1.5A Ultra-small Load Switch with Slew Rate Control

Features

- Integrated P-channel MOSFET load switch
- Input voltage: 1.2V to 5.5V
- 1.5A maximum continuous switch current
- Switch on-resistance(typ.):
  Rdson=61mΩ at VIN=5.5V
  Rdson=68mΩ at VIN=4.2V
  Rdson=77mΩ at VIN=3.3V
  Rdson=91mΩ at VIN=2.5V
  Rdson=121mΩ at VIN=1.8V
  Rdson=211mΩ at VIN=1.2V
- Controlled slew rate to limit inrush currents
- Ultra low shutdown current
- Internal EN pull-down resistor
- Quick Output Discharge(QOD) for AW35124/ AW35124A
- Full time Reverse Current Protection (RCP) for AW35127
- WLCSP 0.775mm×0.775mm-4B package

Applications

Smartphones and Tablets

Portable Devices

Wearables

General Description

The AW3512X family load switch integrates a 77mΩ (typ.) P-channel MOSFET, which can operate over a wide input range of 1.2V to 5.5V. The AW3512X features output slew rate control, limiting inrush currents during turn-on to protect downstream devices.

In addition, AW35124/AW35124A have QOD function which can prevent the output from floating when the switch is disabled.

There is a Reverse Current Protection(RCP) function for AW35127 when V_{OUT} is 60mV(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 AW35127.

Typical Application Circuit

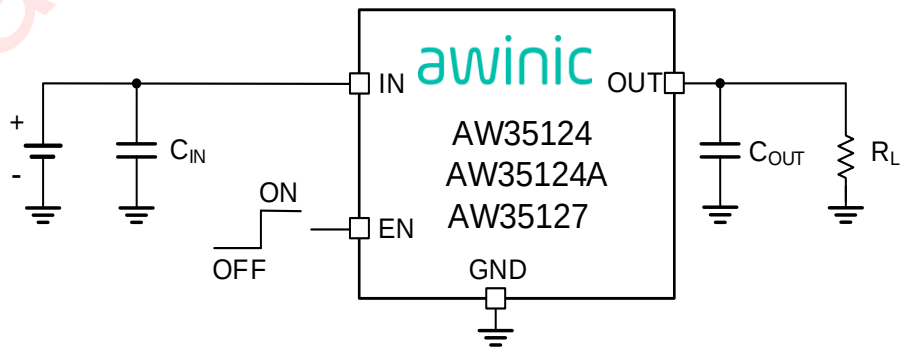
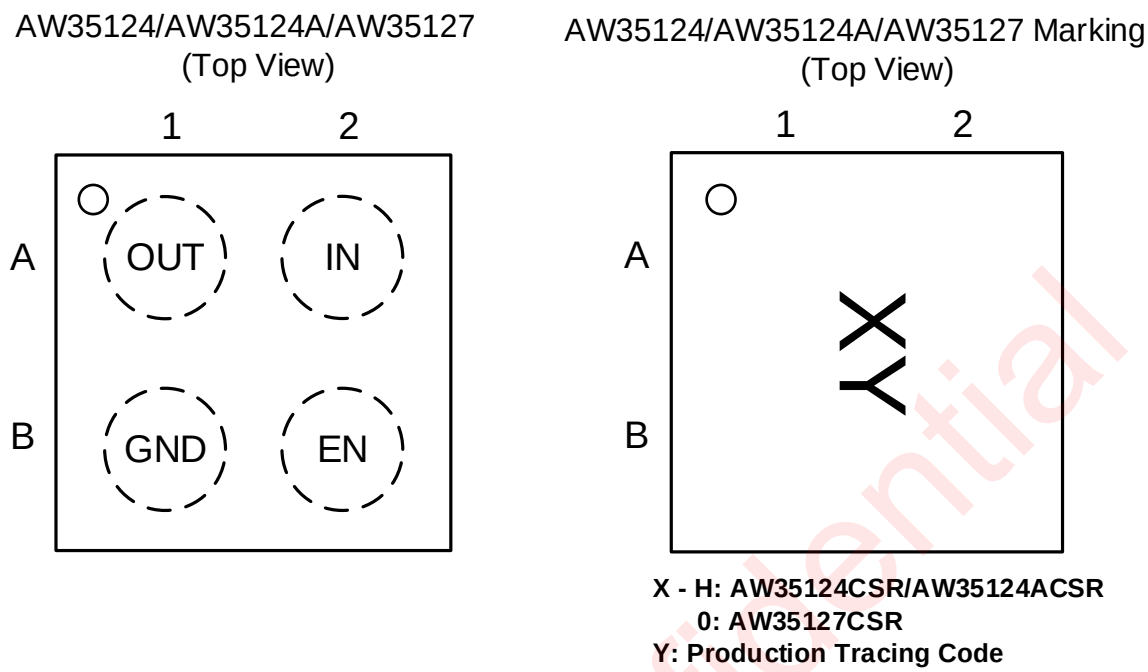


Figure 1 Typical Application Circuit of AW3512X

Pin Configuration And Top Mark



X - H: AW35124CSR/AW35124ACSR
0: AW35127CSR
Y: Production Tracing Code

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, internal 12.4MΩ pull down resistor.

Device Comparison Table

Device	EN Pin Activity	QOD	RCP	t_R	t_{ON}	t_{EN}
AW35124CSR	Active High	Y	N	1158us	1453us	860us
AW35124ACSR	Active High	Y	N	95us	120us	77us
AW35127CSR	Active High	N	Y	1158us	1453us	860us

Functional Block Diagram

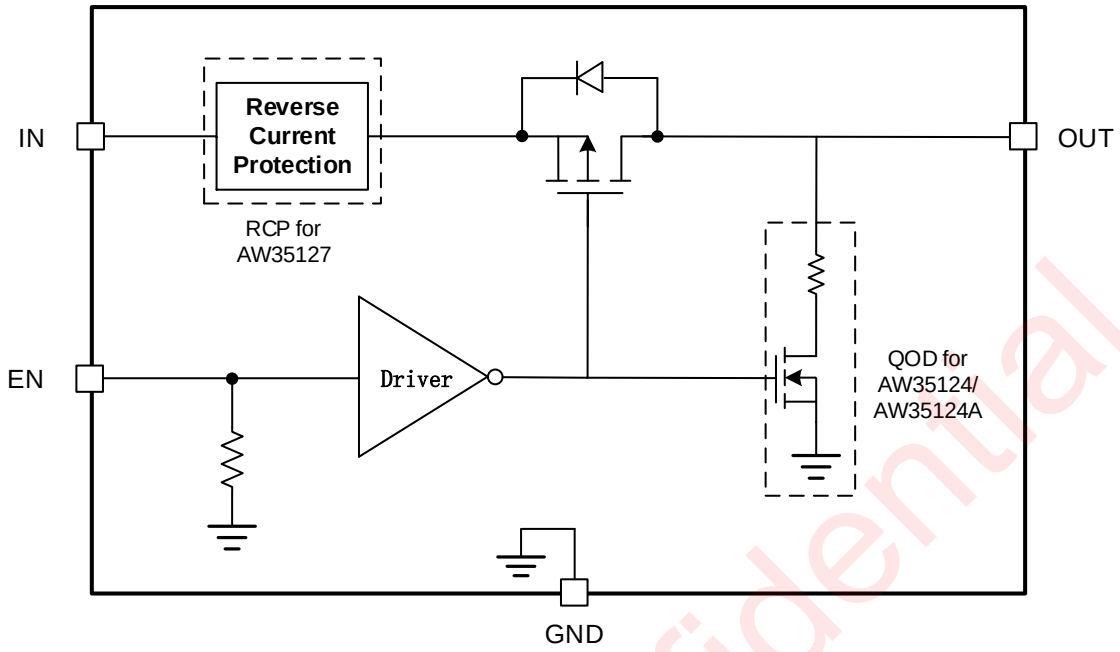


Figure 3 Functional Block Diagram

Typical Application Circuits

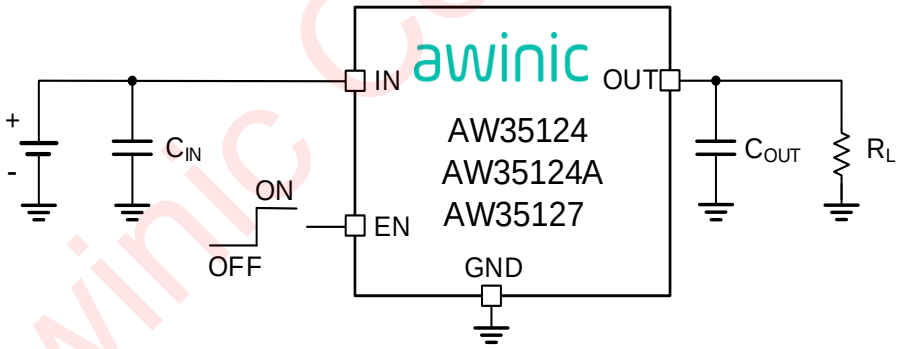


Figure 4 Typical Application Circuit of AW3512X

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW35124CSR	-40℃～85℃	WLCSP 0.775mm×0.775 mm-4B	H	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35124ACSR	-40℃～85℃	WLCSP 0.775mm×0.775 mm-4B	H	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35127CSR	-40℃～85℃	WLCSP 0.775mm×0.775 mm-4B	0	MSL1	ROHS+HF	3000 units/ Tape and Reel

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 VIN ≥ 2V(NOTE 2)		1.5A
Maximum Peak Switch Current for VIN ≥ 2.5V(NOTE 3)		2A
Junction-to-ambient Thermal Resistance θ_{JA}(NOTE 4)		111°C/W
Operating Free-air Temperature Range		-40°C to 85°C
P_D (Power Dissipation) at T_A=25ºC		1.1W
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: Limited by thermal design.

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.

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage	1.2		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}≤ 1.5A and T_A = 25°C.

PARAMETER		TEST CONDITION		MIN	TYP	MAX	UNIT
INPUT CURRENTS							
I_Q	Input quiescent current	AW35124/35124A	V_{IN}=V_{EN}=3.3V,I_{OUT}=0A, T_A=25°C		2	70	nA
			V_{IN}=V_{EN}=3.3V,I_{OUT}=0A, T_A=85°C		4		nA
			V_{IN}=V_{EN}=5.5V,I_{OUT}=0A, T_A=25°C		5	90	nA
			V_{IN}=V_{EN}=5.5V,I_{OUT}=0A, T_A=85°C		9		nA
		AW35127	V_{IN}=V_{EN}=3.3V,I_{OUT}=0A, T_A=25°C		530	1000	nA
			V_{IN}=V_{EN}=3.3V,I_{OUT}=0A, T_A=85°C		640		nA
			V_{IN}=V_{EN}=5.5V,I_{OUT}=0A, T_A=25°C		930	2000	nA
			V_{IN}=V_{EN}=5.5V,I_{OUT}=0A, T_A=85°C		1110		nA
I_{SD}	Shutdown current from IN to GND	AW35124/35124A	V_{IN}=1.2V, V_{EN}=0V, T_A=25°C		3	18	nA
			V_{IN}=1.8V, V_{EN}=0V, T_A=25°C		5	20	nA
			V_{IN}=3.3V, V_{EN}=0V, T_A=25°C		7	45	nA
			V_{IN}=3.3V, V_{EN}=0V, T_A=85°C		435		nA
			V_{IN}=4.5V, V_{EN}=0V, T_A=25°C		10	65	nA
			V_{IN}=5.5V, V_{EN}=0V, T_A=25°C		21	95	nA
			V_{IN}=5.5V, V_{EN}=0V, T_A=85°C		675		nA
		AW35127	V_{IN}=1.2V, V_{EN}=0V, T_A=25°C		126		nA
			V_{IN}=1.8V, V_{EN}=0V, T_A=25°C		159		nA
			V_{IN}=3.3V, V_{EN}=0V, T_A=25°C		340	900	nA
			V_{IN}=3.3V, V_{EN}=0V, T_A=85°C		750		nA
			V_{IN}=4.5V, V_{EN}=0V, T_A=25°C		471		nA
			V_{IN}=5.5V, V_{EN}=0V, T_A=25°C		570	1500	nA
			V_{IN}=5.5V, V_{EN}=0V, T_A=85°C		1150		nA
I_{LEAKEN}	EN pin leakage current	V_{IN}=0V, V_{EN}=5.5V			410	1000	nA
R_{EN}	EN pin pull down resistor	V_{IN}=5V, V_{EN}=5.0V			12.4		MΩ

Electrical Characteristics (continued)

T_A = 25°C unless otherwise noted. Typical values are guaranteed for V_{IN} = 3.3V, C_{IN} = 1μF, I_{IN}≤ 1.5A and T_A = 25°C.

PARAMETER		TEST CONDITION		MIN	TYP	MAX	UNIT
POWER SWITCH							
R_{dson}	Internal switch MOSFET on-state resistance	V_{IN}=5.5V, V_{EN}=high, I_{OUT}=0.2A, T_A=25℃			61	70	mΩ
		V_{IN}=3.3V, V_{EN}=high, I_{OUT}=0.2A, T_A=25℃			77	89	
		V_{IN}=1.8V, V_{EN}=high, I_{OUT}=0.2A, T_A=25℃			121	139	
		V_{IN}=1.2V, V_{EN}=high, I_{OUT}=0.2A, T_A=25℃			211	243	
R_{DIS}	Output discharge resistance(for AW 35124/35124A)	V_{IN}=3.3V, V_{EN}=low, T_A=25℃ , I_{OUT} Sinking 2mA			80	100	Ω
t_R	Output rise time	V_{IN}=3.3V, C_{OUT}=1μF, R_{OUT}=30Ω	AW35124/AW35127		1158		μs
			AW35124A		95		
t_{ON}	Switch turn on time		AW35124/AW35127		1453		
			AW35124A		120		
t_{EN}	Enable time		AW35124/AW35127		860		
			AW35124A		77		
t_F	Output fall time	V_{IN}=3.3V, C_{OUT}=1μF, R_{OUT}=30Ω			53		
t_{OFF}	Switch turn off time				17		
V_{IH}	EN input high threshold level			1.2			V
V_{IL}	EN input low threshold level					0.4	V
REVERSE CURRENT PROTECTION (RCP ONLY FOR AW35127CSR)							
V_{REV}	Reverse current voltage threshold	V_{IN}=3.3V, C_{OUT}=1μF			60		mV
V_{REV_HYS}	Reverse current voltage hysteresis	V_{IN}=3.3V, C_{OUT}=1μF			36		mV
I_{REV_ACT}	Reverse activation current	V_{IN}=3.3V, C_{OUT}=1μF, V_{OUT} > V_{IN}			0.8		A
I_{REV_PRO}	Reverse protection current	V_{OUT} - V_{IN} > V_{REV}			0.2		uA

Timing Diagram

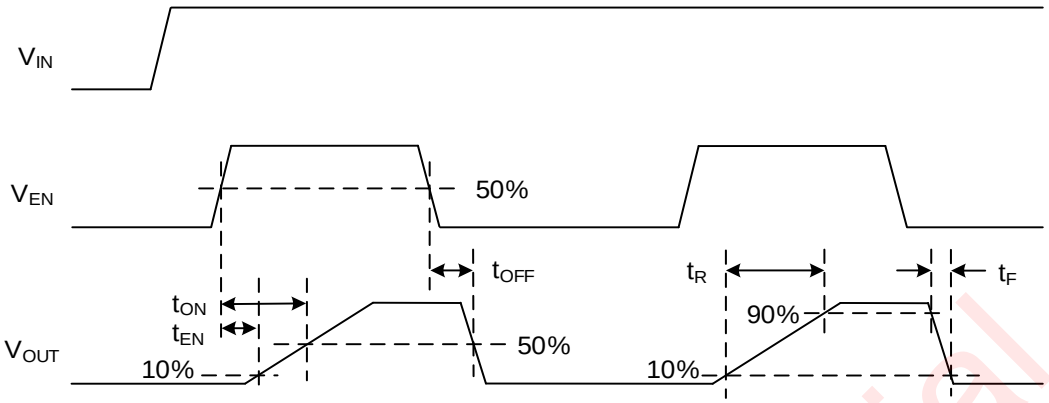


Figure 5 AW3512X Timing Diagram

Typical Characteristics

Ambient temperature is 25°C, C_{IN} = C_{OUT}=1μF, unless otherwise noted.

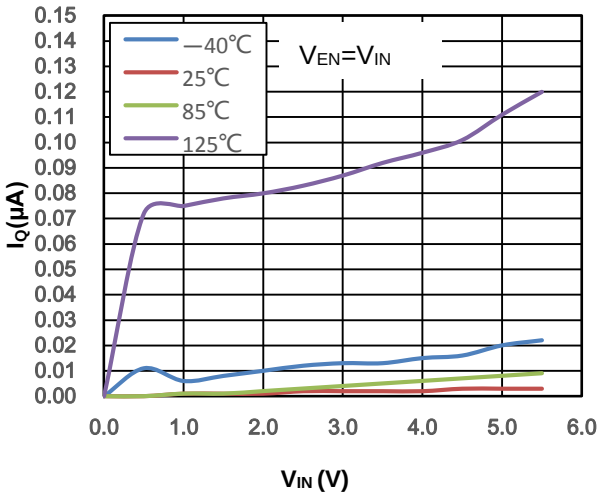


Figure 6 Quiescent Current vs. V_{IN}, No load (For AW35124/AW35124A)

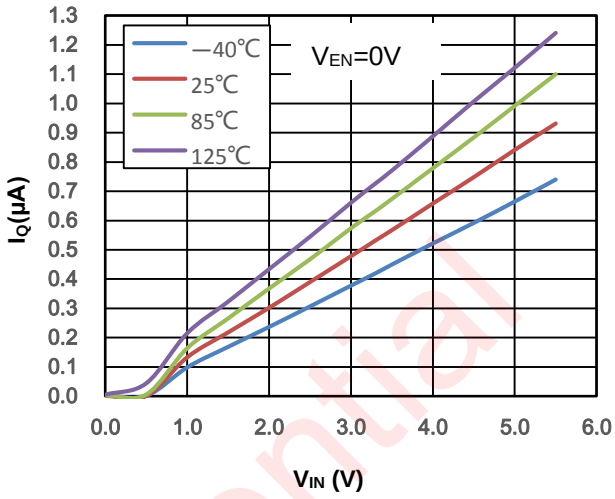


Figure 7 Quiescent Current vs. V_{IN}, No load (For AW35127)

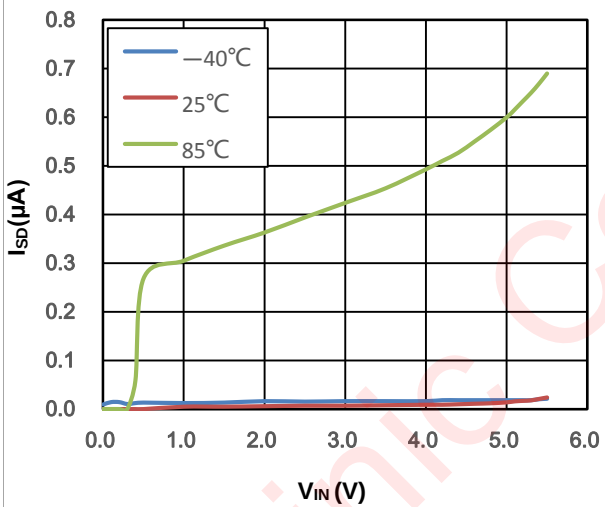


Figure 8 IN Shutdown Current vs. V_{IN} (For AW35124/AW35124A)

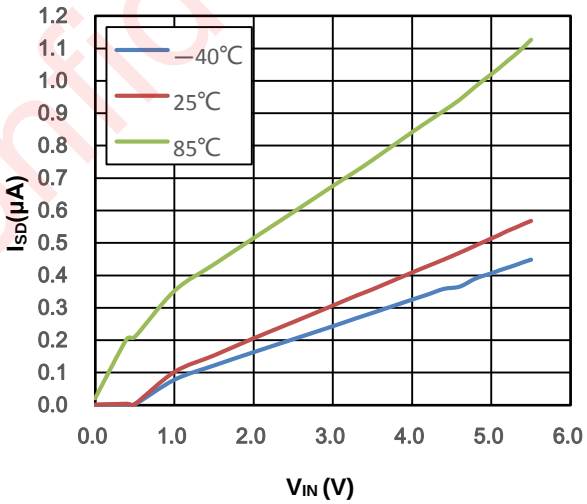


Figure 9 IN Shutdown Current vs. V_{IN} (For AW35127)

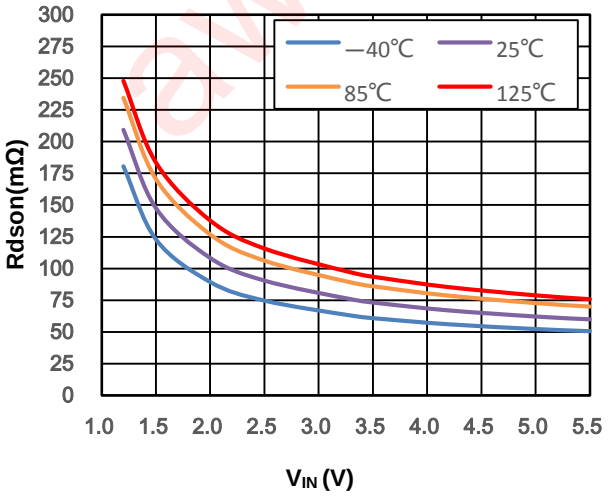


Figure 10 Rdson vs. V_{IN}(I_{OUT}=200mA)

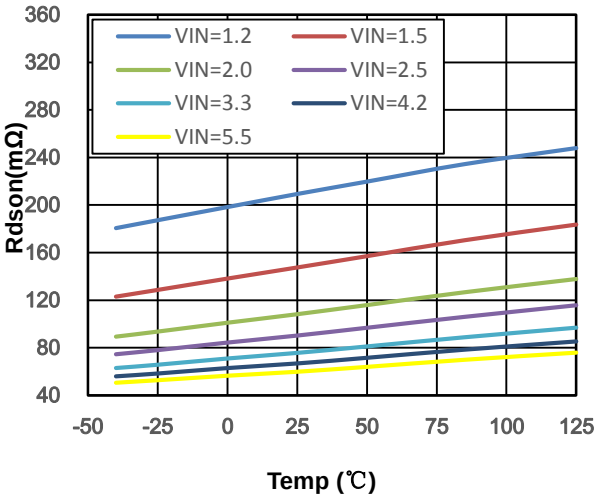


Figure 11 Rdson vs. Temperature(I_{OUT}=200mA)

Typical Characteristics (continued)

Ambient temperature is 25°C, C_{IN} = C_{OUT}=1μF, unless otherwise noted.

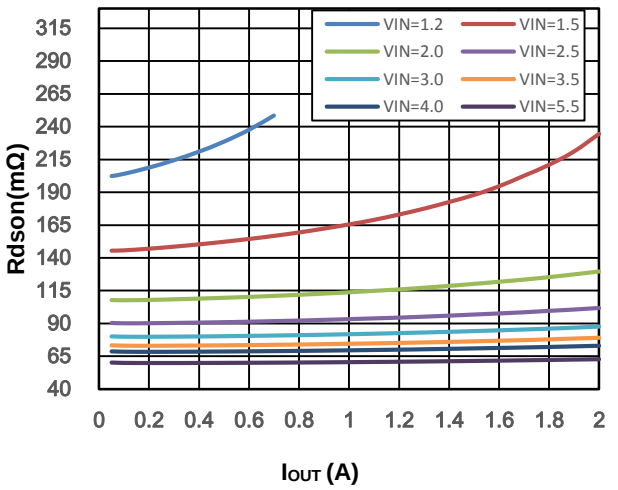


Figure 12 Rdson vs. I_{OUT}

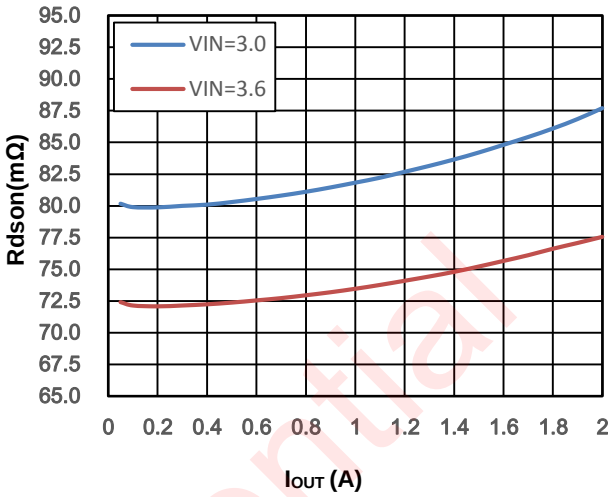
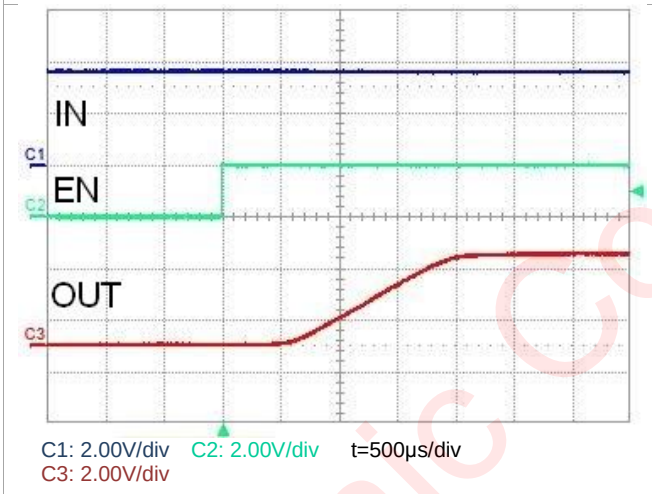
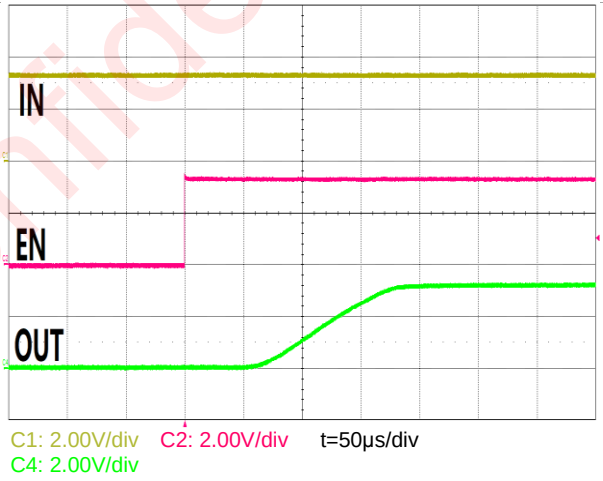


Figure 13 Rdson vs. I_{OUT}



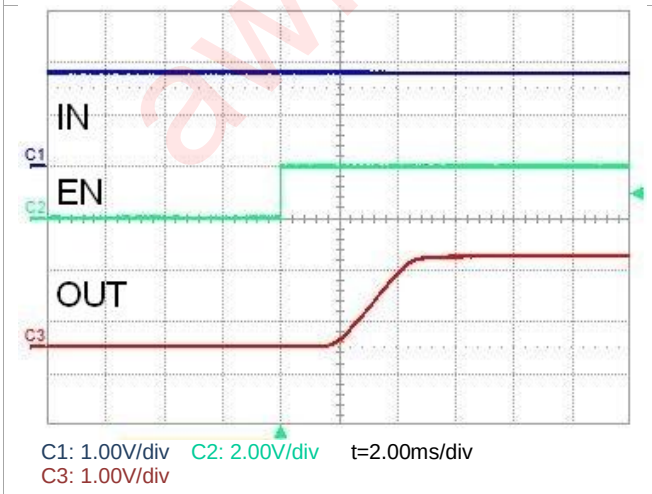
V_{IN}=3.3V，C_{IN}=1μF，C_{OUT}=1μF，R_{load}=30Ω

Figure 14 Turn On Response (For AW35124/AW35127)



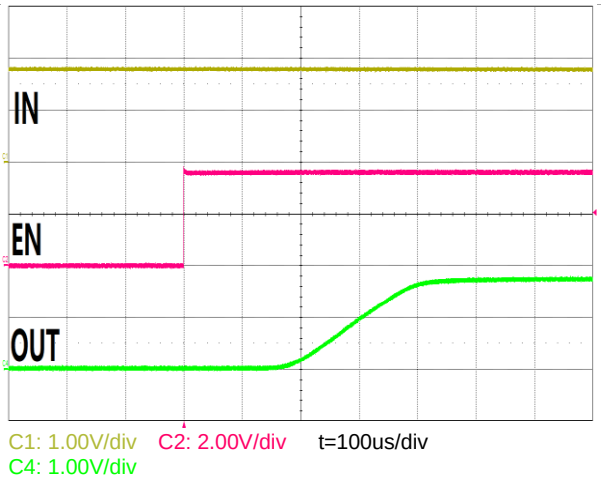
V_{IN}=3.3V，C_{IN}=1μF，C_{OUT}=1μF，R_{load}=30Ω

Figure 15 Turn On Response (For AW35124A)



V_{IN}=1.8V，C_{IN}=1μF，C_{OUT}=1μF，R_{load}=30Ω

Figure 16 Turn On Response (For AW35124/AW35127)

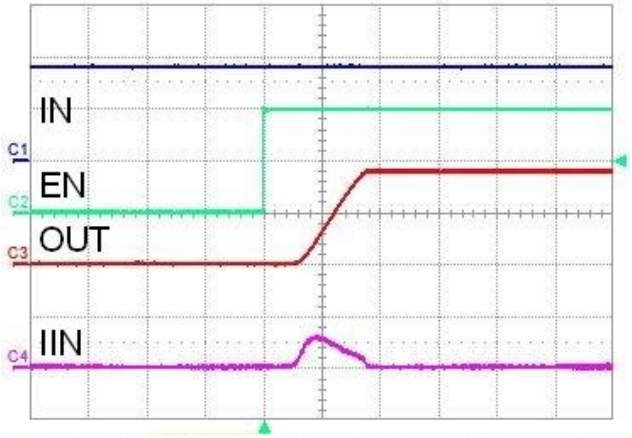


V_{IN}=1.8V，C_{IN}=1μF，C_{OUT}=1μF，R_{load}=30Ω

Figure 17 Turn On Response (For AW35124A)

Typical Characteristics (continued)

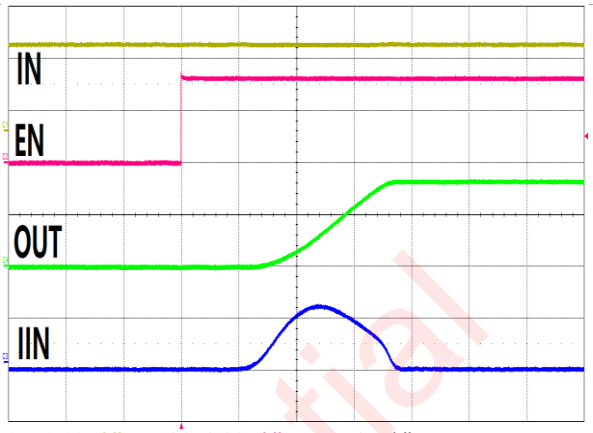
Ambient temperature is 25°C, C_{IN} = C_{OUT}=1μF, unless otherwise noted.



C1: 2.00V/div C2: 1.00V/div t=1.00ms/div
C3: 2.00V/div C4: 50mA/div

V_{IN}=3.3V，C_{IN}=1μF，C_{OUT}=10μF，no R_{load}

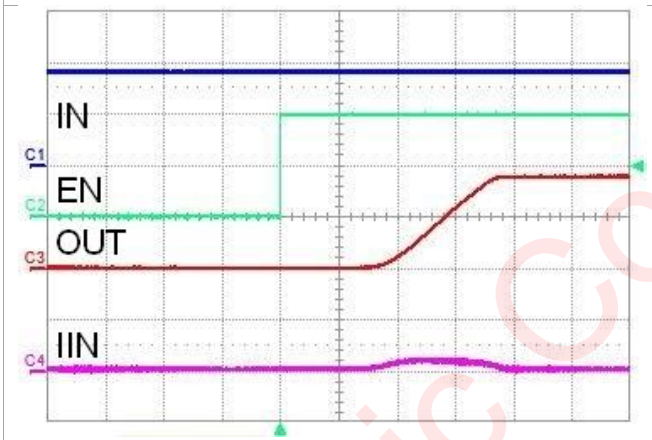
Figure 18 Inrush Current (For AW35124/AW35127)



C1: 2.00V/div C2: 2.00V/div t=50us/div
C3: 200mA/div C4: 2.00V/div

V_{IN}=3.3V，C_{IN}=1μF，C_{OUT}=10μF，no R_{load}

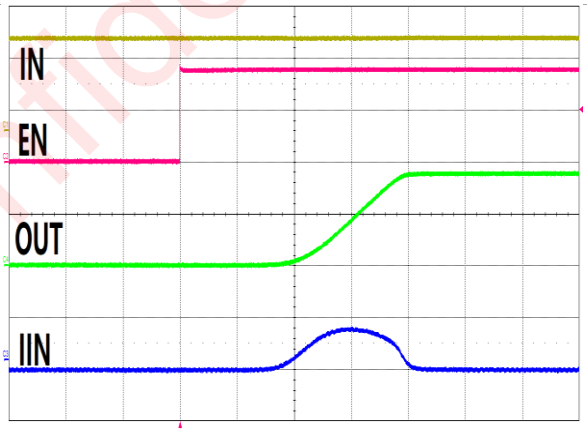
Figure 19 Inrush Current (For AW35124A)



C1: 1.00V/div C2: 1.00V/div t=1.00ms/div
C3: 1.00V/div C4: 50mA/div

V_{IN}=1.8V，C_{IN}=1μF，C_{OUT}=10μF，no R_{load}

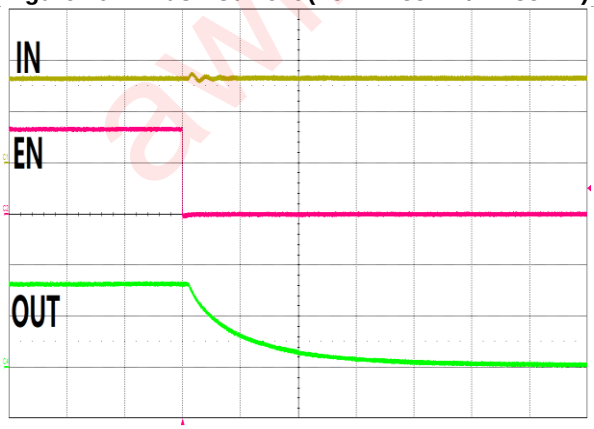
Figure 20 Inrush Current (For AW35124/AW35127)



C1: 1.00V/div C2: 1.00V/div t=100us/div
C3: 100mA/div C4: 1.00V/div

V_{IN}=1.8V，C_{IN}=1μF，C_{OUT}=10μF，no R_{load}

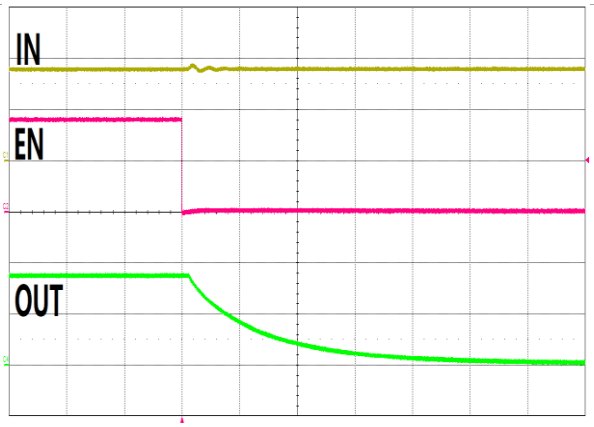
Figure 21 Inrush Current (For AW35124A)



C1: 2.00V/div C2: 2.00V/div t=20.0μs/div
C4: 2.00V/div

V_{IN}=3.3V，C_{IN}=1μF，C_{OUT}=1μF，R_{load}=30Ω

Figure 22 Turn Off Response



C1: 1.00V/div C2: 2.00V/div t=20.0μs/div
C3: 1.00V/div

V_{IN}=1.8V，C_{IN}=1μF，C_{OUT}=1μF，R_{load}=30Ω

Figure 23 Turn Off Response

Detailed Functional Description

The AW3512X 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 1.2V to 5.5V.

Turn On/Off Control

Enable pin is an active high port. The device is opened when EN pin is tied low (disable) or pulled down by internal 12.4MΩ resistor, forcing PMOS switch off. The IN/OUT path is activated with a minimum of Vin of 1.2V and EN forced to high level.

Table 1. Functional Table

EN	IN to OUT	OUT to GND
Low	OFF	ON
High	ON	OFF

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 AW35124/AW35124A include the Quick Output Discharge (QOD) feature, in order to discharge the application capacitor connected on OUT pin. When EN pin is set to low level (disable state), a discharge resistance with a typical value of 80Ω 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 AW35127 includes 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 AW35127 always has 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 24 can be calculated by the following formula

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

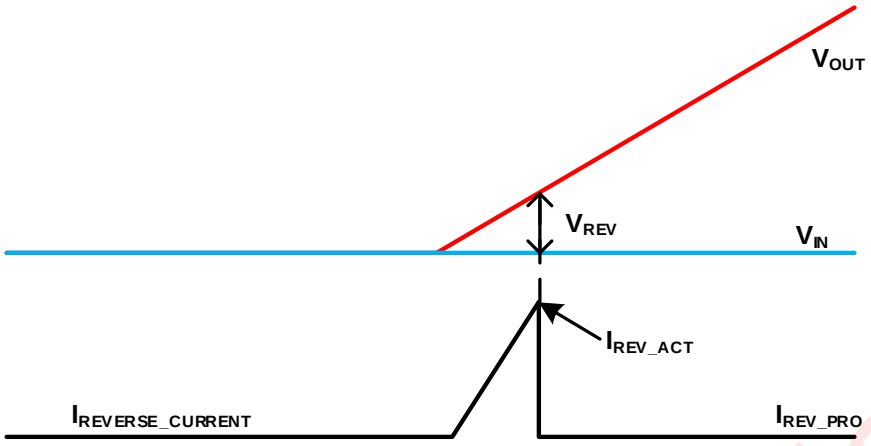


Figure 24 Reverse Current Test

PCB Layout Consideration

The AW3512X 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 AW3512X) and close to IN pin, and place the output capacitor C_{OUT} on the top layer (same layer as the AW3512X) and close to OUT pin.

2. The AW3512X integrates an up to 1.5A 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. Red bold paths in Figure 25 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 AW3512X to decrease EMI coupling.

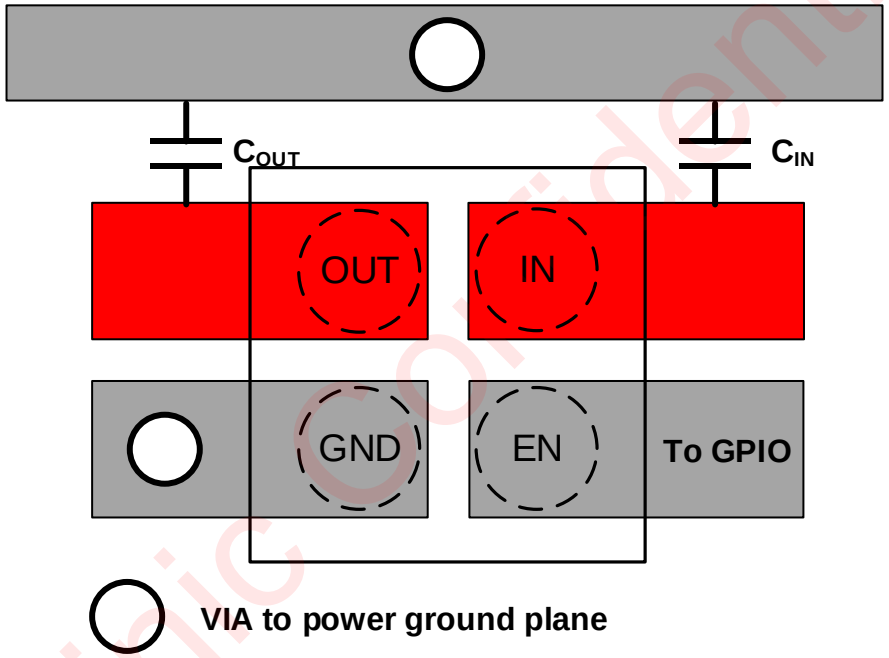
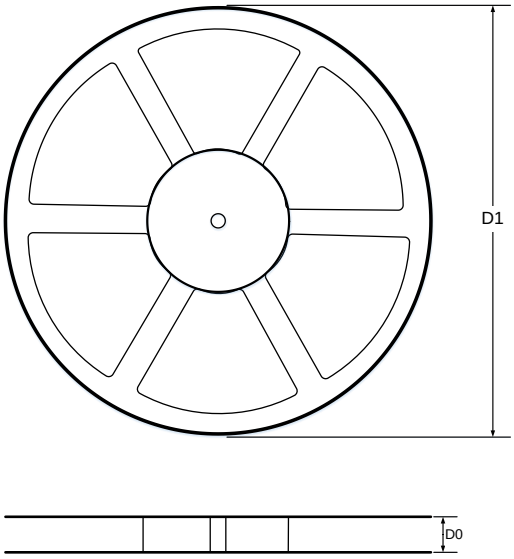


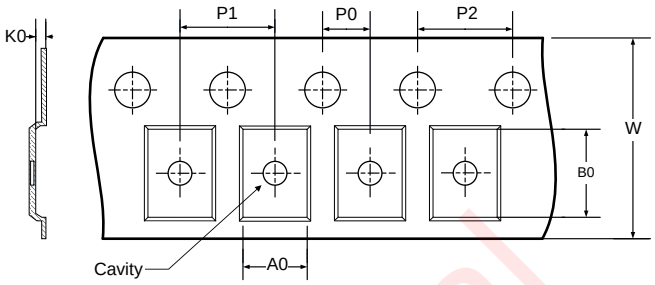
Figure 25 PCB layout example

Tape And Reel Information

REEL DIMENSIONS

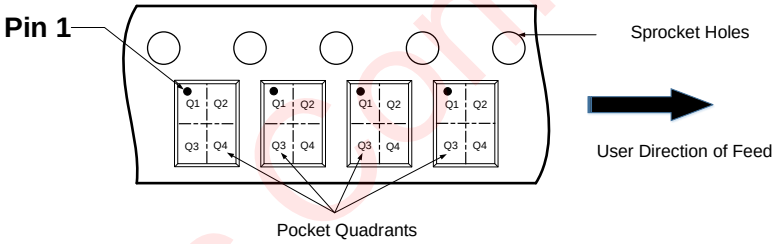


TAPE DIMENSIONS



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

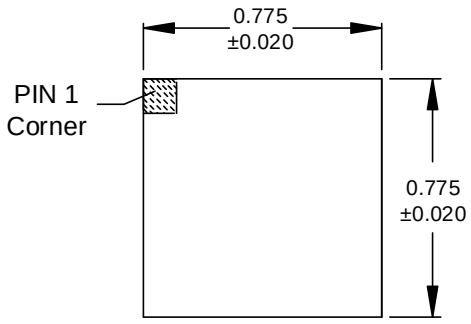


DIMENSIONS AND PIN1 ORIENTATION

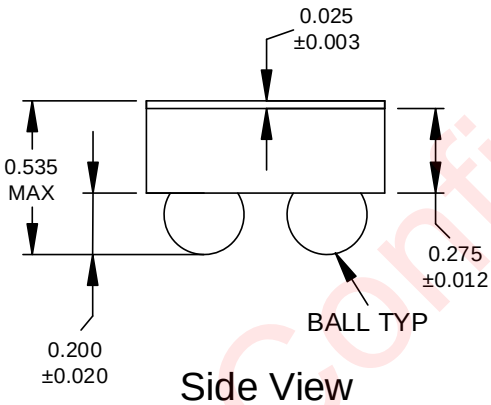
D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
179.00	9.00	0.85	0.85	0.59	2.00	4.00	4.00	8.00	Q1

All dimensions are nominal

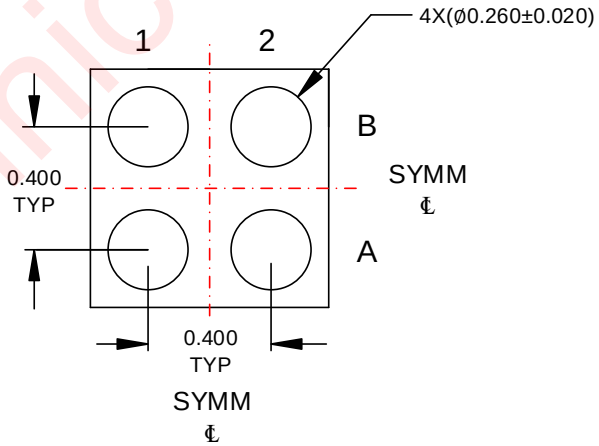
Package Description



Top View



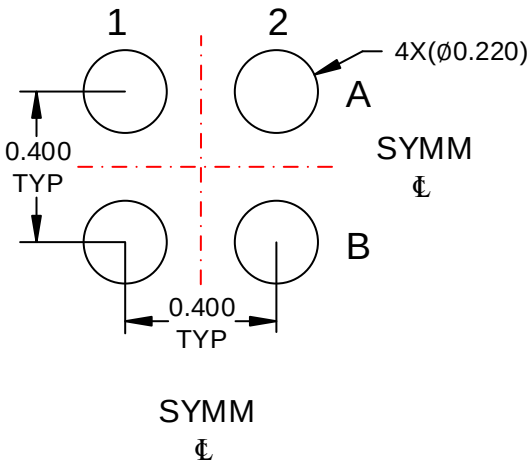
Side View

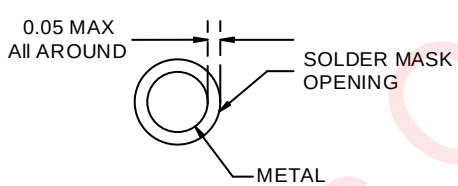


Bottom View

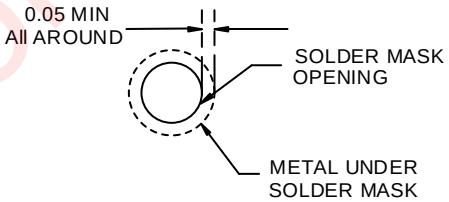
Unit: mm

Land Pattern Data





NON-SOLDER MASK DEFINED



SOLDER MASK DEFINED

Unit: mm

Revision History

Version	Date	Change Record
V1.0	September 2019	Datasheet V1.0 Released
V1.1	October 2019	1. Add the P_D (Power Dissipation) Parameter (P4) 2. Modify the Tape And Reel Information, Increase the Number of Decimal Points 3. Add the Information of AW35124A/AW35127
V1.2	June 2020	1. Modify the ordinate title of Figure 12 2. Delete the ordinate title of Figure 18 3. Modify the description (P12)

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