Power Distribution Switch with Adjustable Current Limit

Features

- Integrated P-channel MOSFET power switch
- Input voltage: 2.5V to 5.5V
- 0.4~2.5A adjustable current Limit
- Switch on-resistance(typ.):
  Rdson=65mΩ at V_{IN}=5V
- ±9% current limit accuracy at 1A(typ.)
- Reverse current protection
- Internal EN pull-down/up resistor
- Under voltage lockout
- Over temperature protection
- Quick Output Discharge(QOD)
  - ✧ AW35003BD/AW35013BD: Auto QOD
  - ✧ AW35003B/AW35013B: No QOD
- SOT23-6L package

General Description

AW35003BD/AW35013BD/AW35003B/ AW35013B is a P-channel MOSFET power distribution switch which intended for high-side load-switching applications. The device integrates adjustable current limit function with an external resistor from ISET pin to ground. Besides, a flag output is available to indicate fault conditions.

AW35003BD/AW35013BD/AW35003B/AW35013B also features fast short-circuit response, under voltage lockout, over temperature protection, reverse current protection. The AW35003BD and AW35013BD builds in quick output discharge function.

Set adjustable current limit:

AW35003BD AW35013BD AW35003B AW35013B	I_{LIMIT}=6800/R_{SET}

Applications

USB Ports

Power Distribution Switch

Notebook and Desktop Computer

High-Definition Television(HDTV)

Typical Application Circuit

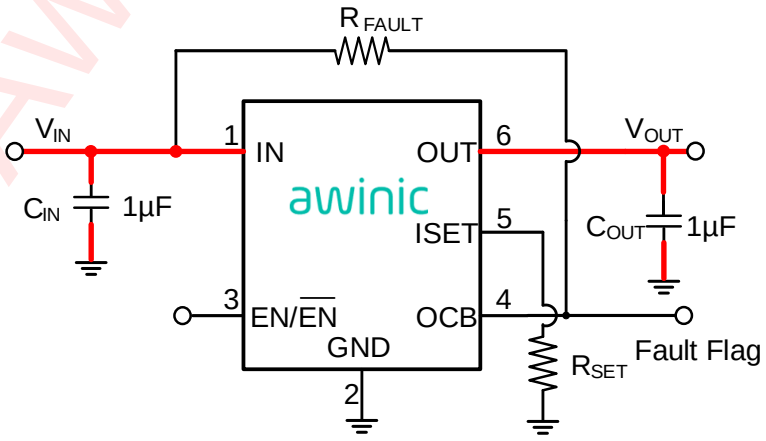


Figure 1 Typical Application Circuit

Pin Configuration And Top Mark

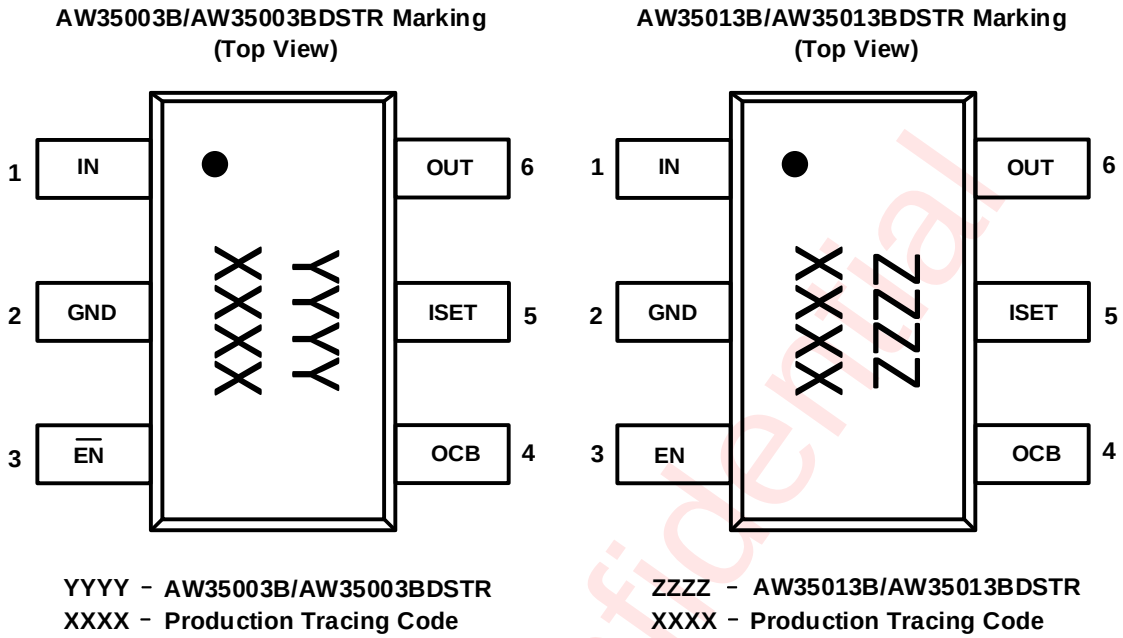


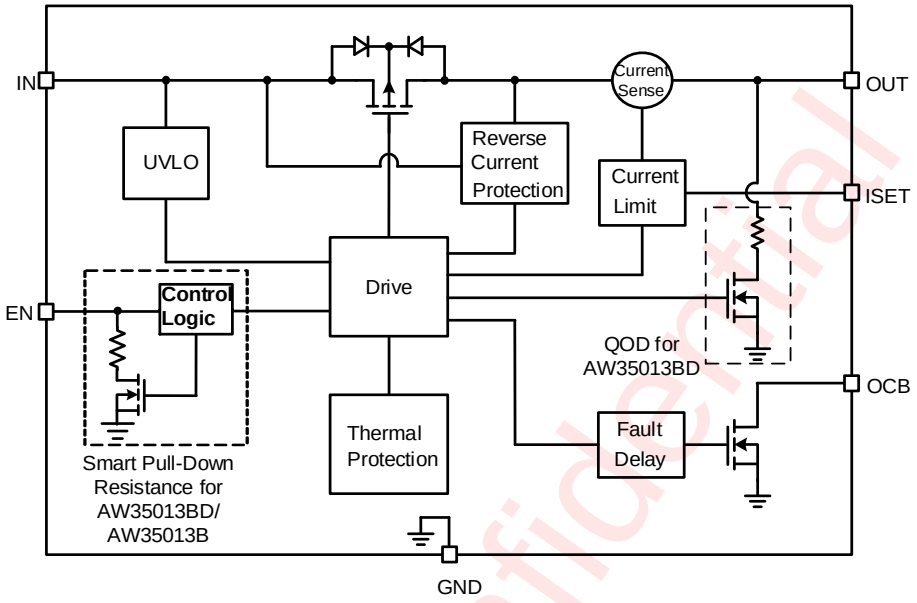
Figure 2 Pin Configuration and Top Mark

Pin Definition

Pin	Name	Description
1	IN	Power supply input
2	GND	Ground
3	EN/$\overline{EN}$	Chip enable (Active High/Low)
4	OCB	Fault flag output
5	ISET	Current limit threshold setting pin
6	OUT	Output pin

Functional Block Diagram

- **For Enable Active High Version**



- **For Enable Active Low Version**

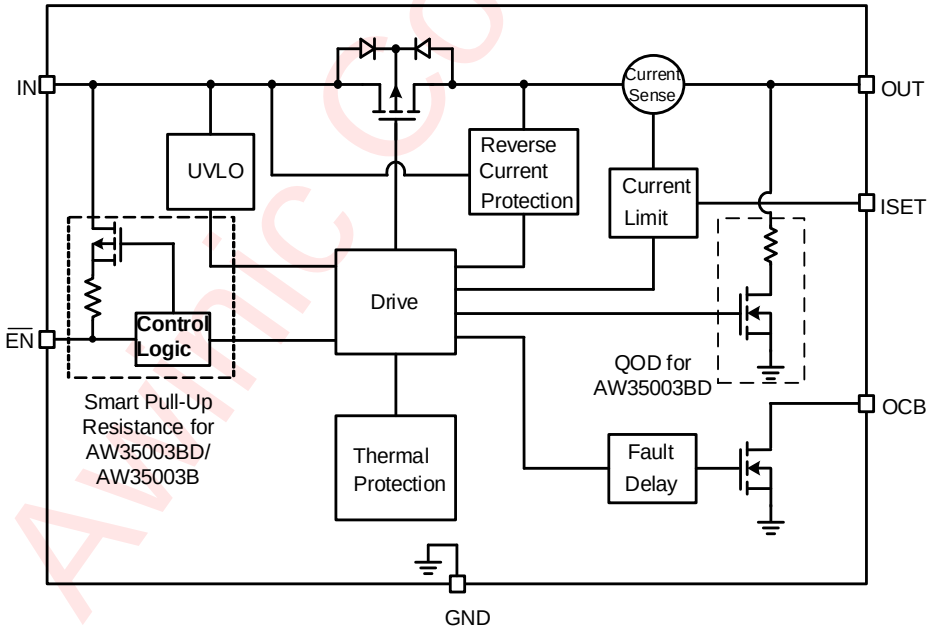


Figure 3 Functional Block Diagram

Typical Application Circuits

- **For Enable Active High Version**

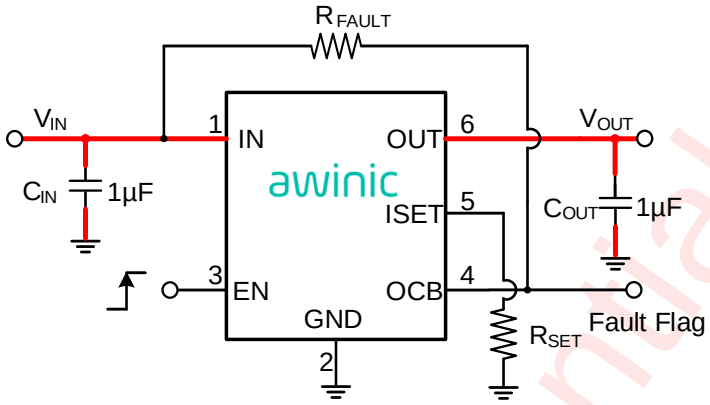


Figure 4 Typical Application Circuit of AW35013BD/AW35013B

- **For Enable Active Low Version**

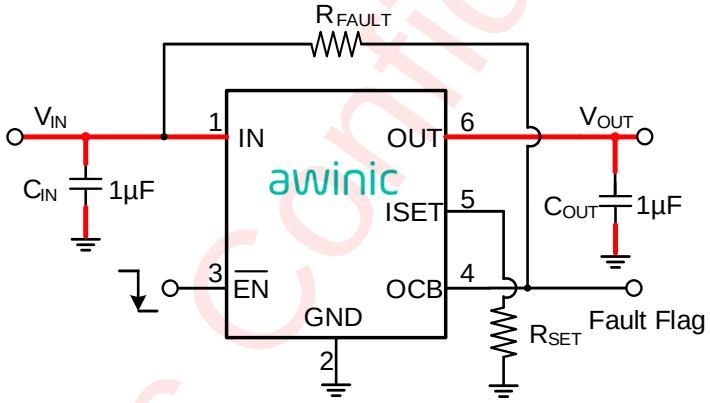


Figure 5 Typical Application Circuit of AW35003BD/AW35003B

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW35003BDSTR	-40°C ~ 85°C	SOT23-6L	PFAN	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35013BDSTR	-40°C ~ 85°C	SOT23-6L	3AN0	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35003BSTR	-40°C ~ 85°C	SOT23-6L	7SQ7	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35013BSTR	-40°C ~ 85°C	SOT23-6L	QFAJ	MSL1	ROHS+HF	3000 units/ Tape and Reel

Absolute Maximum Ratings(NOTE1)

PARAMETERS		RANGE
Supply Voltage Range V_{IN}		-0.3V to 6V
EN Voltage Range	EN	-0.3V to 6V
Output Voltage Range	OUT	-0.3V to 6V
Maximum Continuous Switch Current for VIN ≥ 2.5V(NOTE 2)		2.5A
Maximum Peak Switch Current for VIN ≥ 2.5V(NOTE 3)		3A
Junction-to-ambient thermal resistance θ_{JA}(NOTE 4)		158.9°C/W
Junction-to-case thermal resistance θ_{JC}		57°C/W
Operating Free-air Temperature Range		-40°C to 85°C
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 resistances follow JEDEC 2S2P standards, and is usually 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: JEDEC78E.

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage	2.5		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} = 5V, C_{IN} = 1μF, I_{IN}≤ 2.5A.

PARAMETER		TEST CONDITION		MIN	TYP	MAX	UNIT
SUPPLY CURRENT							
I_Q	Input quiescent current	V_{IN}=5.0V, EN($\overline{EN}$)=Active, I_{OUT}=0A			28	50	μA
I_{SD}	Shutdown current from IN to GND	V_{IN}=5.0V, EN($\overline{EN}$)=Inactive			0.32	1	μA
I_{LEAKEN}	EN pin leakage current	V_{IN}=0V, V_{EN}=5.5V			0.52	1	μA
POWER SWITCH							
R_{dson}	Internal switch MOSFET on-state resistance	V_{IN}=5.0V, I_{OUT}=500mA			65		mΩ
R_{EN}	EN pin pull up/down resistor	V_{IN}=5V, V_{EN}=0.1V (AW35013B/013BD)			9.2		MΩ
		V_{IN}=5V, V_{EN}=3V (AW35003B/003BD)					
R_{DIS}	Output discharge resistance	V_{IN}=5.0V, EN($\overline{EN}$)=Inactive, I_{OUT} Sinking 2mA (for AW35003BD/AW35013BD)			75		Ω
t_R	Output rise time	V_{IN}=5.0V, C_{OUT}=1μF, R_L=100Ω			285		μs
t_{ON}	Switch turn on time				520		μs
t_F	Output fall time	V_{IN}=5.0V, C_{OUT}=1μF, R_L=100Ω	AW35003B/013B		185		μs
			AW35003BD/013BD		80		μs
t_{OFF}	Switch turn off time		AW35003B/013B		215		μs
			AW35003BD/013BD		95		μs
V_{IH}	EN input high threshold level			1.4			V
V_{IL}	EN input low threshold level					0.4	V
CURRNET LIMIT							
I_{LIMIT}	Current limit threshold	R_{SET}=2.72kΩ		2000	2500	3000	mA
		R_{SET}=3.4kΩ		1790	2000	2330	
		R_{SET}=6.8kΩ		910	1000	1090	
		R_{SET}=17kΩ			400		
t_{IOS}	Response time to short circuit	V_{IN}=5.0V			10		μs
t_{OCP}	Current limit response time	V_{IN}=5.0V, I_{OUT}=1.5 × I_{LIMIT}			100		μs

Electrical Characteristics (continued)

T_A = 25°C unless otherwise noted. Typical values are guaranteed for V_{IN} = 5V, C_{IN} = 1μF, I_{IN}≤ 2.5A.

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
UNDER VOLTAGE LOCKOUT						
V_{UVLO}	UVLO threshold voltage	V_{IN} rising		2.3	2.5	V
V_{UVLO_HYS}	UVLO hysteresis	V_{IN} falling		95		mV
REVERSE VOLTAGE PROTECT						
V_{REV}	Reverse voltage trip point	EN($\overline{EN}$)=Active, V_{OUT} > V_{IN}		43		mV
I_{REV}	Reverse leakage current	V_{OUT}=5V, V_{IN}=0V, EN($\overline{EN}$)=Inactive		0.68		μA
I_{REV_ACT}	Reverse activation current	V_{IN}=5V, C_{OUT}=1μF, V_{OUT} > V_{IN}		0.6		A
I_{REV_PRO}	Reverse protection current	V_{OUT} - V_{IN} > V_{REV}		5		μA
FAULT FLAG						
R_{OCB}	OCB output low Resistance	V_{IN}=5V, I_{SINK}=1mA		190		Ω
I_{LEAK_OCB}	OCB off-state leakage current	V_{OCB}=5.5V		0.03		μA
t_{OCB}	OCB delay time	V_{IN}=5V, From fault condition to OCB assertion		2		ms
THERMAL PROTECTION						
T_{SD}	Thermal shutdown threshold			155		°C
T_{SD_HYS}	Thermal shutdown hysteresis			25		°C

Timing Diagram

- **For Enable Active High Version**

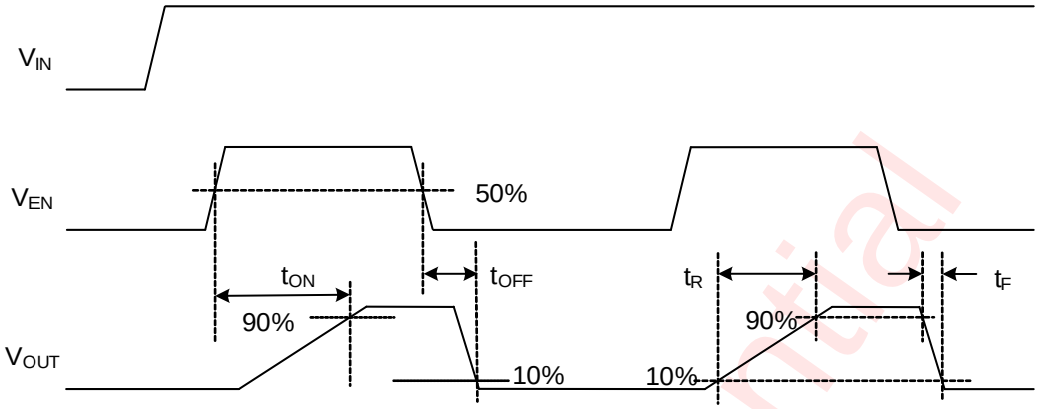


Figure 6 AW35013BD/AW35013B Timing Diagram

- **For Enable Active Low Version**

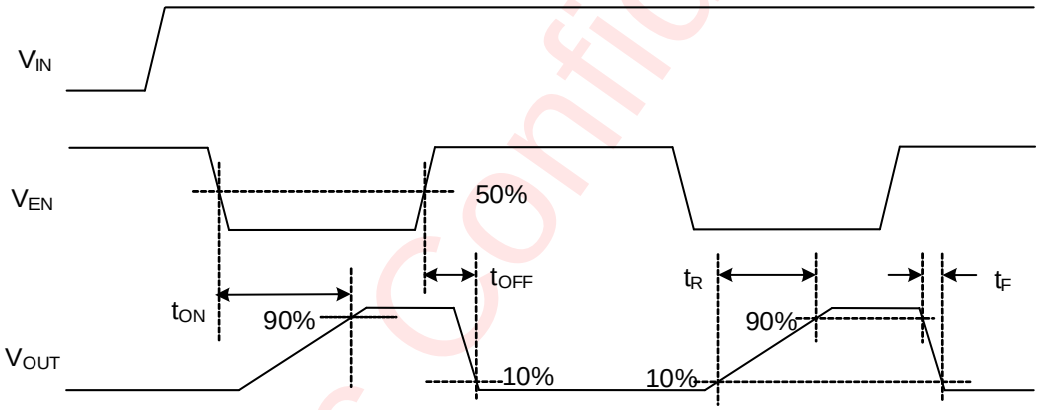


Figure 7 AW35003BD/AW35003B Timing Diagram

Typical Characteristics

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

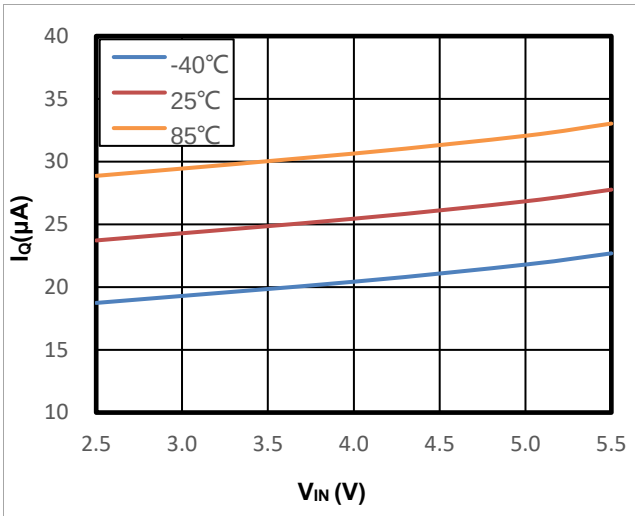


Figure 8 Quiescent Current vs. V_{IN}, No load

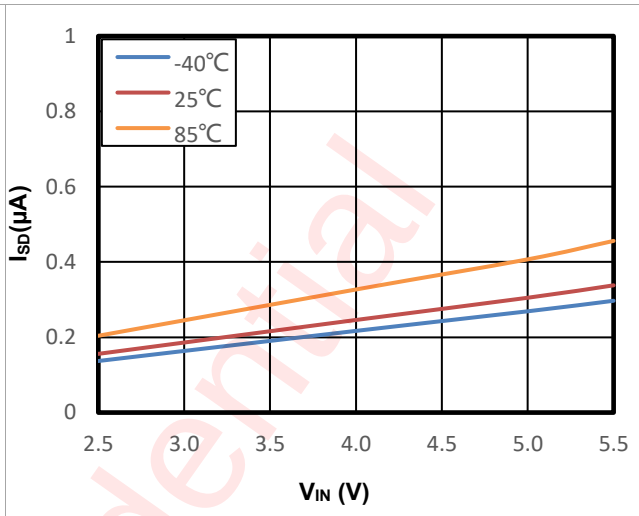


Figure 9 IN Shutdown Current vs. V_{IN}

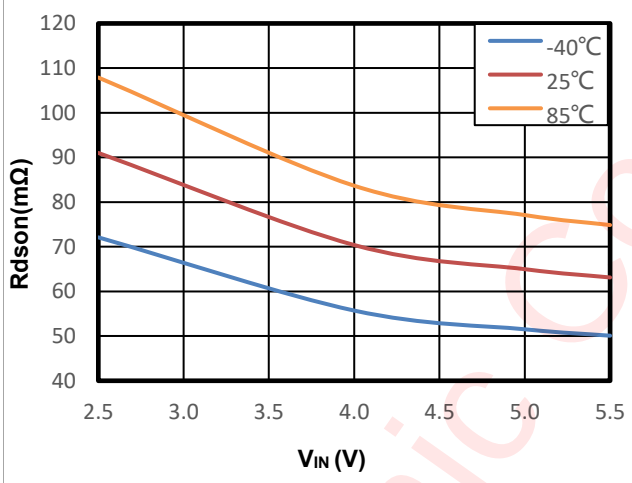


Figure 10 Rdson vs. V_{IN}(I_{OUT}=500mA)

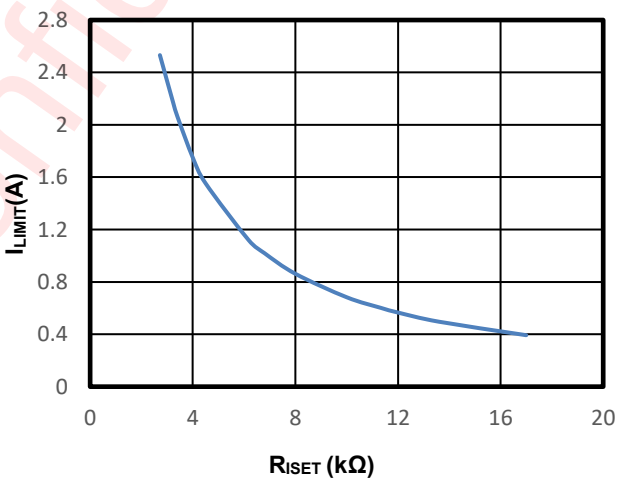


Figure 11 I_{LIMIT} vs. R_{ISET}

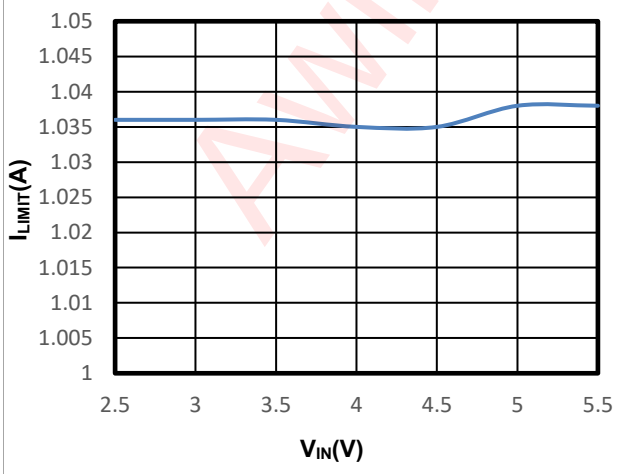


Figure 12 I_{LIMIT} vs. V_{IN}

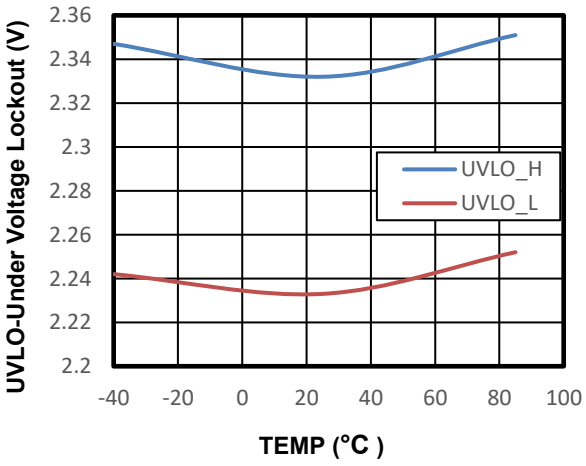
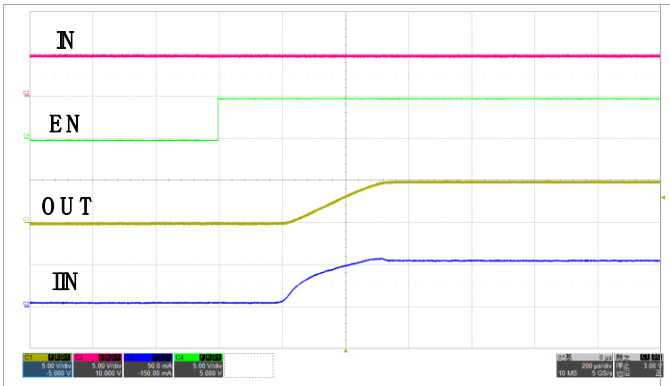


Figure 13 UVLO vs. TEMP

Typical Characteristics (continued)

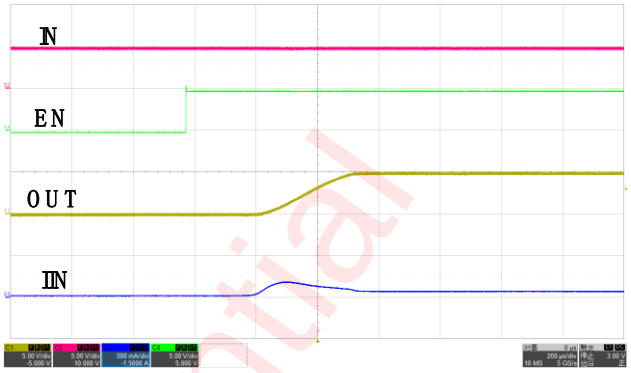
Ambient temperature is 25°C, C_{IN} = C_{OUT}=1μF, unless otherwise noted.



C1: 5.00V/div C2: 5.00V/div t=200μs/div
C3: 50mA/div C4: 5.00V/div

V_{IN}=5V，C_{IN}=1μF，C_{OUT}=1μF，Set I_{LIMIT}=1.0A，R_L=100Ω

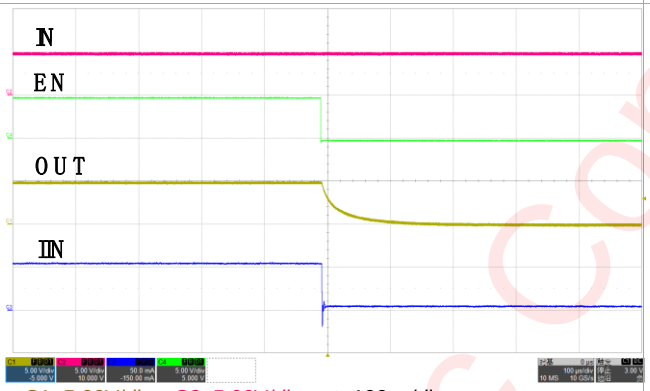
Figure 14 Turn On Response (AW35013BD)



C1: 5.00V/div C2: 5.00V/div t=200μs/div
C3: 500mA/div C4: 5.00V/div

V_{IN}=5V，C_{IN}=1μF，C_{OUT}=10μF，Set I_{LIMIT}=1.0A，R_L=100Ω

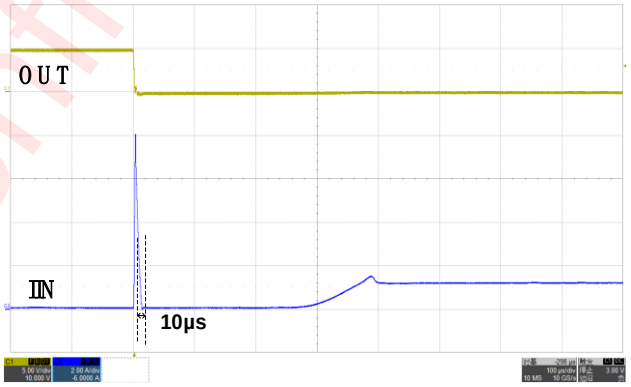
Figure 15 Turn On Response (AW35013BD)



C1: 5.00V/div C2: 5.00V/div t=100μs/div
C3: 50mA/div C4: 5.00V/div

V_{IN}=5V，C_{IN}=1μF，C_{OUT}=1μF，Set I_{LIMIT}=1.0A，R_L=100Ω

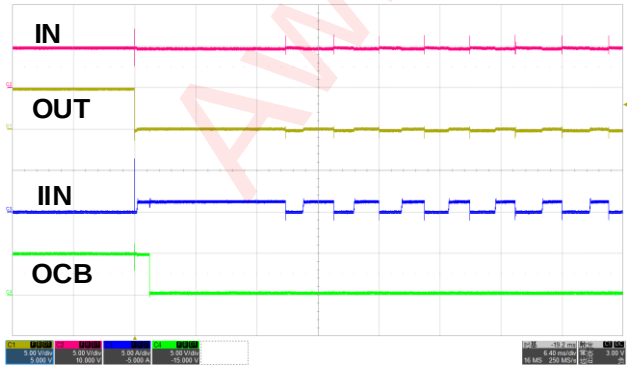
Figure 16 Turn Off Response (AW35013BD)



C1: 5.00V/div C3: 2A/div t=100μs/div

V_{IN}=5V，C_{IN}=1μF，C_{OUT}=1μF，Set I_{LIMIT}=1.0A

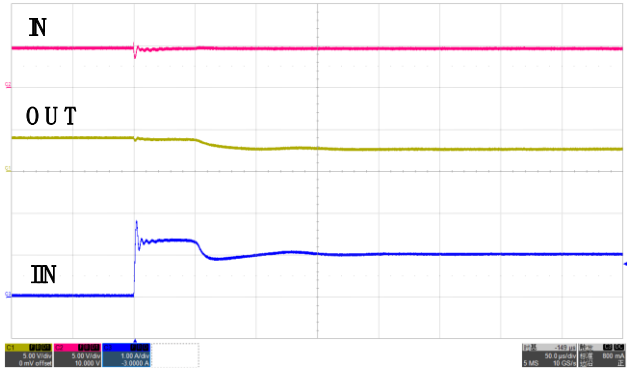
Figure 17 Short Circuit Response (AW35013BD)



C1:5.00V/div C2: 5.00V/div t=6.4ms/div
C3: 5A/div

V_{IN}=5V，C_{IN}=1μF，C_{OUT}=1μF

Figure 18 Continuous Short Response



C1: 5.00V/div C2: 5.00V/div t=50μs/div
C3: 1A/div

V_{IN}=5V，C_{IN}=1μF，C_{OUT}=1μF，Set I_{LIMIT}=1.0A

Figure 19 Current Limit Response

Functional Description

The AW35003BD/AW35013BD/AW35003B/AW35013B is a P channel MOSFET power distribution switch with current limit function. In addition, the switch also features fast short-circuit response, under voltage lockout, over temperature protection and reverse current protection.

CURRENT LIMIT THRESHOLD SETTING

The AW35003BD/AW35013BD/AW35003B/AW35013B provides adjustable current limit threshold which implemented by an external resistor from ISET to ground. The current limit function can prevent the switch from over current condition. The adjustable current limit value can be calculated using the following equations:

$$I_{LIMIT}=6800/R_{SET}$$

The minimum current limit is 400mA，beyond 2.5A is forbidden.

FAST SHORT CIRCUIT PROTECTION

The AW35003BD/AW35013BD/AW35003B/AW35013B provides short circuit protection function which can limit the output current to a safe level without damaging the switch.

UNDER VOLTAGE LOCKOUT (UVLO)

The AW35003BD/AW35013BD/AW35003B/AW35013B has under voltage lockout function which can disable the switch until the input voltage reaches the UVLO threshold (typical 2.3V). The UVLO threshold has a 95mV hysteresis voltage which can prevent the unwanted on/off cycling when there is noise on the input voltage.

OVER TEMPERATURE PROTECTION (OTP)

When the junction temperature exceeds 155°C, the internal OTP circuit turn off the power switch. There is a temperature hysteresis 25°C, in other words, the OTP circuit can turn on the switch only if the junction temperature is below 130°C.

QUICK OUTPUT DISCHARGE(QOD)

The AW35003BD/AW35013BD include the Quick Output Discharge (QOD) feature, in order to discharge the application capacitor connected on OUT pin. When EN(/$\overline{EN}$) pin is set to low(/high) level, a discharge resistance with a typical value of 75Ω is connected between the output and ground, pull down the output and prevent it from floating when the device is disabled.

REVERSE CURRENT PROTECTION (RCP)

The AW35003BD/AW35013BD/AW35003B/AW35013B 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 AW35003BD/AW35013BD/AW35003B/AW35013B 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 20 can be calculated by the following formula: $I_{REV\_ACT} = \frac{V_{REV}}{R_{dson}}$

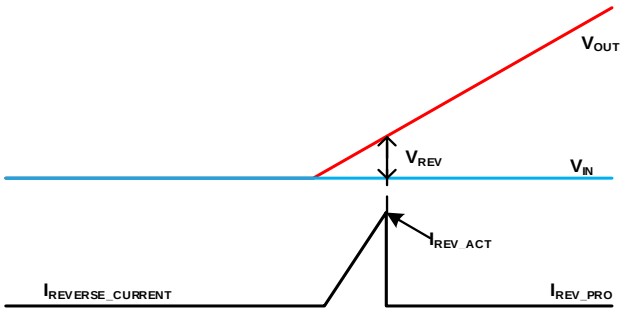


Figure 20 RCP parameter diagram

OCB OUTPUT

The AW35003BD/AW35013BD/AW35003B/AW35013B provides an open-drain output to indicate that a fault condition has occurred. When any of over current or over temperature or reverse current protection occurs for a deglitch time of t_{OCB}, the OCB goes low. If fault condition remove, OCB will goes high. Connect a resistor to between OCB and V_{IN} for normal work.

Application Information

INPUT AND OUTPUT CAPACITOR SELECTION

Input and output capacitance improves the performance of the device, the actual capacitance should be optimized for the particular application. For all applications, a 1μF or greater ceramic bypass capacitor between IN and GND is recommended as close to the device as possible for local noise de-coupling. 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.

Placing a 1μF or greater ceramic capacitor on the output pin is recommended when large transient currents are expected on the output.

PROGRAMMING THE CURRENT-LIMIT THRESHOLD

The AW35003BD/AW35013BD/AW35003B/AW35013B uses an internal regulation loop to provide a regulated voltage on the ISET pin. The current limit threshold is proportional to the current sourced out of ISET. The recommended 1% resistor range for R_{SET} is 2.72kΩ ≤ R_{SET} ≤ 17kΩ to ensure stability of the internal regulation loop. Many applications require that the minimum current limit is above a certain current level or that the maximum current limit is below a certain current level, so it is important to consider the tolerance of the overcurrent threshold when selecting a value for R_{SET}. The traces routing the R_{SET} resistor to the AW35003BD/AW35013BD/AW35003B/AW35013B should be as short as possible to reduce parasitic effects on the current limit accuracy. The following equations can be used to calculate the resulting current limit threshold for a given external resistor value (R_{SET}):

$$I_{LIMIT}=6800/R_{SET}$$

where 2.72kΩ ≤ R_{SET} ≤ 17kΩ.

PCB Layout Consideration

AW35003BD/AW35013BD/AW35003B/AW35013B is a low ON-Resistance power 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 AW35003BD/AW35013BD/AW35003B/AW35013B) and close to IN pin, and place the output capacitor C_{OUT} on the top layer (same layer as the AW35003BD/AW35013BD/AW35003B/AW35013B) and close to OUT pin.

2. The AW35003BD/AW35013BD/AW35003B/AW35013B integrates an up to 2.5A 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. Blue bold paths on Figure 21 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 AW35003BD/AW35013BD/AW35003B/AW35013B to decrease EMI coupling.

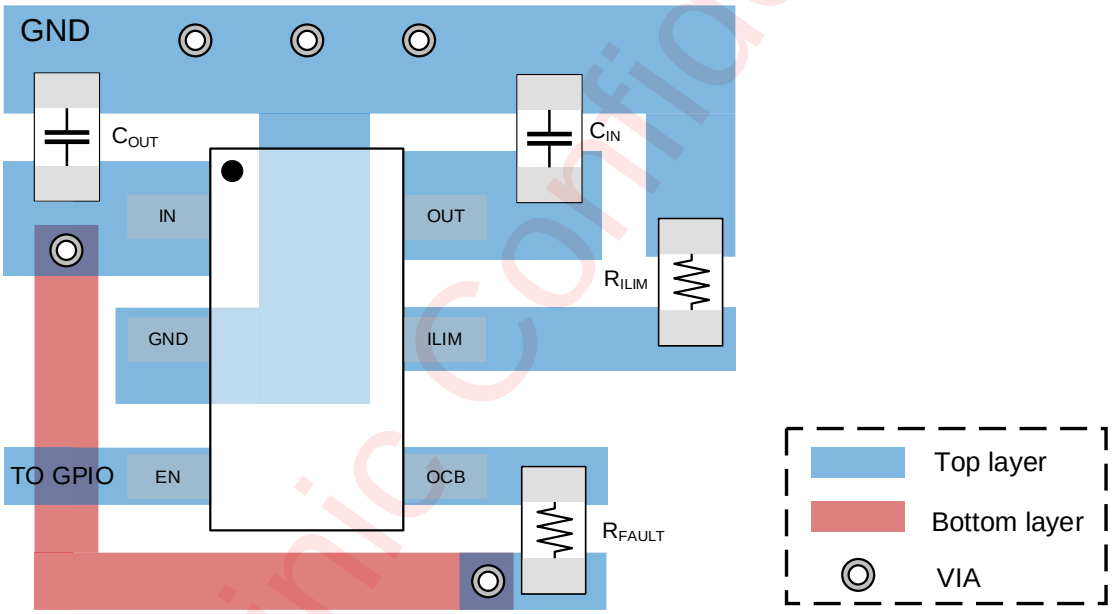
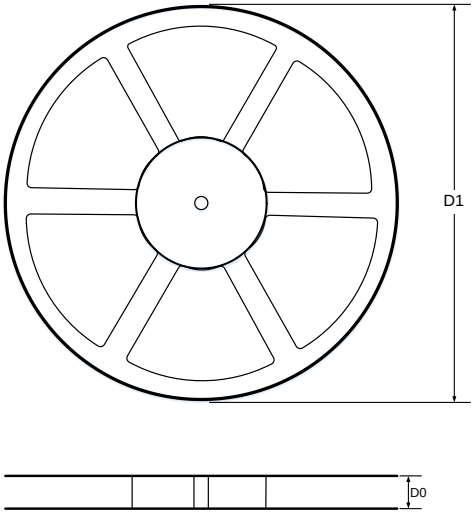


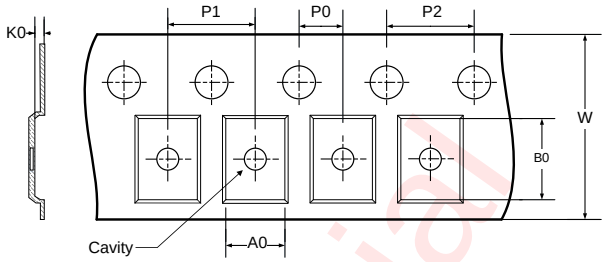
Figure 21 PCB layout example

Tape And Reel Information

REEL DIMENSIONS

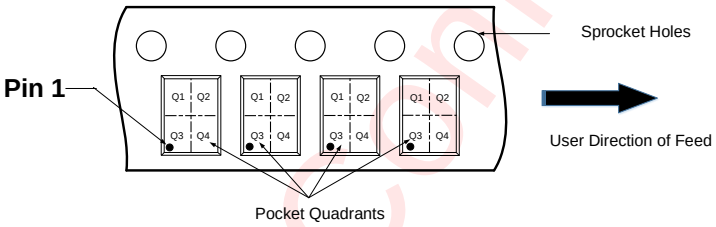


TAPE DIMENSIONS



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



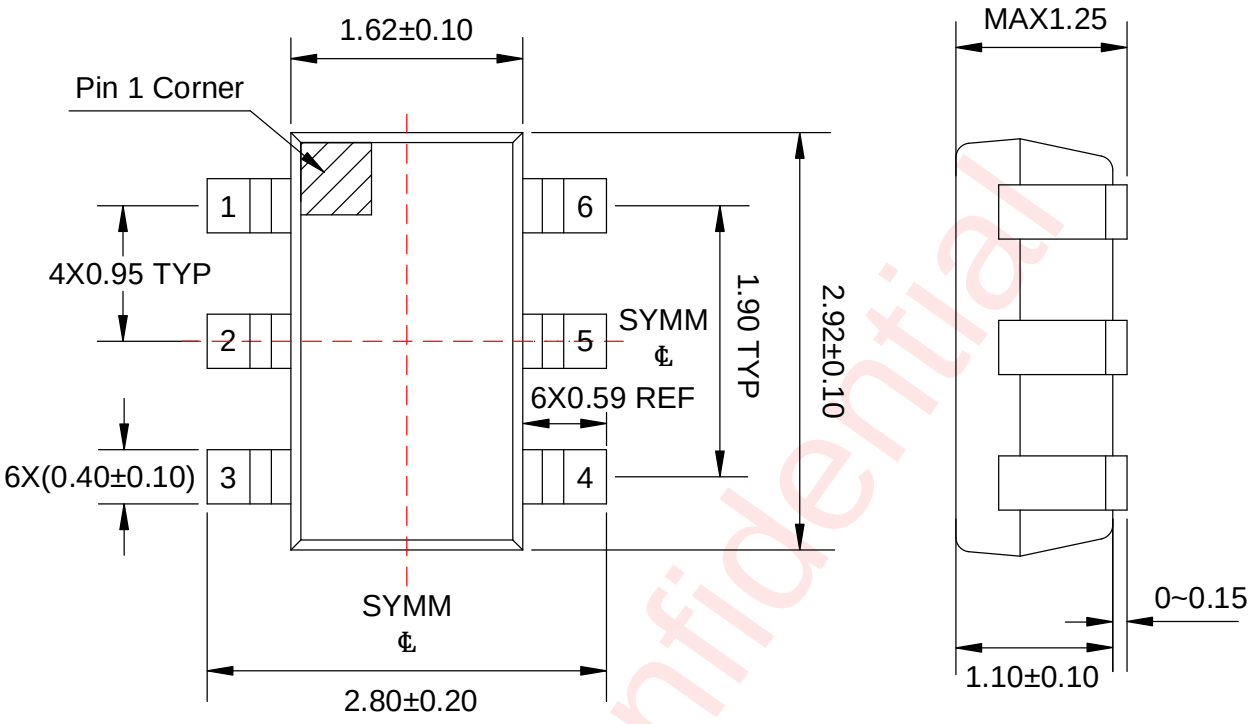
Note：The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

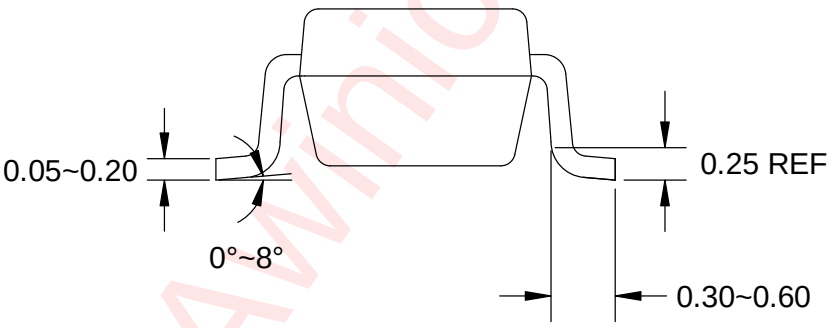
D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178	8.5	3.3	3.2	1.4	2	4	4	8	Q3

All dimensions are nominal

Package Description



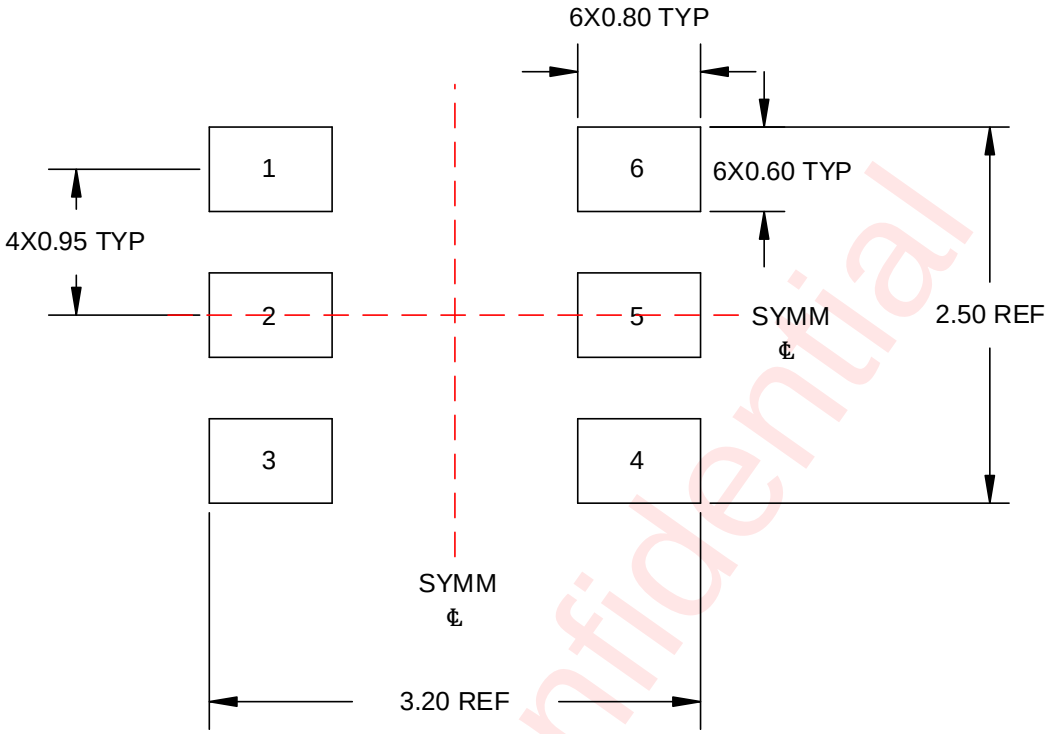
Top View **Side View**

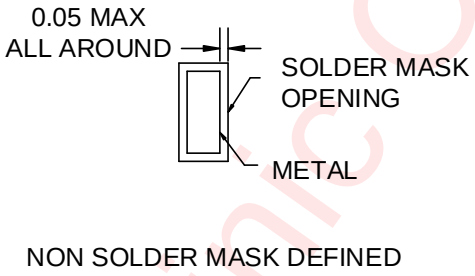


Side View

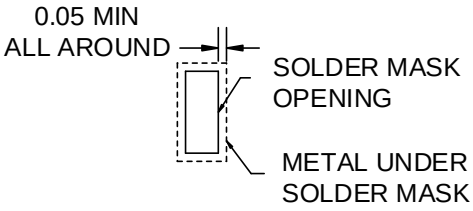
Unit: mm

Land Pattern Data





NON SOLDER MASK DEFINED



SOLDER MASK DEFINED

Unit: mm

Revision History

Version	Date	Change Record
V1.0	Jun. 2023	Officially released
V1.1	Jun. 2025	1. Update the ordering information of AW35013BD(P4) 2. Add the parameter of θ_{JA}/θ_{JC} (P5) 3. Add the maximum value of I_Q(P6) 4. Modify the test condition of R_{EN}(P6) 5. Add the parameters of t_F and t_{OFF}(P6)

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