

2A Ultra-small Load Switch with Slew Rate Control

Features

- Integrated P-channel MOSFET load switch
- Input voltage: 1V to 5.5V
- 2A maximum continuous switch current
- Switch on-resistance(typ.):
Rdson=52mΩ at VIN=5.5V
Rdson=57mΩ at VIN=4.2V
Rdson=64mΩ at VIN=3.3V
Rdson=76mΩ at VIN=2.5V
Rdson=100mΩ at VIN=1.8V
Rdson=164mΩ at VIN=1.2V
Rdson=230mΩ at VIN=1V
- Controlled slew rate to limit inrush currents
- Ultra low shutdown current
- Internal EN pull-down/up resistor
- Quick Output Discharge(QOD) for AW35111/
AW35113/AW35114
- Full time Reverse Current Protection (RCP) for
AW35112/AW35112B/AW35113
- FCDFN 0.8mm×0.8mm-4L package
FOWLP 0.8mm×0.8mm-4B package
FOWLP 0.9mm×0.9mm-4B package

General Description

The AW3511X family load switch integrates a 64mΩ (typ.) P-channel MOSFET, which can operate over a wide input range of 1V to 5.5V. The AW3511X features output slew rate control, limiting inrush currents during turn-on to protect downstream devices.

In addition, AW35111/ AW35113/AW35114 have QOD function which can prevent the output from floating when the switch is disabled.

There is a Reverse Current Protection(RCP) function for AW35112/AW35112B/AW35113 when V_{OUT} is 33mV(typ.) greater than V_{IN} , which can prevent the current to flowing through the P-FET or the body diode. There is no output discharge resistor for AW35112 and AW35112B.

The AW35111FDR/112FDR/113FDR/114FDR is available in FCDFN 0.8mm×0.8mm-4L package, and the AW35111FOR/112BFOR is available in FOWLP 0.8mm×0.8mm-4B package, and the AW35113FOR is available in FOWLP 0.9mm×0.9mm-4B package.

Applications

Smartphones and Tablets

Portable Devices

Wearables

Typical Application Circuit

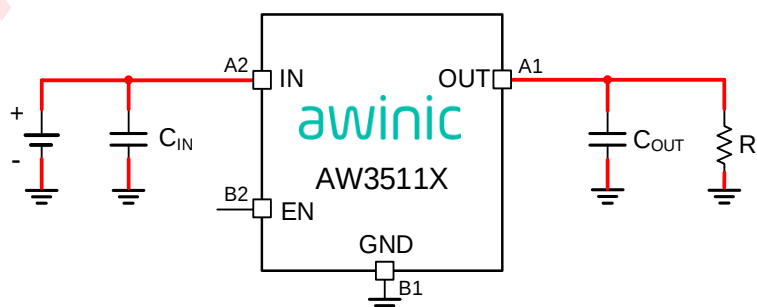


Figure 1 Typical Application Circuit of AW3511X

Pin Configuration And Top Mark

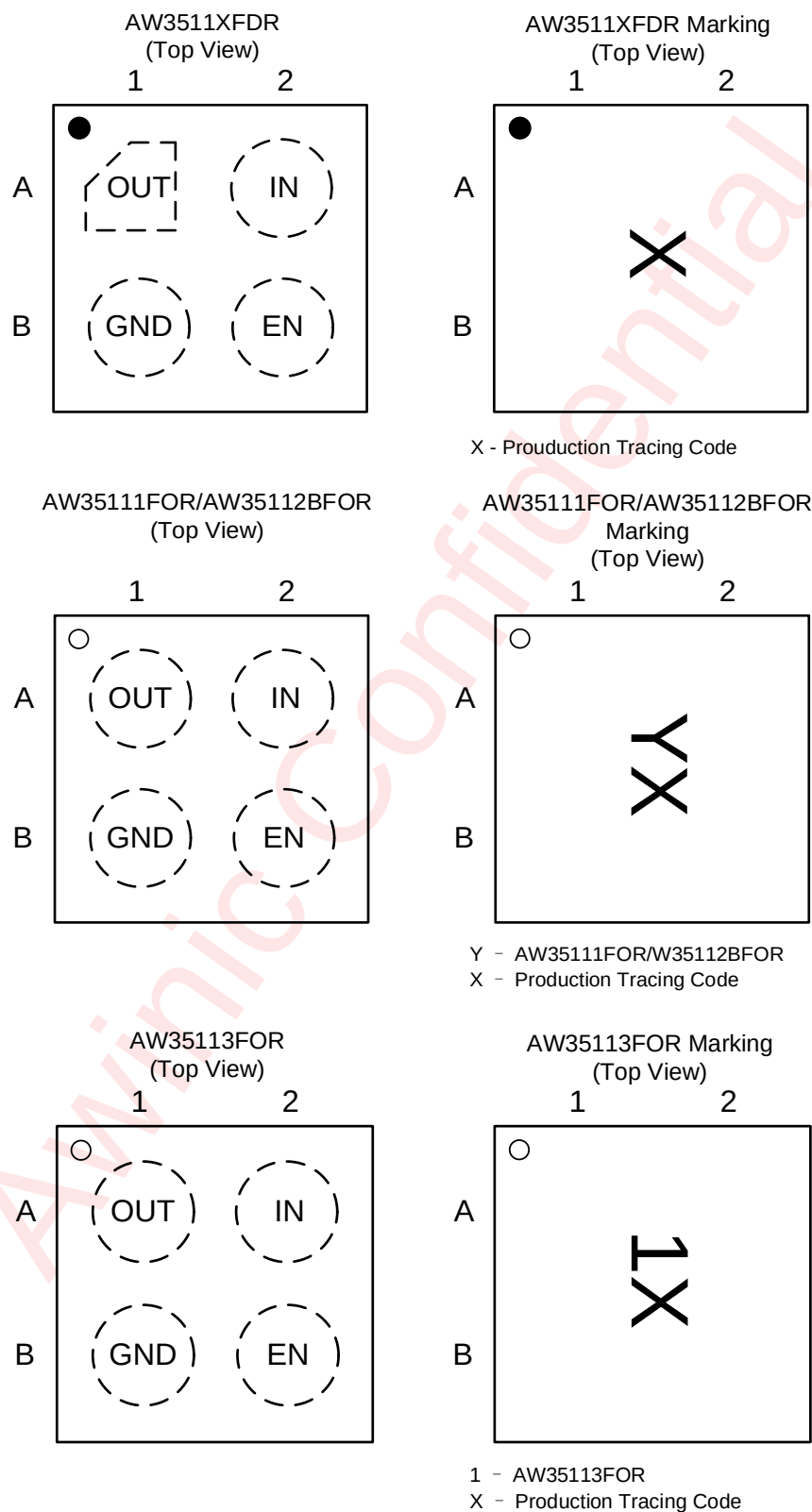


Figure 2 Pin Configuration and Top Mark

Pin Definition

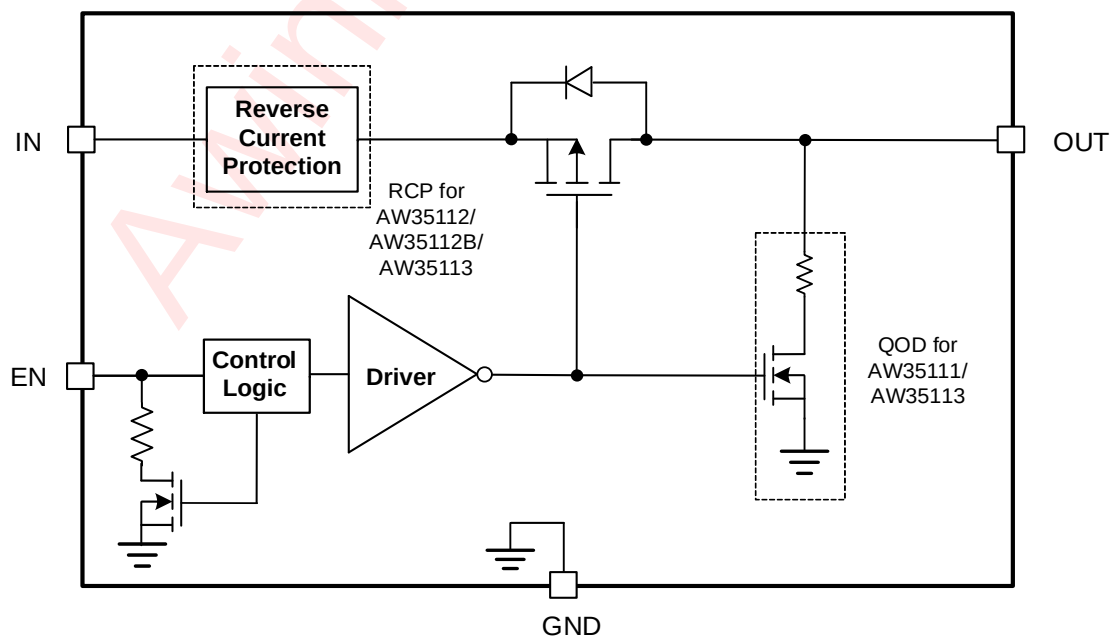
Pin	Name	Description
A1	OUT	Switch output
A2	IN	Switch input and power supply
B1	GND	Device ground
B2	EN	Switch control input, active high for AW35111/112/112B/113, internal 7.2MΩ pull down resistor. And active low for AW35114, internal 7.2MΩ pull up resistor.

Device Comparison Table

Device	EN Pin Activity	QOD	RCP	t_R	t_{ON}	t_{EN}
AW35111FDR	Active High	Y	N	84μs	90μs	50μs
AW35111FOR	Active High	Y	N	84μs	90μs	50μs
AW35112FDR	Active High	N	Y	74μs	83μs	50μs
AW35112BFOR	Active High	N	Y	900μs	970μs	515μs
AW35113FDR	Active High	Y	Y	274μs	285μs	160μs
AW35113FOR	Active High	Y	Y	274μs	285μs	160μs
AW35114FDR	Active Low	Y	N	274μs	285μs	160μs

Functional Block Diagram

- For Enable Active High Version



- **For Enable Active Low Version**

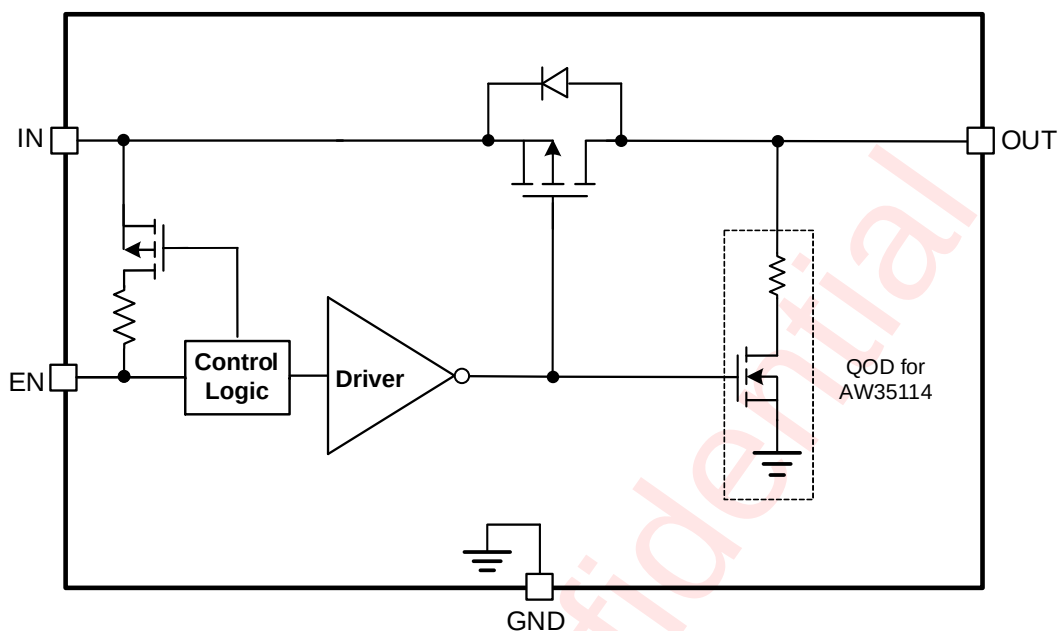


Figure 3 Functional Block Diagram

Typical Application Circuits

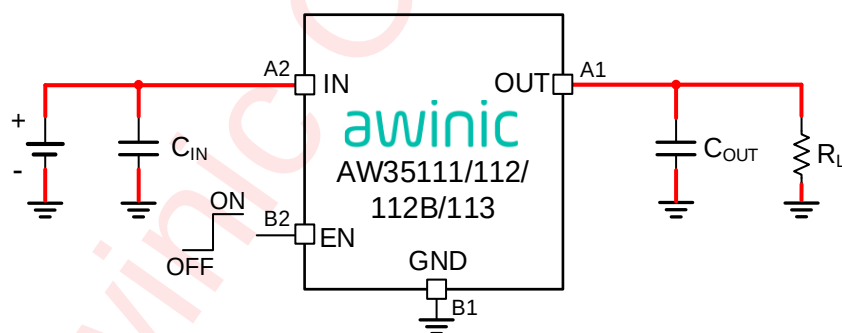


Figure 4 Typical Application Circuit of AW35111/112/112B/113

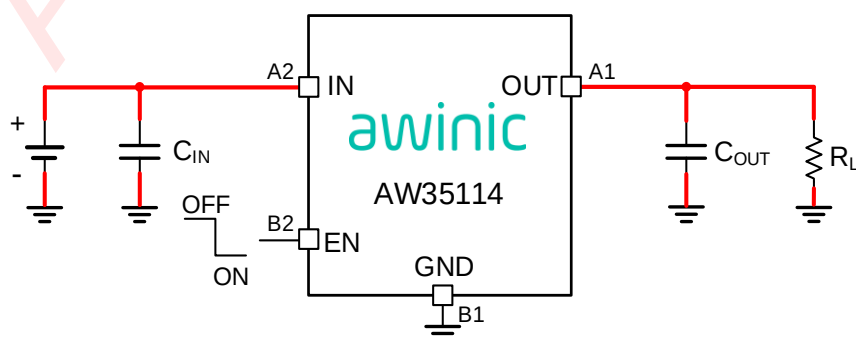


Figure 5 Typical Application Circuit of AW35114

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW35111FDR	-40°C ~ 85°C	FCDFN 0.8mm×0.8mm-4L		MSL1	ROHS+HF	4500 units/ Tape and Reel
AW35111FOR	-40°C ~ 85°C	FOWLP 0.8mm×0.8mm-4B	U	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35112FDR	-40°C ~ 85°C	FCDFN 0.8mm×0.8mm-4L		MSL1	ROHS+HF	4500 units/ Tape and Reel
AW35112BFOR	-40°C ~ 85°C	FOWLP 0.8mm×0.8mm-4B	2	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35113FDR	-40°C ~ 85°C	FCDFN 0.8mm×0.8mm-4L		MSL1	ROHS+HF	4500 units/ Tape and Reel
AW35113FOR	-40°C ~ 85°C	FOWLP 0.9mm×0.9mm-4B	1	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35114FDR	-40°C ~ 85°C	FCDFN 0.8mm×0.8mm-4L		MSL1	ROHS+HF	4500 units/ Tape and Reel

Part Number	Tracing code number	Tracing code range
AW35111FDR	1	A~E, 1~9
AW35112FDR	1	F~K
AW35113FDR	1	L~Q
AW35114FDR	1	R~V

Absolute Maximum Ratings^(NOTE1)

PARAMETERS		RANGE
Supply Voltage Range V_{IN}		-0.3V to 6V
Enable Voltage Range	EN	-0.3V to 6V
Output Voltage Range	OUT	-0.3V to 6V
Maximum Continuous Switch Current for $V_{IN} \geq 2V$		2A
Maximum Continuous Switch Current for $V_{IN} \geq 1.5V$		1.5A
Maximum Continuous Switch Current for $1.2V \leq V_{IN} < 1.5V$ ^(NOTE 2)		1A
Maximum Continuous Switch Current for $1V \leq V_{IN} < 1.2V$ ^(NOTE 2)		0.5A
Maximum Peak Switch Current for $V_{IN} \geq 2.5V$ ^(NOTE 3)		2.5A
Junction-to-ambient Thermal Resistance θ_{JA} ^(NOTE 4)		153°C/W
Operating Free-air Temperature Range		-40°C to 85°C
P_D (Power Dissipation) at $T_A=25^\circ\text{C}$		0.81W
Maximum Junction Temperature T_{JMAX}		150°C
Storage Temperature T_{STG}		-65°C to 150°C
Lead Temperature (Soldering 10 Seconds)		260°C
ESD		
HBM (Human Body Model) ^(NOTE 5)		±2kV
CDM(Charged Device Model) ^(NOTE 6)		±1.5kV
Latch-Up		
Latch-Up ^(NOTE 7)		+IT: 200mA -IT: -200mA

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: The power mos enters saturation region, load capacity is reduced.

NOTE3: Limited by thermal design, and tested in 10ms width pulse current.

NOTE4: Thermal resistance from junction to ambient is highly dependent on PCB layout.

NOTE5: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: ESDA/JEDEC JS-001-2017.

NOTE6: All pins. Test Condition: ESDA/JEDEC JS-002-2018.

NOTE7: Test Condition: JESD78E for AW3511XFDR and JEDEC78E for AW3511XFOR.

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage	1		5.5	V
V_{EN}	EN Voltage	0		5.5	V
V_{OUT}	Output Voltage	0		V_{IN}	V
C_{IN}	Input capacitance	0.1	1		μF
C_{OUT}	Output load capacitance	0.1	1		μF

Electrical Characteristics

T_A = 25°C unless otherwise noted. Typical values are guaranteed for V_{IN} = 3.3V, C_{IN} = 1μF, I_{IN} ≤ 2A.

PARAMETER		TEST CONDITION		MIN	TYP	MAX	UNIT
INPUT CURRENTS							
I _Q	Input quiescent current	AW35111	V _{IN} =V _{EN} =3.3V, I _{OUT} =0A, T _A =25°C		2		nA
			V _{IN} =V _{EN} =3.3V, I _{OUT} =0A, T _A =85°C		8		nA
			V _{IN} =V _{EN} =5.5V, I _{OUT} =0A, T _A =25°C		3		nA
			V _{IN} =V _{EN} =5.5V, I _{OUT} =0A, T _A =85°C		15		nA
		AW35112/112B/113	V _{IN} =V _{EN} =3.3V, I _{OUT} =0A, T _A =25°C		350	1000	nA
			V _{IN} =V _{EN} =3.3V, I _{OUT} =0A, T _A =85°C		400		nA
			V _{IN} =V _{EN} =5.5V, I _{OUT} =0A, T _A =25°C		610	2000	nA
			V _{IN} =V _{EN} =5.5V, I _{OUT} =0A, T _A =85°C		730		nA
		AW35114	V _{IN} =3.3V,V _{EN} =0V, I _{OUT} =0A,T _A =25°C		2		nA
			V _{IN} =3.3V,V _{EN} =0V, I _{OUT} =0A,T _A =85°C		8		nA
			V _{IN} =5.5V,V _{EN} =0V, I _{OUT} =0A,T _A =25°C		3		nA
			V _{IN} =5.5V,V _{EN} =0V, I _{OUT} =0A,T _A =85°C		15		nA
I _{SD}	Shutdown current from IN to GND	AW35111	V _{IN} =3.3V, V _{EN} =0V, T _A =25°C		16		nA
			V _{IN} =3.3V, V _{EN} =0V, T _A =85°C		1000		nA
			V _{IN} =5.5V, V _{EN} =0V, T _A =25°C		35		nA
			V _{IN} =5.5V, V _{EN} =0V, T _A =85°C		1650		nA
		AW35112/112B/113	V _{IN} =3.3V, V _{EN} =0V, T _A =25°C		275	900	nA
			V _{IN} =3.3V, V _{EN} =0V, T _A =85°C		750		nA
			V _{IN} =5.5V, V _{EN} =0V, T _A =25°C		500	1500	nA
			V _{IN} =5.5V, V _{EN} =0V, T _A =85°C		1550		nA
		AW35114	V _{IN} =3.3V, V _{EN} =3.3V, T _A =25°C		16		nA
			V _{IN} =3.3V, V _{EN} =3.3V, T _A =85°C		1000		nA
			V _{IN} =5.5V, V _{EN} =5.5V, T _A =25°C		35		nA
			V _{IN} =5.5V, V _{EN} =5.5V, T _A =85°C		1650		nA
POWER SWITCH							
I _{LEAKEN}	EN pin leakage current	V _{IN} =0V, V _{EN} =5.5V			700	1000	nA
R _{EN}	EN pin pull down resistor	V _{IN} =5V, V _{EN} =0.4V (AW35111/112/112B/113)			7.2		MΩ
	EN pin pull up resistor	V _{IN} =5V, V _{EN} =3V (AW35114)					
R _{DIS}	Output discharge resistance	V _{IN} =5.0V, EN disable, I _{OUT} Sinking 2mA (AW35111/113/114)			88		Ω

Electrical Characteristics (continued)

$T_A = 25^\circ\text{C}$ unless otherwise noted. Typical values are guaranteed for $V_{IN} = 3.3\text{V}$, $C_{IN} = 1\mu\text{F}$, $I_{IN} \leq 2\text{A}$.

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
R _{dson}	Internal switch MOSFET on-state resistance	V _{IN} =5.5V, I _{OUT} =0.2A, T _A =25°C		52	60	mΩ
		V _{IN} =3.3V, I _{OUT} =0.2A, T _A =25°C		64	80	
		V _{IN} =1.8V, I _{OUT} =0.2A, T _A =25°C		100	120	
		V _{IN} =1.2V, I _{OUT} =0.2A, T _A =25°C		164	200	
		V _{IN} =1V, I _{OUT} =0.2A, T _A =25°C		230	280	
POWER SWITCH						
t _R	Output rise time	V _{IN} =3.3V, C _{OUT} =0.1μF, R _{OUT} =10Ω for AW35111 V _{IN} =3.3V, C _{OUT} =1μF, R _{OUT} =30Ω for AW35112/112B/113/114	AW35111		84	μs
			AW35112		74	
			AW35112B		900	
			AW35113/114		274	
t _{ON}	Switch turn on time		AW35111		90	
			AW35112		83	
			AW35112B		970	
			AW35113/114		285	
t _{EN}	Enable time		AW35111		50	
			AW35112		50	
			AW35112B		515	
			AW35113/114		160	
t _F	Output fall time		AW35111		2	
			AW35112		63	
			AW35112B		80	
			AW35113/114		53	
t _{OFF}	Switch turn off time		AW35111		2.5	
			AW35112		15	
			AW35112B		15	
			AW35113/114		13	
V _{IH}	EN input high threshold level		1			V
V _{IL}	EN input low threshold level				0.4	V

Electrical Characteristics (continued)

$T_A = 25^\circ\text{C}$ unless otherwise noted. Typical values are guaranteed for $V_{IN} = 3.3\text{V}$, $C_{IN} = 1\mu\text{F}$, $I_{IN} \leq 2\text{A}$.

PARAMETER	TEST CONDITION	MIN	TYP	MAX	UNIT
REVERSE CURRENT PROTECTION (RCP FOR AW35112/AW35112B/AW35113)					
V_{REV}	Reverse current voltage threshold		33		mV
V_{REV_HYS}	Reverse current voltage hysteresis		27		mV
I_{REV_ACT}	Reverse activation current		0.5		A
I_{REV_PRO}	Reverse protection current		7.5		μA

Timing Diagram

For Enable Active High Version

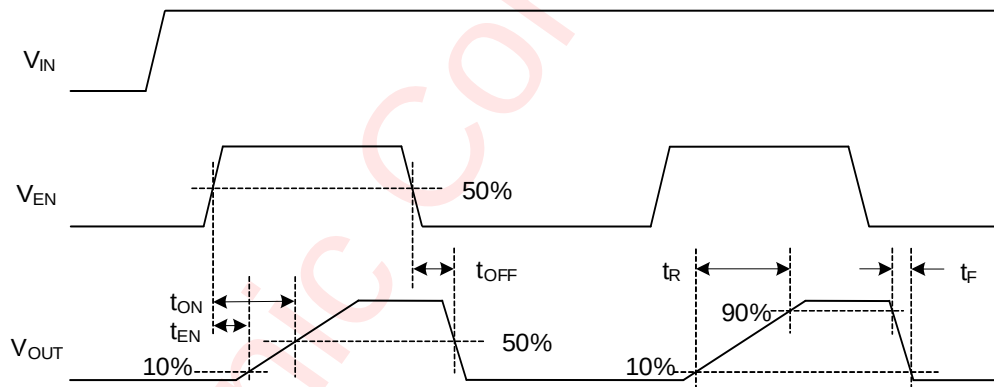


Figure 6 AW35111/112/112B/113 Timing Diagram

For Enable Active Low Version

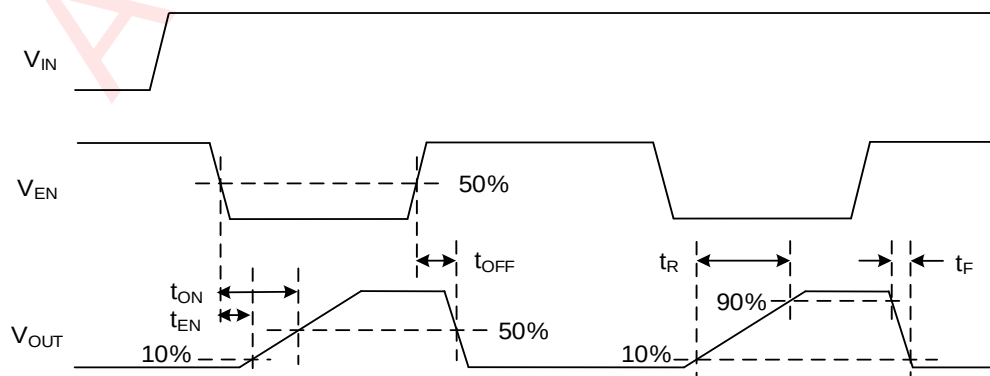


Figure 7 AW35114 Timing Diagram

Typical Characteristics

Ambient temperature is 25°C, $C_{IN} = C_{OUT} = 1\mu F$, unless otherwise noted.

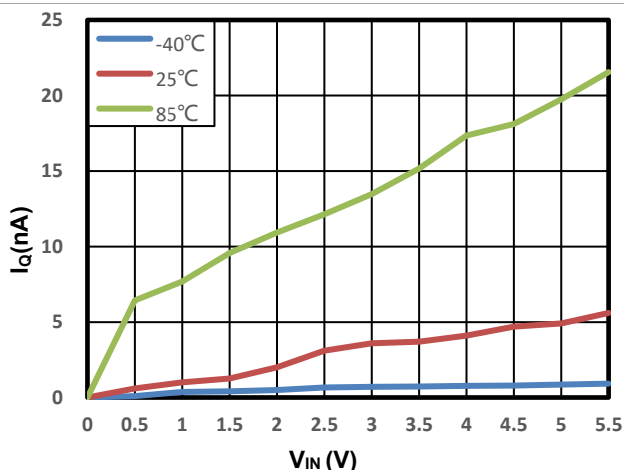


Figure 8 Quiescent Current vs. V_{IN} , No load (AW35111/AW35114)

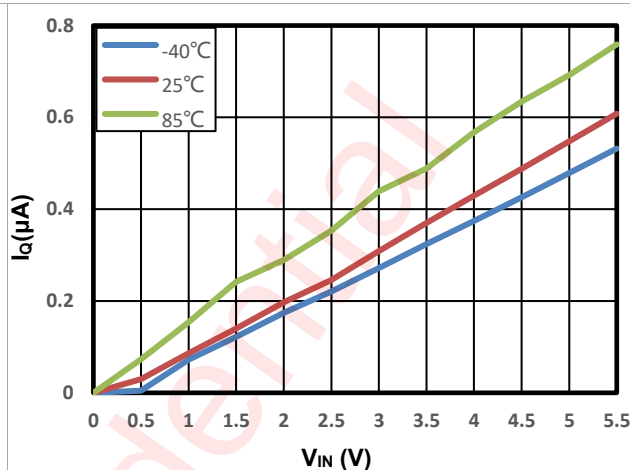


Figure 9 Quiescent Current vs. V_{IN} , $R_{load}=10\Omega$ (AW35112/AW35112B)

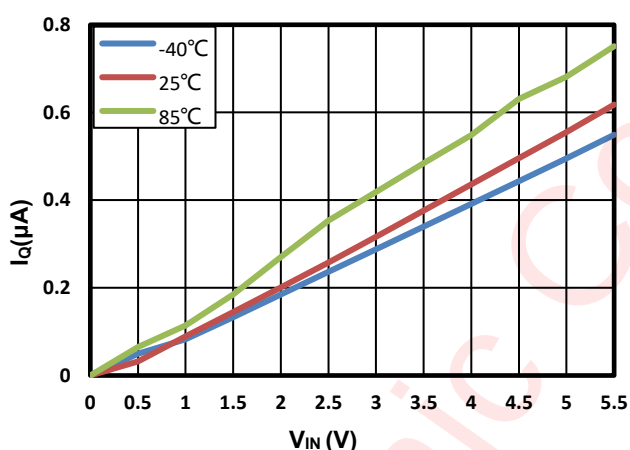


Figure 10 Quiescent Current vs. V_{IN} (AW35113)

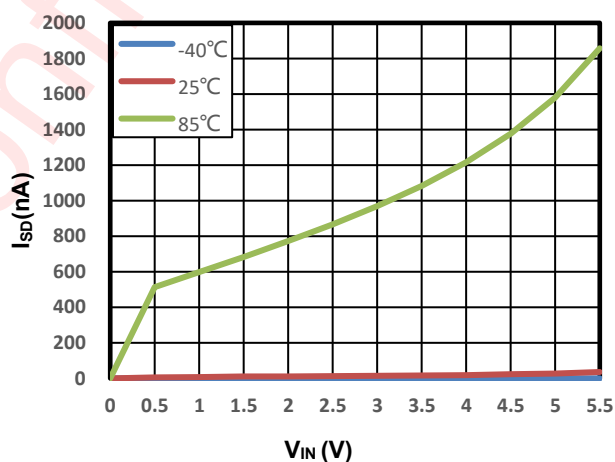


Figure 11 IN Shutdown Current vs. V_{IN} (AW35111/AW35114)

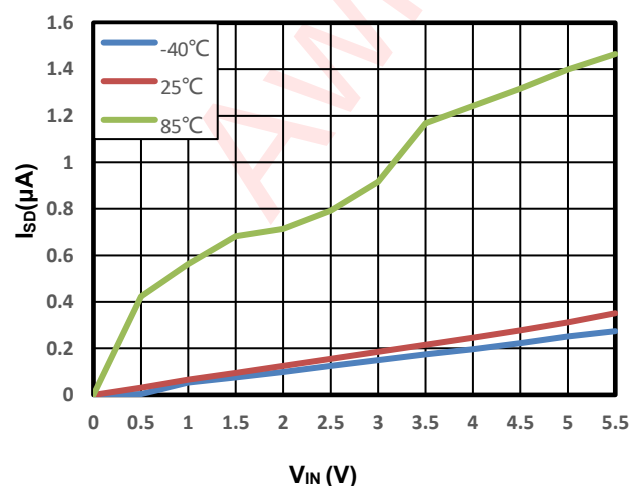


Figure 12 IN Shutdown Current vs. V_{IN} (AW35112/AW35112B)

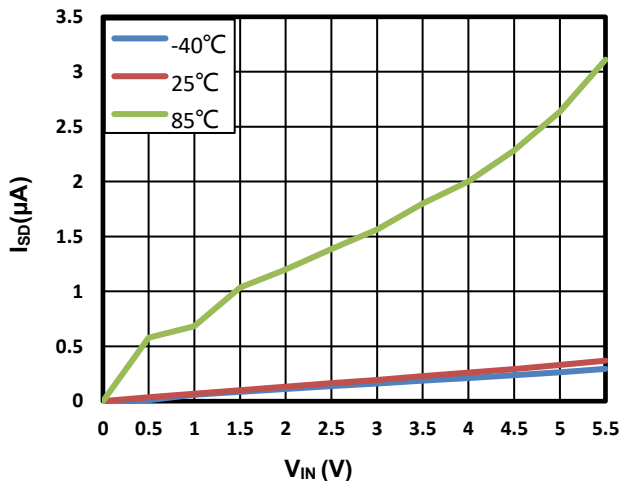


Figure13 IN Shutdown Current vs. V_{IN} (AW35113)

Typical Characteristics (continued)

Ambient temperature is 25°C, $C_{IN} = C_{OUT} = 1\mu F$, unless otherwise noted.

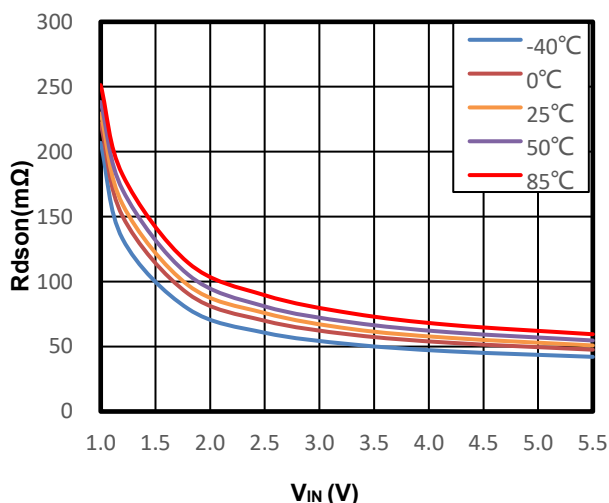


Figure 14 R_{dson} vs. V_{IN} ($I_{OUT} = 200mA$)

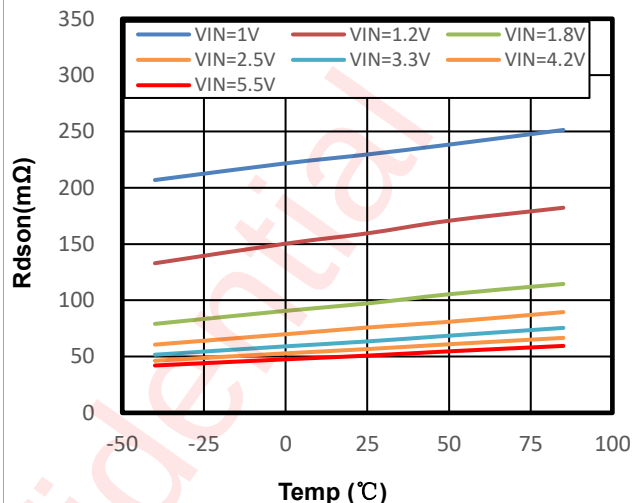


Figure 15 R_{dson} vs. Temperature ($I_{OUT} = 200mA$)

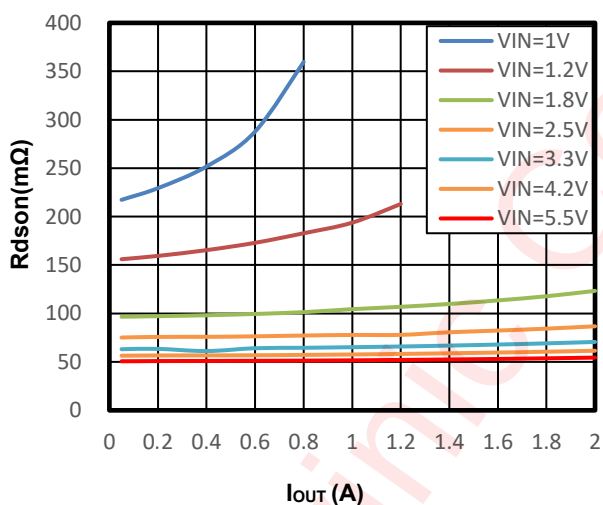


Figure 16 R_{dson} vs. I_{OUT}

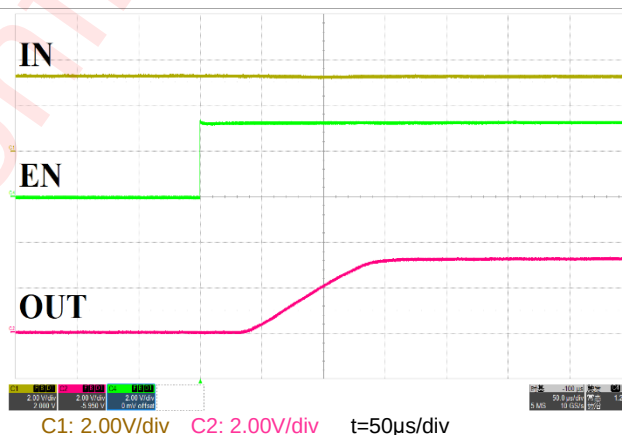


Figure 17 Turn On Response
(AW35111)

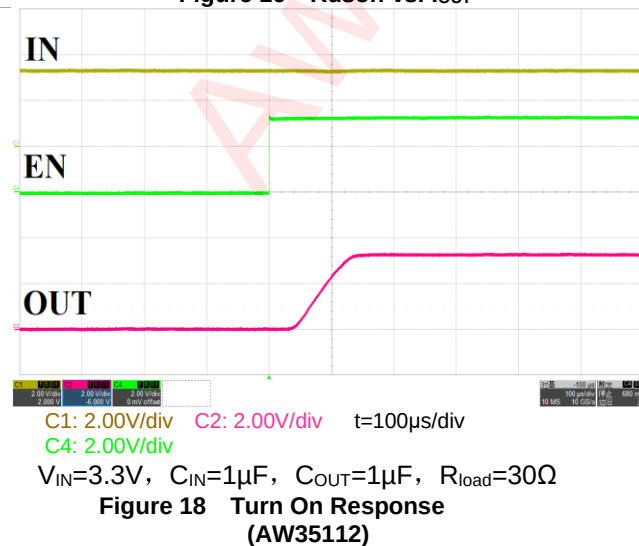


Figure 18 Turn On Response
(AW35112)

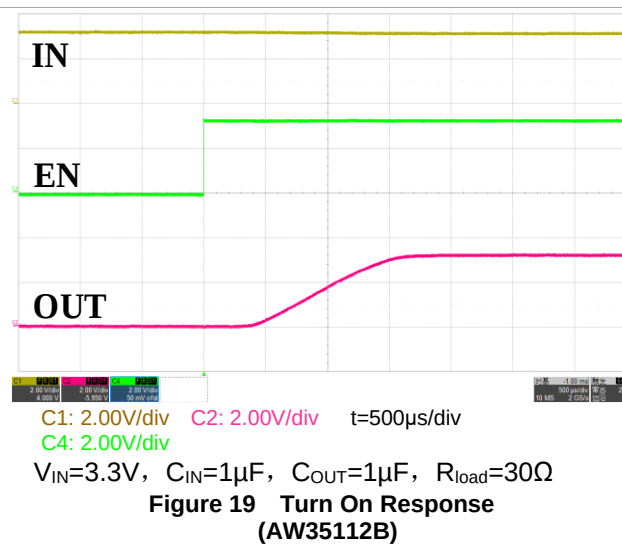
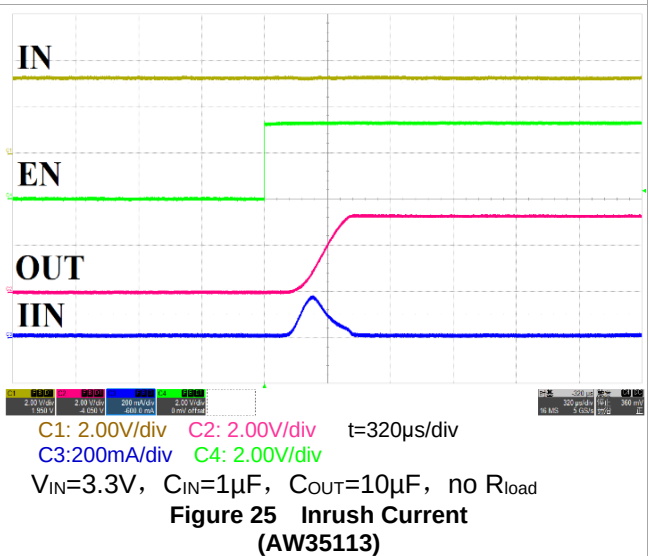
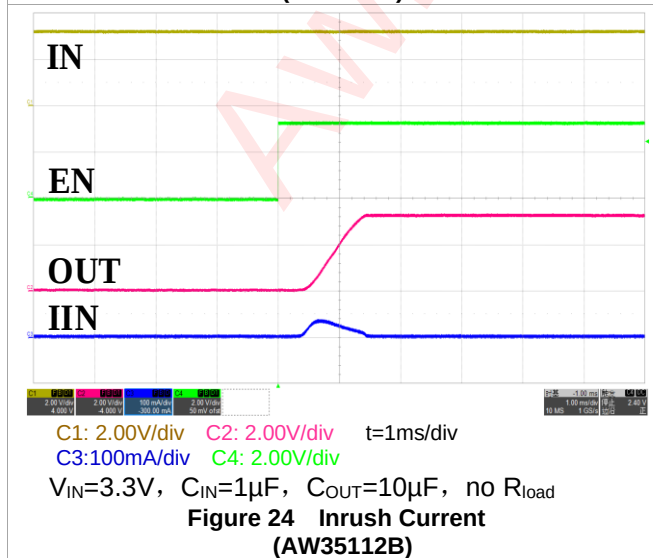
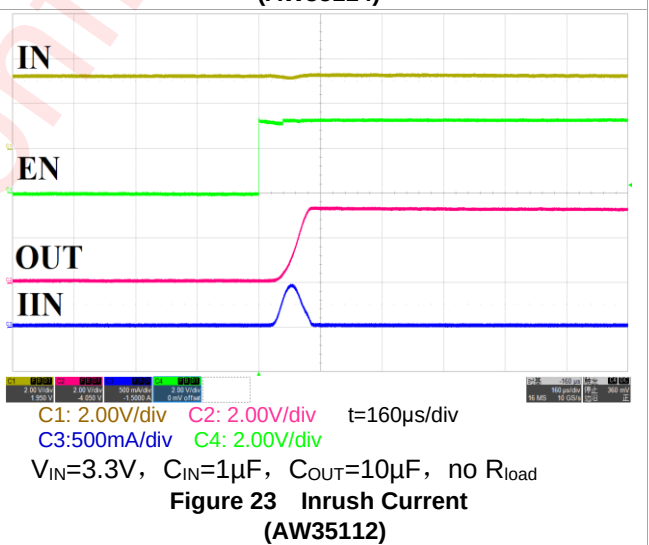
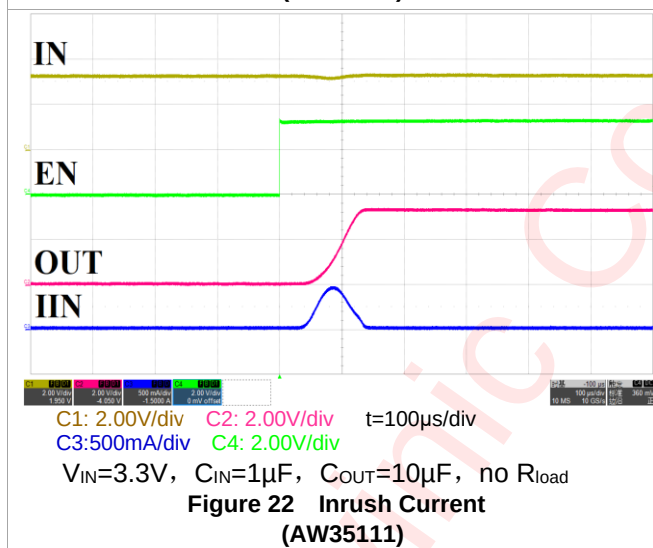
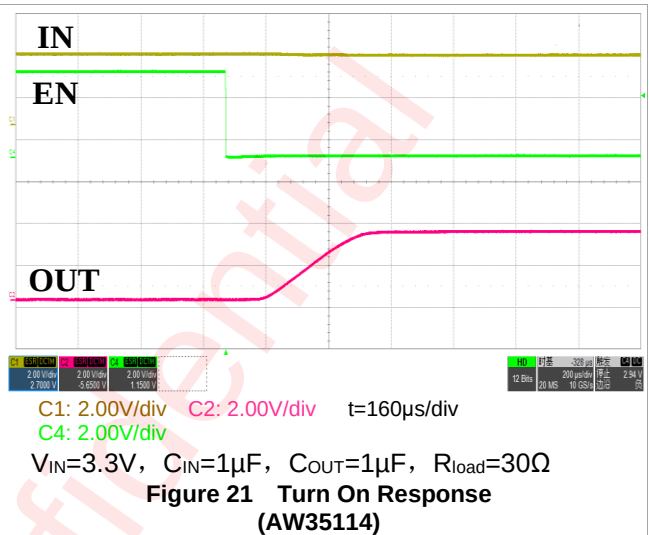
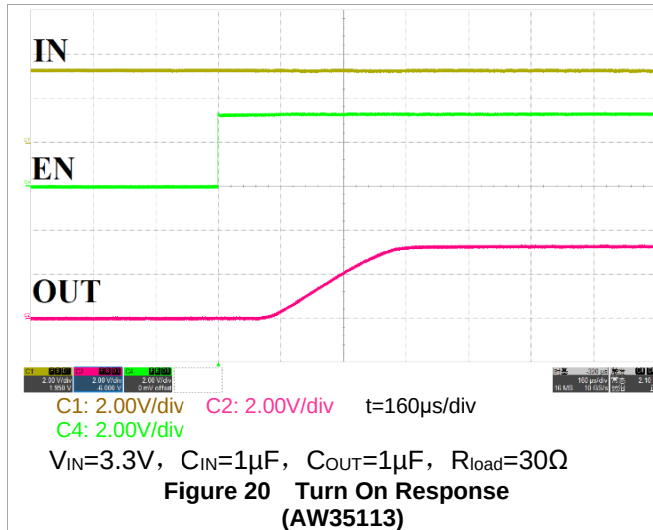


Figure 19 Turn On Response
(AW35112B)

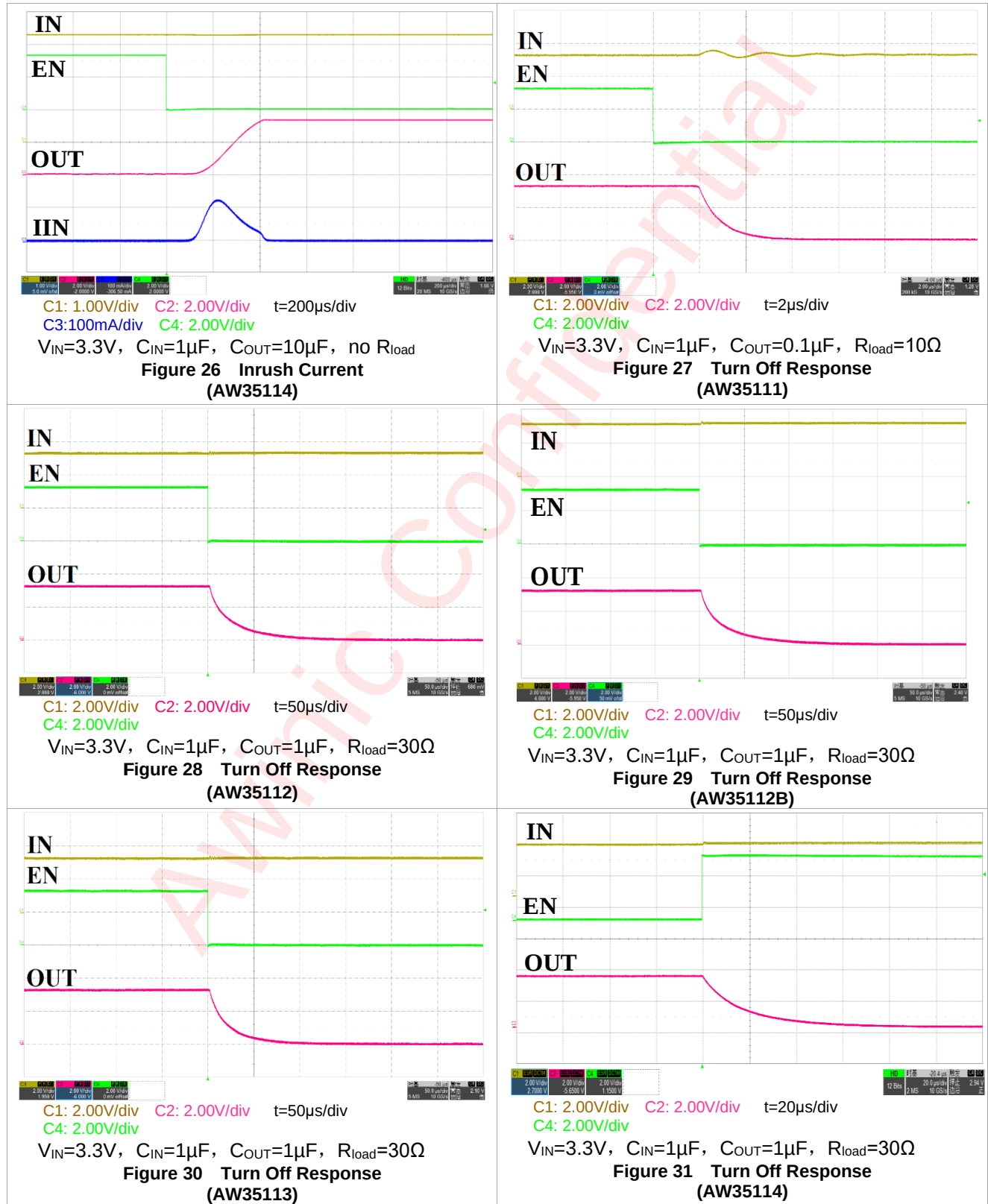
Typical Characteristics (continued)

Ambient temperature is 25°C, $C_{IN} = C_{OUT} = 1\mu F$, unless otherwise noted.



Typical Characteristics (continued)

Ambient temperature is 25°C, $C_{IN} = C_{OUT} = 1\mu F$, unless otherwise noted.



Detailed Functional Description

The AW3511X integrates a high side P channel MOSFET, and provide a low on-resistance for a low voltage drop across the device. A controlled slew rate is used in applications to limit the inrush current. The part can be turned on, with a supply voltage from 1V to 5.5V.

Turn On/Off Control

Enable pin is an active high port for AW35111/112/112B/113, and an active low port for AW35114. The device is closed when EN pin is tied low(high) or pulled down(pull up) by internal 7.2MΩ resistor, forcing PMOS switch off. The IN/OUT path is activated with a minimum of V_{IN} of 1V and EN forced to high(low) level.

Table 1. Functional Table

	EN	IN to OUT	OUT to GND
AW35111/35113	Low	OFF	ON
	High	ON	OFF
AW35112/AW35112B	Low	OFF	HIZ
	High	ON	HIZ
AW35114	Low	ON	OFF
	High	OFF	ON

Slew Rate Control

When the switch is enabled, the device regulates the gate voltage of MOSFET, and controls the V_{OUT} slew rate during t_R to avoid a large input inrush current. The feature reduces the interference to the power supply.

Quick Output Discharge

The AW35111/AW35113/AW35114 includes the Quick Output Discharge (QOD) feature, in order to discharge the application capacitor connected on OUT pin. When EN pin is disabled, a discharge resistance with a typical value of 88Ω is connected between the output and ground, pull down the output and prevent it from floating when the device is disabled.

Full-Time Reverse Current Protection

The AW35112/AW35112B/AW35113 include the Reverse Current Protection(RCP) function, which can prevent the current to flowing through the P-FET or the body diode when V_{OUT} greater than V_{IN} . Whatever the switch is on or off, the AW35112/AW35112B/AW35113 always have this function. When $V_{OUT}-V_{IN}$ greater than V_{REV} , the internal comparator quickly turns off the switch, in order to prevent large reverse current from V_{OUT} to V_{IN} . The switch will return to normal operation once the reverse voltage scenario disappeared.

The I_{REV_ACT} parameter in the Figure 32 can be calculated by the following formula

$$I_{REV_ACT} = \frac{V_{REV}}{R_{dson}}$$

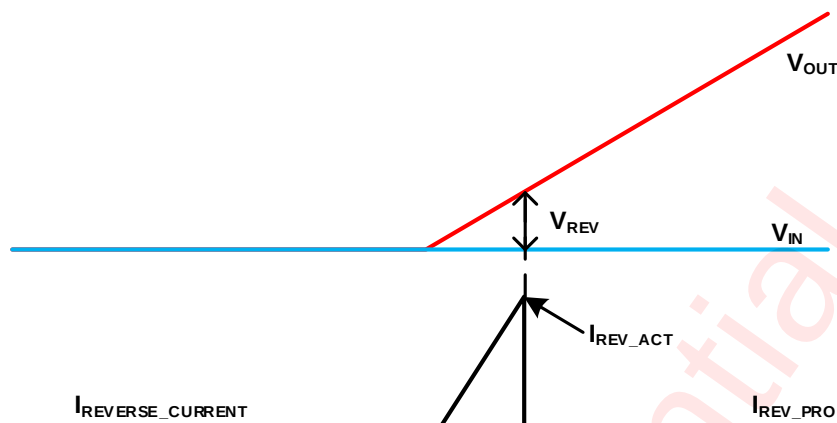


Figure 32 Reverse Current Test

Application Information

INPUT AND OUTPUT CAPACITANCE

Input and output capacitance improves the performance of the device, the actual capacitance should be optimized for the particular application. For all applications, a 1 μ F or greater ceramic bypass capacitor between V_{IN} and GND is recommended as close to the device as possible. This precaution reduces ringing on the input due to power supply transients. Additional input capacitance may be needed on the input to reduce voltage overshoot from exceeding the absolute maximum voltage of the device during heavy transient conditions. This is especially important during bench testing when long inductive cables are used to connect the evaluation board to the bench power-supply.

Placing a high value electrolytic capacitor on the output pin is recommended when large transient currents are expected on the output.

PCB Layout Consideration

The AW3511X is low ON-Resistance load switch, to obtain the optimal performance, PCB layout should be considered carefully. Here are some guidelines:

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 AW3511X) and close to IN pin, and place the output capacitor C_{OUT} on the top layer (same layer as the AW3511X) and close to OUT pin.
2. The AW3511X integrates an up to 2A rated PMOS FET, and the PCB design rules must be respected to properly evacuate the heat out of the silicon. By increasing PCB area, especially around IN and OUT pins, the $R\theta_{JA}$ of the package can be decreased, allowing higher power dissipation. Blue bold paths in Figure 33 are power lines that will flow large current, please route them on PCB as straight, wide and short as possible.
3. Use rounded corners on the power trace from the power supply connector to AW3511X to decrease EMI coupling.

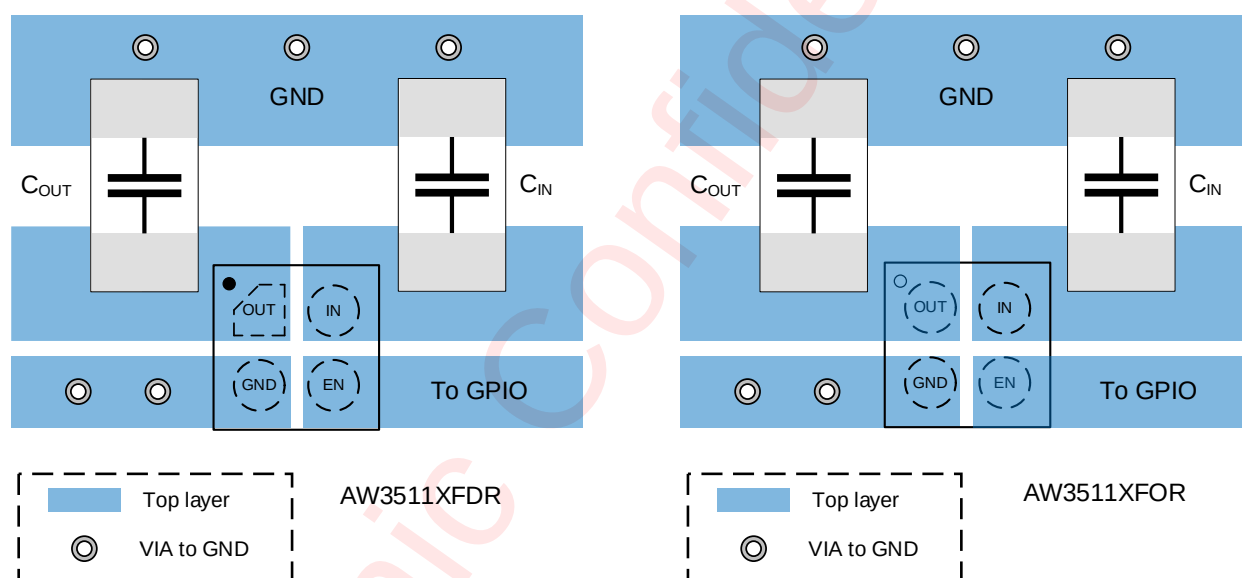
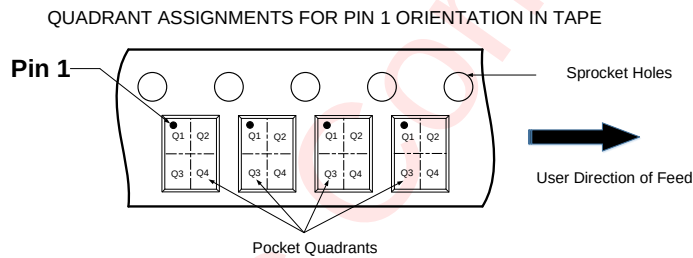
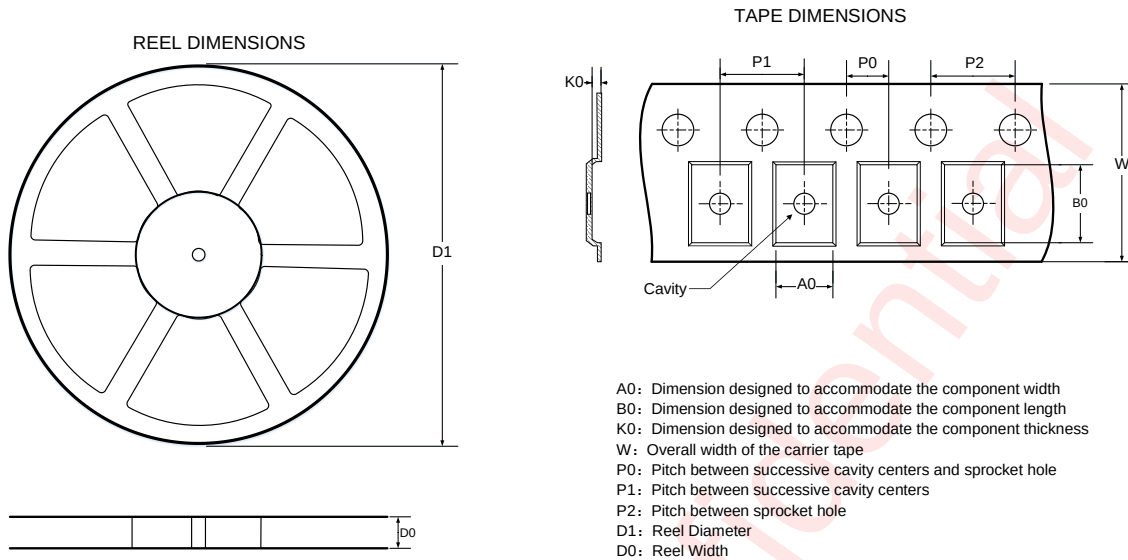


Figure 33 PCB layout example

Tape And Reel Information

FCDFN 0.8mm*0.8mm-4L



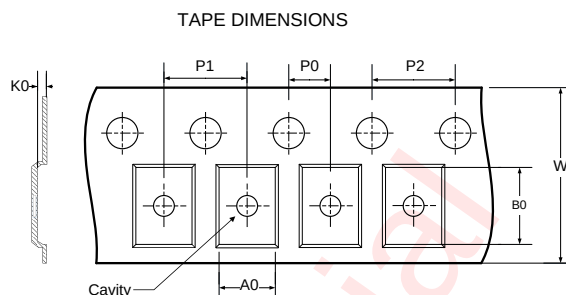
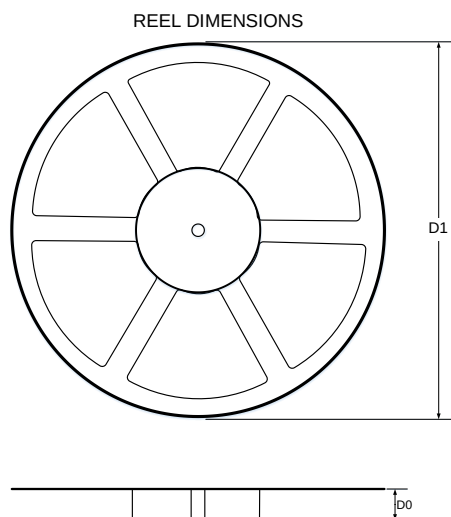
Note: The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178.0	8.40	0.91	0.91	0.66	2.00	4.00	4.00	8.00	Q1

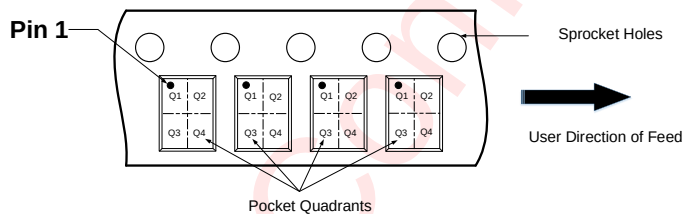
All dimensions are nominal

FOWLP 0.8mm*0.8mm-4B



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 centers
 D1: Reel Diameter
 D0: Reel Width

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



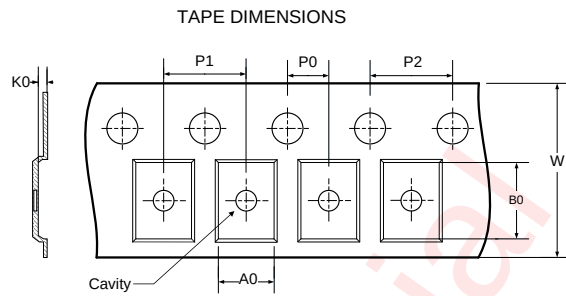
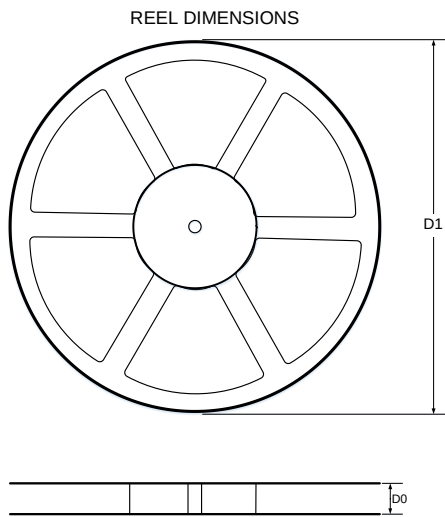
Note: The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

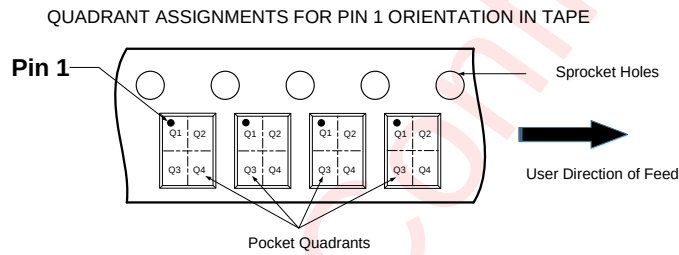
D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
179.0	9.2	0.85	0.85	0.59	2.00	4.00	4.00	8.00	Q1

All dimensions are nominal

FOWLP 0.9mm*0.9mm-4B



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



Note: The above picture is for reference only. Please refer to the value in the table below for the actual size

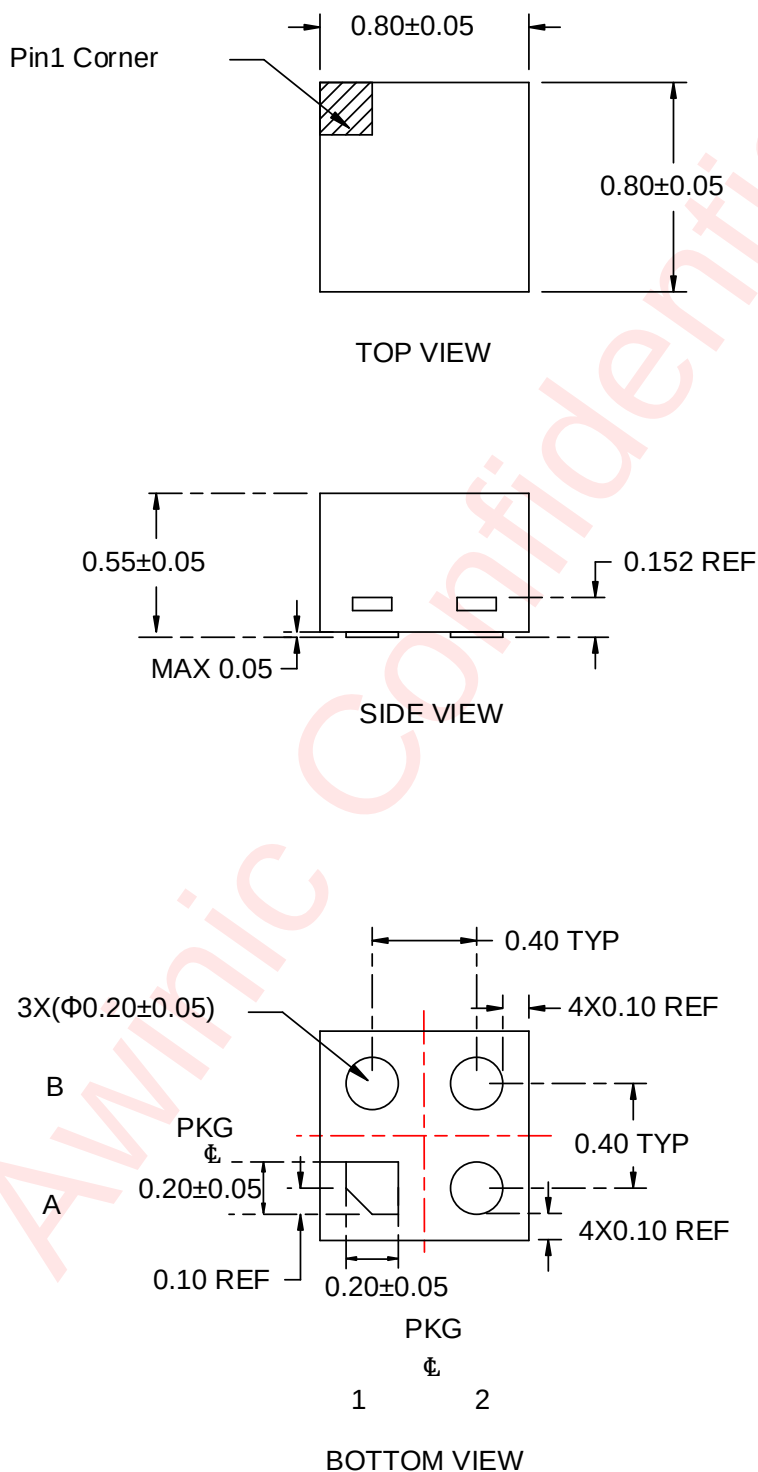
DIMENSIONS AND PIN1 ORIENTATION

D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
179.0	9.2	1.00	1.00	0.63	2.00	4.00	4.00	8.00	Q1

All dimensions are nominal

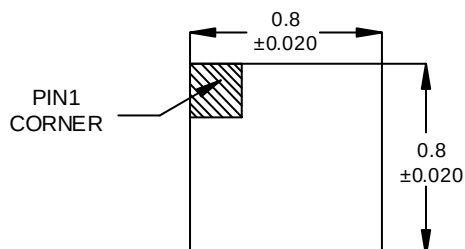
Package Description

FCDFN 0.8mm*0.8mm-4L

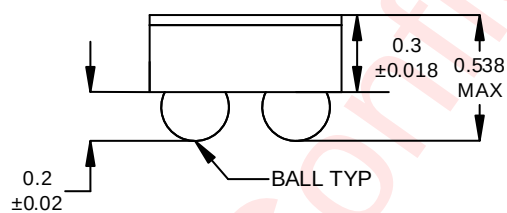


Unit:mm

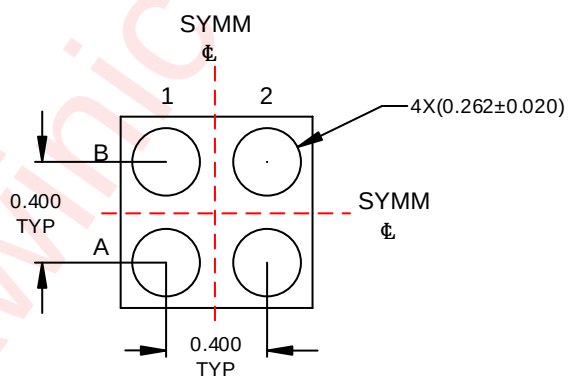
FOWLP 0.8mm*0.8mm-4B



Top View



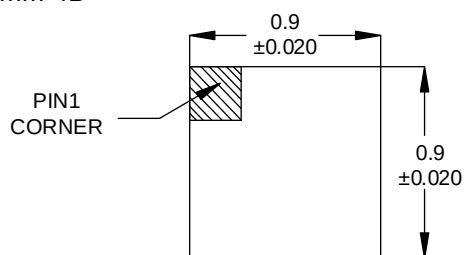
Side View



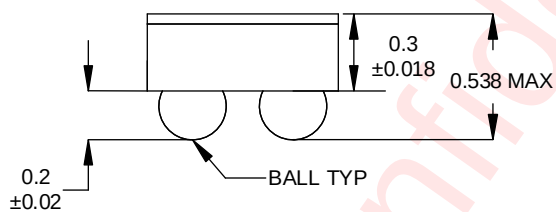
Bottom View

Unit: mm

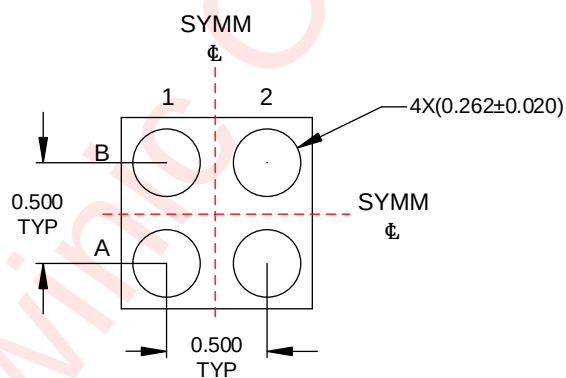
FOWLP 0.9mm*0.9mm-4B



Top View



Side View

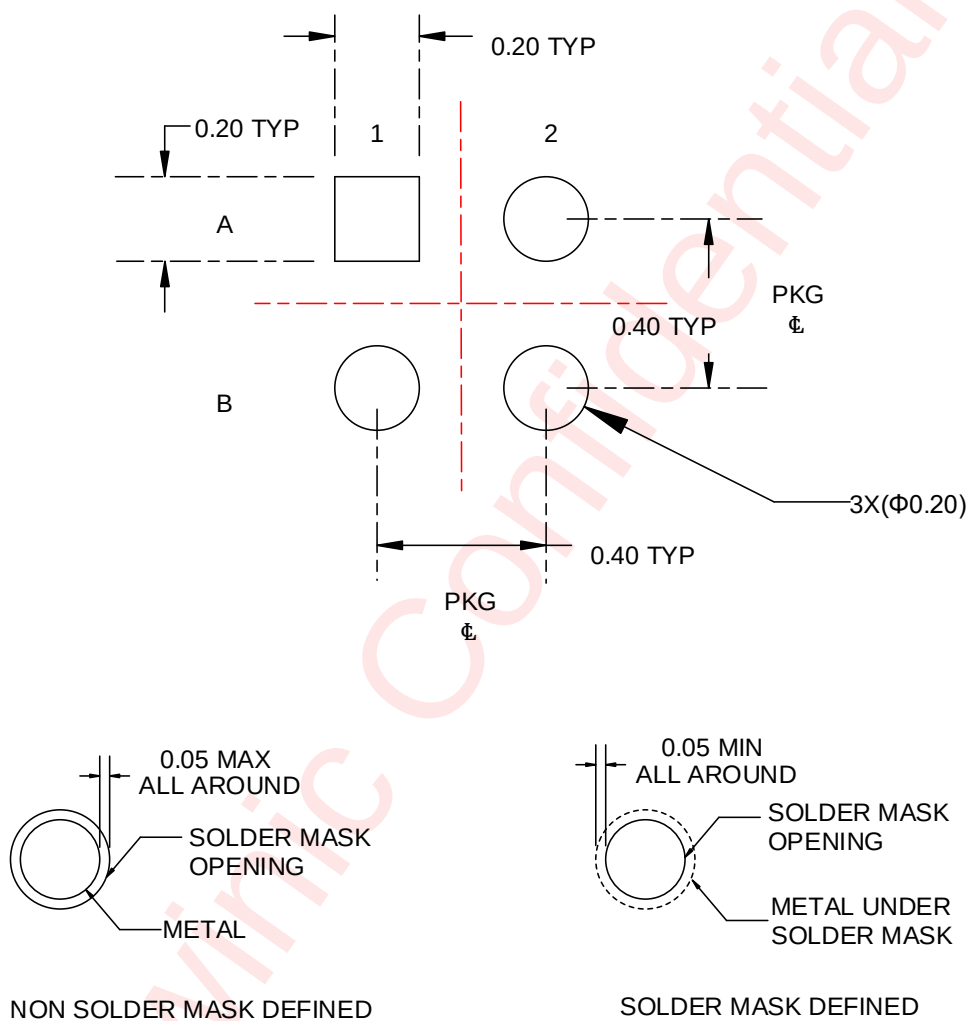


Bottom View

Unit: mm

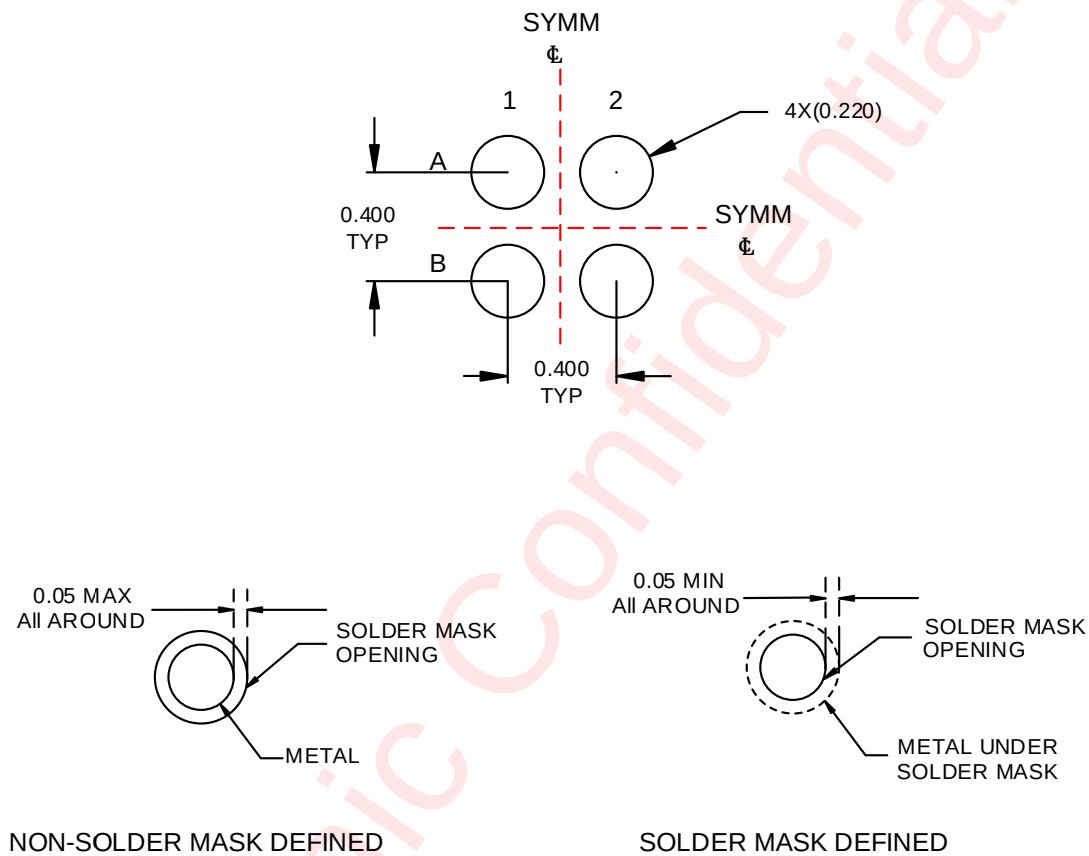
Land Pattern Data

FCDFN 0.8mm*0.8mm-4L



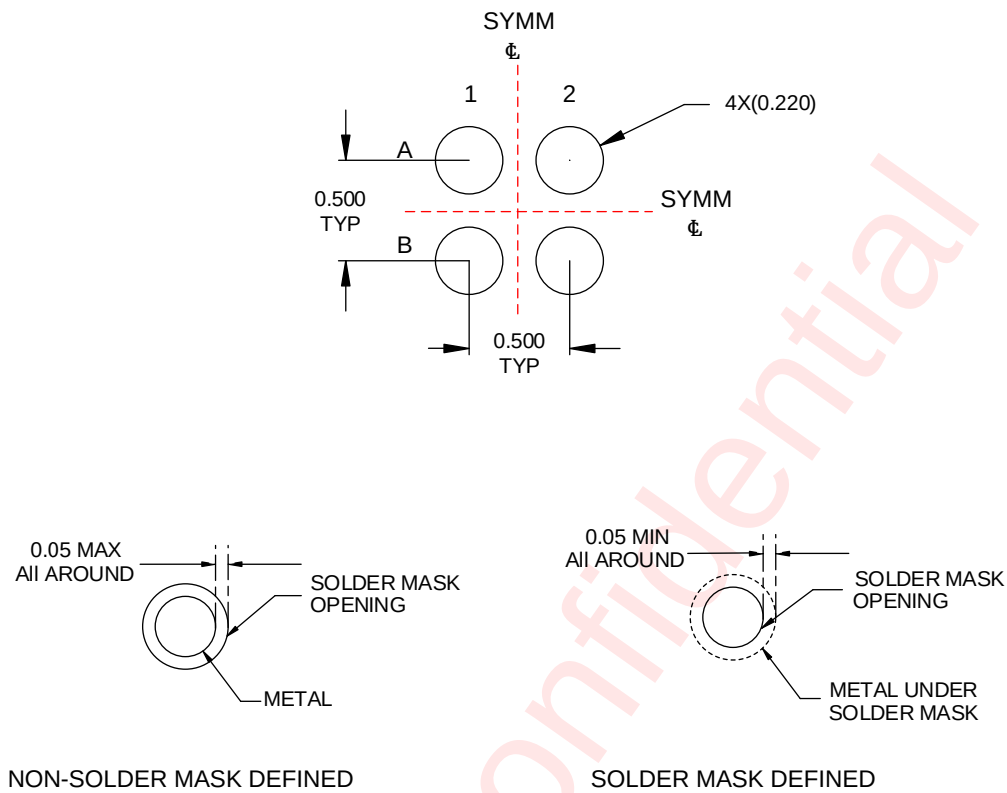
Unit: mm

FOWLP 0.8mm*0.8mm-4B



Unit: mm

FOWLP 0.9mm*0.9mm-4B



Unit: mm

Revision History

Version	Date	Change Record
V1.0	Feb. 2022	Officially released
V1.1	Mar. 2022	1.Add the R_{DIS} Parameter 2.Modify the value of θ_{JA} and P_D 3.Modify the Typical Characteristics(P10、P11)
V1.2	May. 2022	1.Modify the delivery form (9000→4500) 2.Modify the pitch (2→4) of Tape And Reel Information(P15)
V1.3	Oct. 2022	Add the Maximum Continuous Switch Current for $V_{IN} \geq 2V$ to 2A
V1.4	Nov. 2022	Modify the V_{IH} threshold from 1.2V to 1.1V(P7)
V1.5	Feb. 2023	1.Add the FOWLP package information and the PCB Layout example 2.Add Electrical Characteristics and Typical Characteristics of AW35112B 3.Modify the V_{IN} minimum from 1.2V to 1V, and add R_{dson} data of V_{IN} at 1V 4.Modify the V_{IH} threshold from 1.1V to 1V(P7)
V1.6	Jul. 2024	1.Add the information of AW35113FOR and AW35114FDR 2.Add the tracing code for FCDFN package.(P5)

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