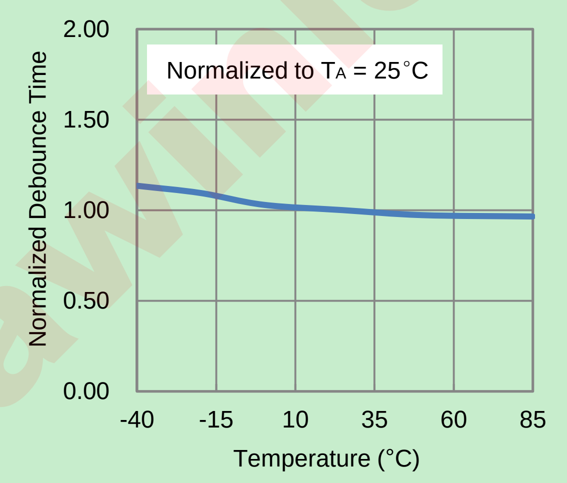


Figure 13 Normalized Debounce Time vs. Temp.

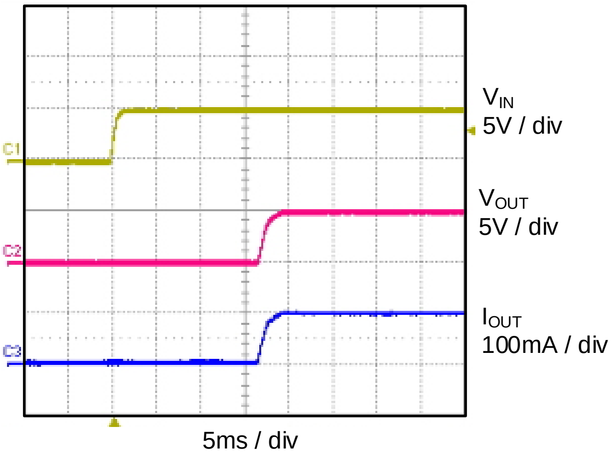


Figure 14 Power-up (C_{OUT} = 1µF, 100mA load)

TYPICAL CHARACTERISTICS (CONTINUED)

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

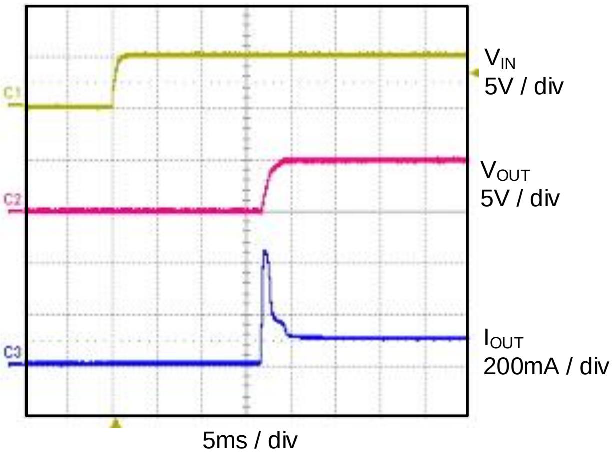


Figure 15 Power-up (C_{OUT} = 100μF, 100mA load)

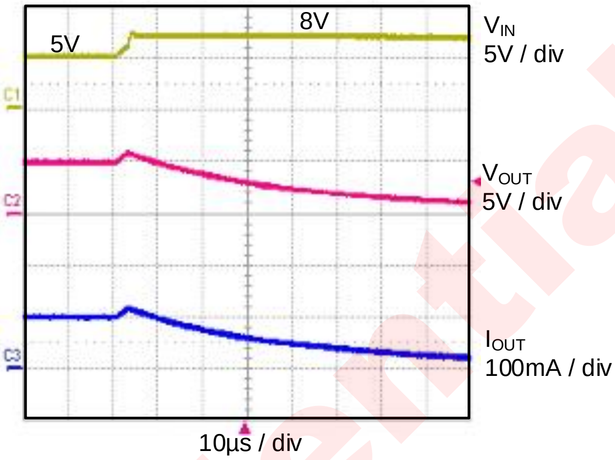


Figure 16 OVP Response (AW33801)

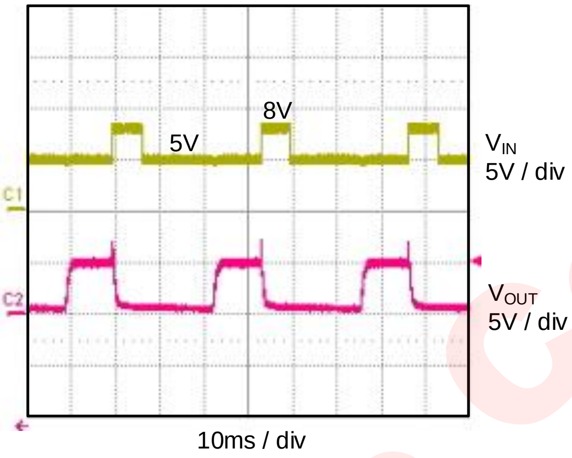


Figure 17 Recovery from OVP(AW33801)

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 = 51kΩ and R_2 = 12.4kΩ, 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

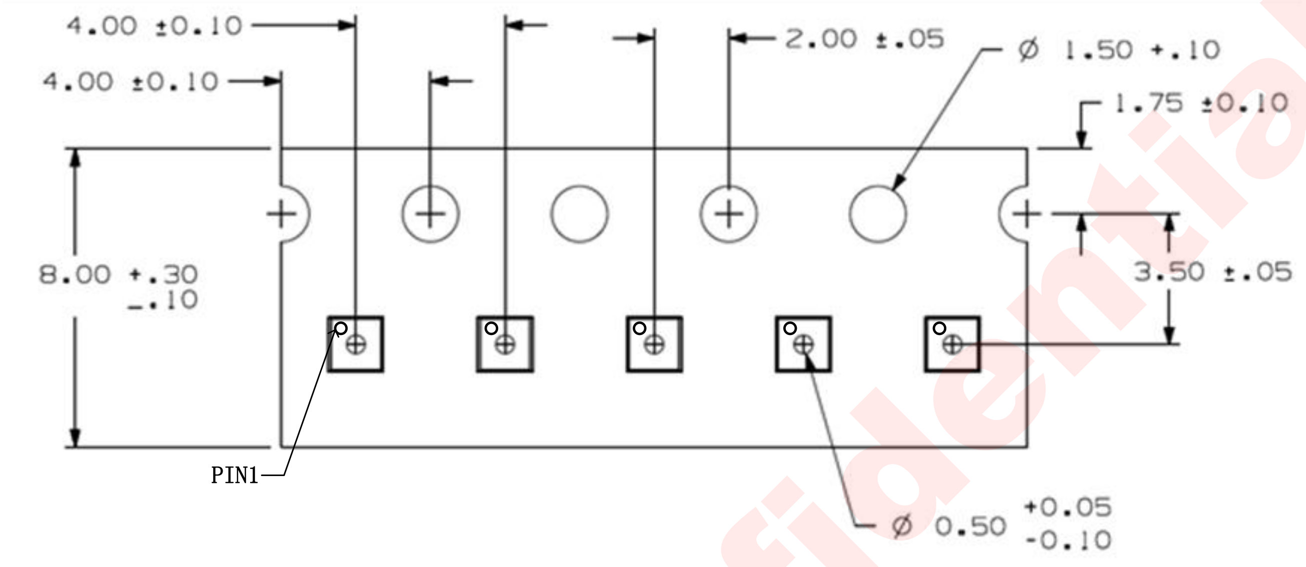
To make fully use of the performance of AW338XX, the guidelines below should be followed.

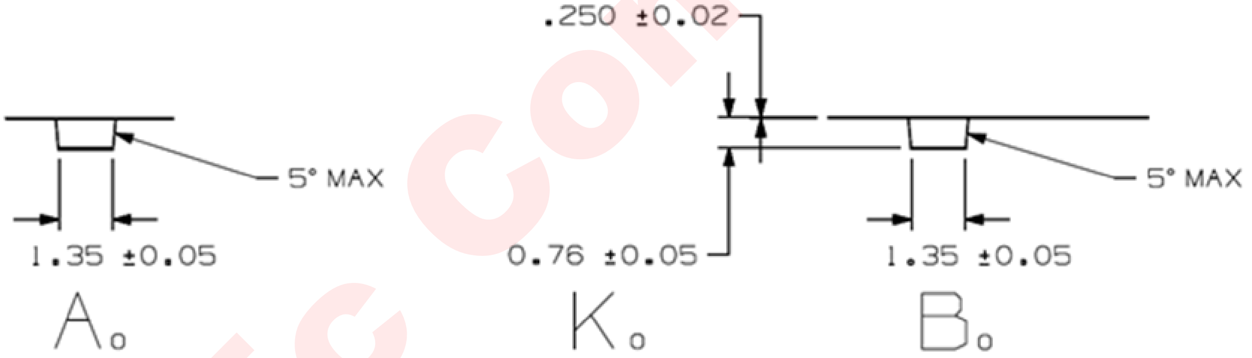
1. All the peripherals should be placed as close to the device as possible. Place the input capacitor C_{IN} on the top layer (same layer as the AW338XX) and close to IN pin, and place the output capacitor C_{OUT} on the top layer (same layer as the AW338XX) and close to OUT pin.

2. Route the power line (shown in Figure 1) as widely and shortly as possible to reduce parasitic impedance.

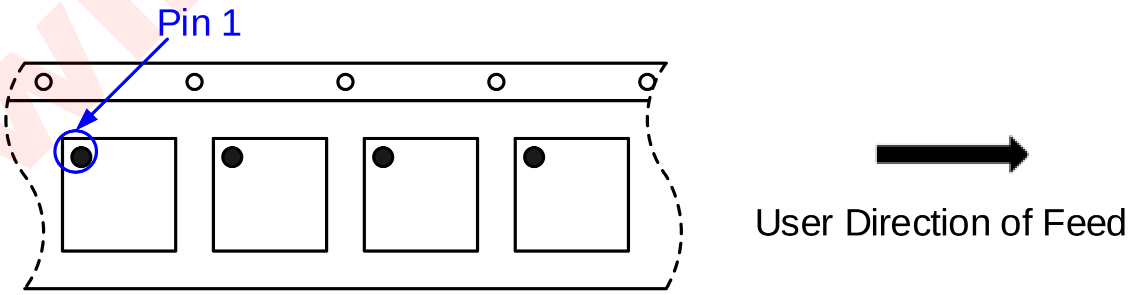
TAPE AND REEL INFORMATION

CARRIER TAPE

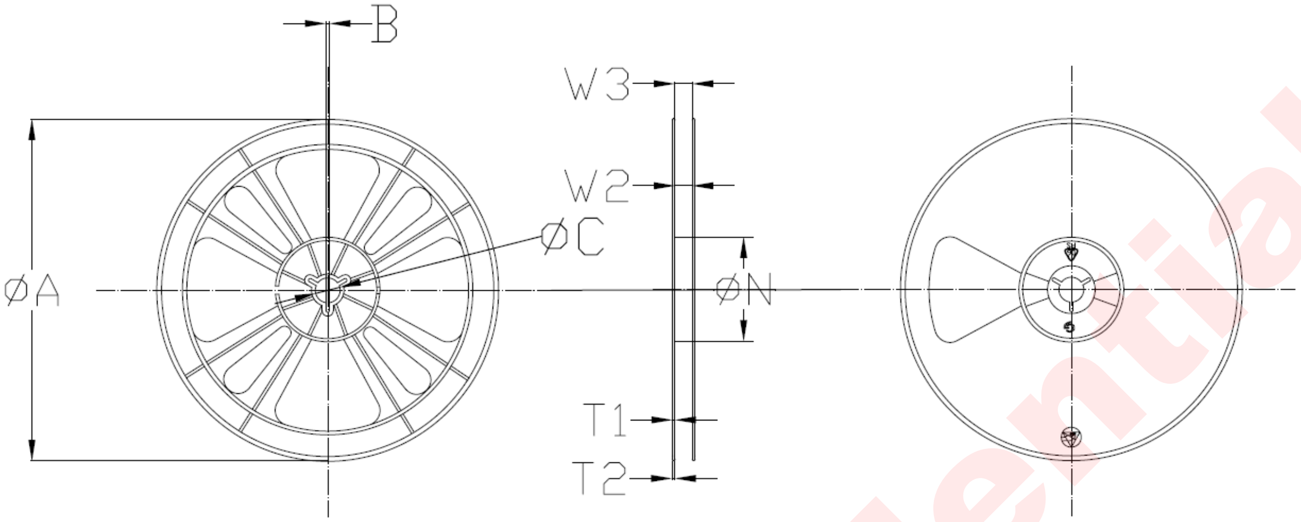

4.00 ±0.10
4.00 ±0.10
2.00 ±.05
Ø 1.50 +.10
1.75 ±0.10
8.00 +.30 -.10
3.50 ±.05
PIN1
Ø 0.50 +0.05 -0.10

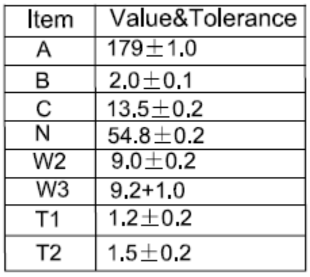

.250 ±0.02
5° MAX
5° MAX
1.35 ±0.05
0.76 ±0.05
1.35 ±0.05
A_0
K_0
B_0

Pin 1 direction


Pin 1
User Direction of Feed

REEL





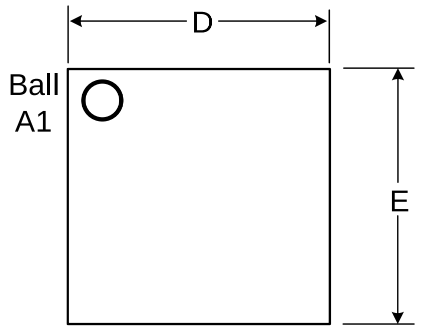
Item	Value&Tolerance
A	179±1.0
B	2.0±0.1
C	13.5±0.2
N	54.8±0.2
W2	9.0±0.2
W3	9.2+1.0
T1	1.2±0.2
T2	1.5±0.2

NOTE:

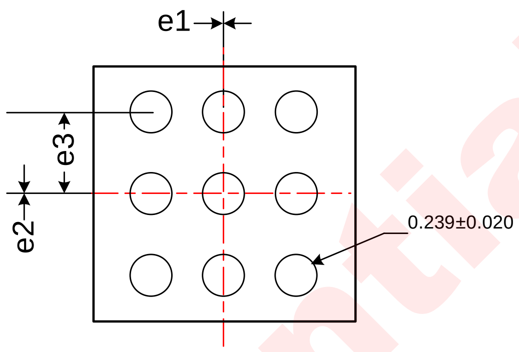
1. Unit: mm;
2. Surface resistivity: 10^5 to 10^{11} ohms/sq;
3. Restriction criterion of hazardous substance for packing material follow GP-M001.

PACKAGE DESCRIPTION

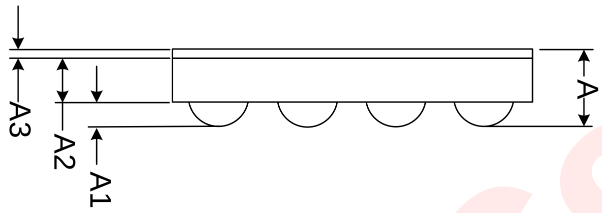
TOP VIEW



BOTTOM VIEW



SIDE VIEW



Symbol	NOM	Tolerance
A	0.597	±0.055
A1	0.177	±0.020
A2	0.380	±0.025
A3	0.040	±0.010
D	1.245	±0.025
E	1.245	±0.025
e1	0	NA
e2	0	NA
e3	0.400	NA

Unit: mm

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

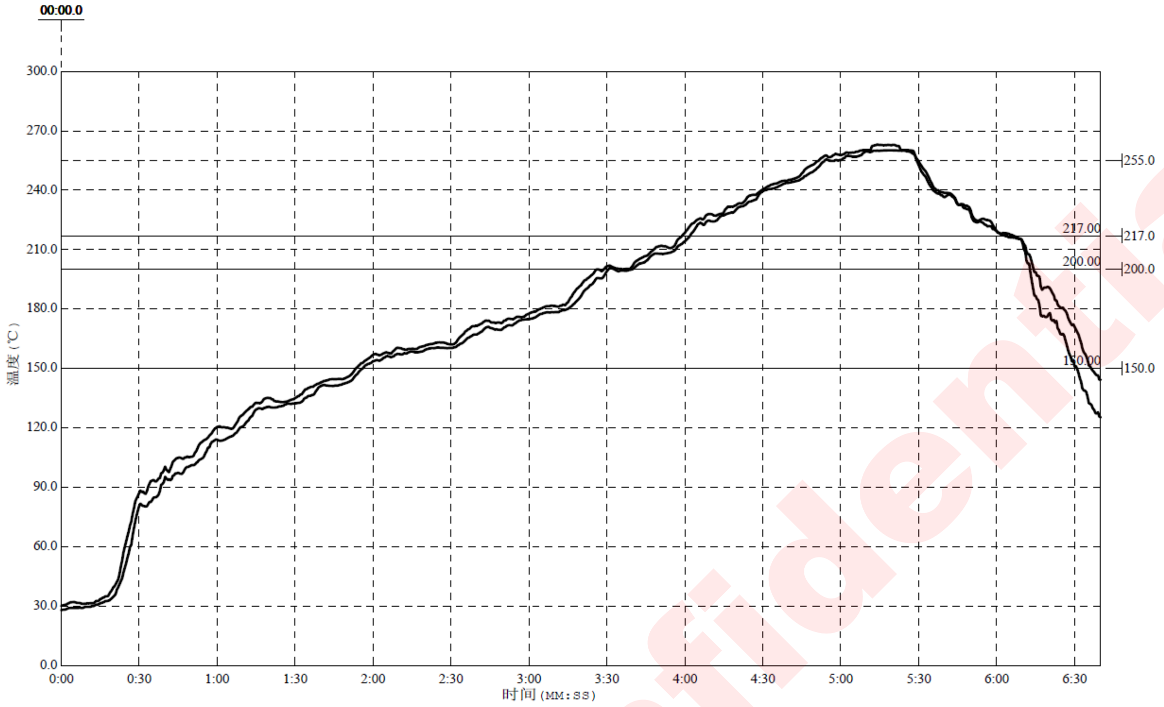


Figure 15 Package Reflow Oven Thermal Profile

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

DISCLAIMER

Information in this document is believed to be accurate and reliable. However, Shanghai AWINIC Technology Co., Ltd (AWINIC Technology) does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

AWINIC Technology reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. Customers shall obtain the latest relevant information before placing orders and shall verify that such information is current and complete. This document supersedes and replaces all information supplied prior to the publication hereof.

AWINIC Technology products are not designed, authorized or warranted to be suitable for use in medical, military, aircraft, space or life support equipment, nor in applications where failure or malfunction of an AWINIC Technology product can reasonably be expected to result in personal injury, death or severe property or environmental damage. AWINIC Technology accepts no liability for inclusion and/or use of AWINIC Technology products in such equipment or applications and therefore such inclusion and/or use is at the customer’s own risk.

Applications that are described herein for any of these products are for illustrative purposes only. AWINIC Technology makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.
All products are sold subject to the general terms and conditions of commercial sale supplied at the time of order acknowledgement.

Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Reproduction of AWINIC information in AWINIC data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. AWINIC is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of AWINIC components or services with statements different from or beyond the parameters stated by AWINIC for that component or service voids all express and any implied warranties for the associated AWINIC component or service and is an unfair and deceptive business practice. AWINIC is not responsible or liable for any such statements.