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)
  - ✧ AW35003D/AW35013D: Auto QOD
  - ✧ AW35003/AW35013: No QOD
- SOT23-6L package

General Description

The AW35003D/AW35013D/AW35003/AW35013 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.

The AW35003D/AW35013D/AW35003/AW35013 also features fast short-circuit response, under voltage lockout, over temperature protection, reverse current protection. The AW35003D and AW35013D builds in quick output discharge function.

Set adjustable current limit:

AW35003D AW35013D AW35003 AW35013	$I_{LIMIT}=6800/R_{SET}$

Applications

USB Ports
Power Distribution Switch
Notebook and Desktop Computer
High-Definition Television(HDTV)

Typical Application Circuit

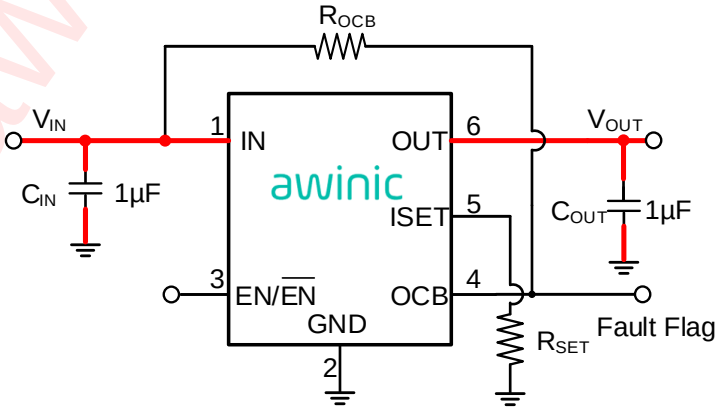


Figure 1 Typical Application Circuit

Pin Configuration And Top Mark

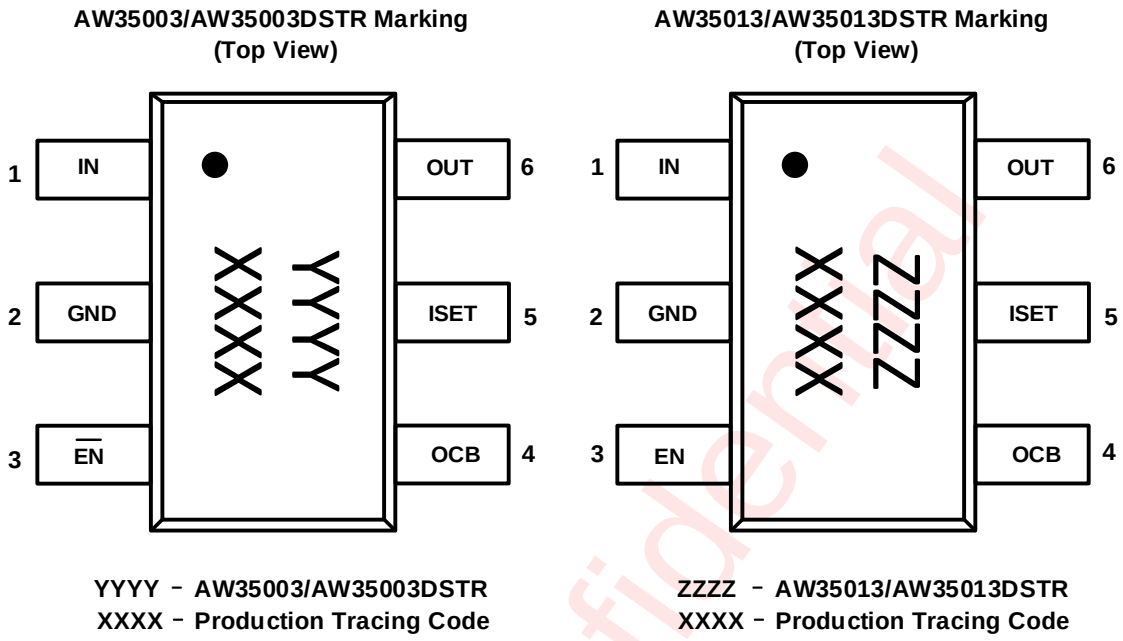


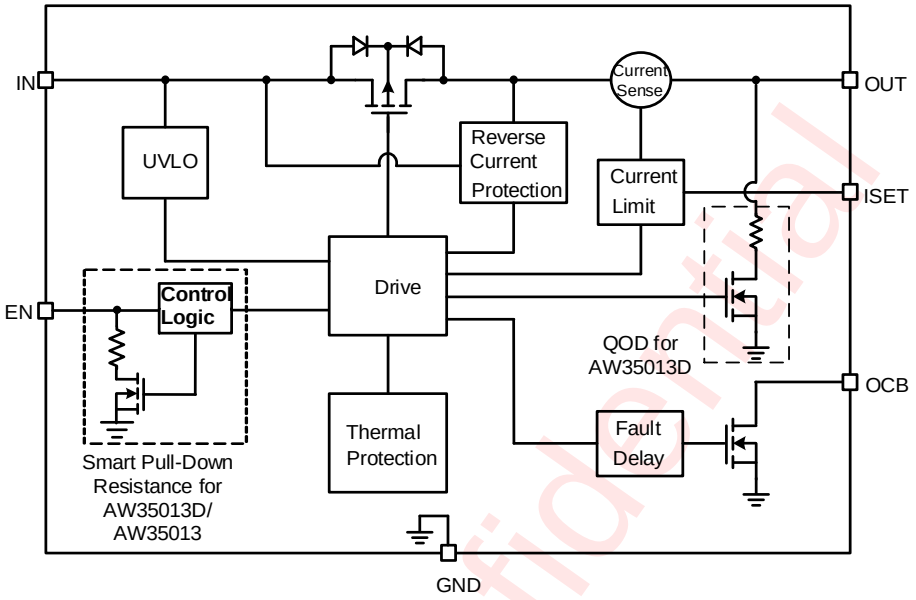
Figure 2 Pin Configuration and Top Mark

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**

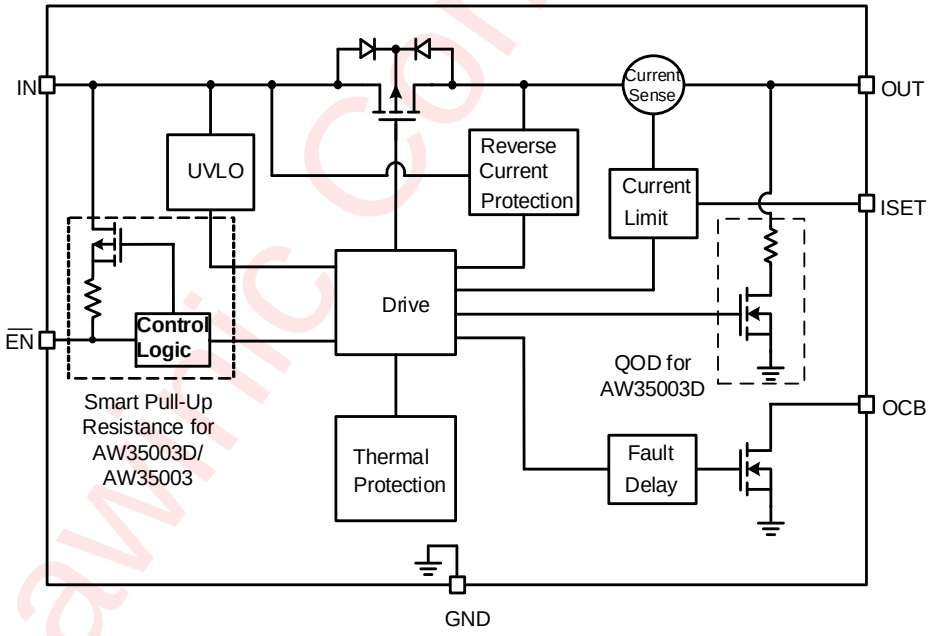


Figure 3 Functional Block Diagram

Typical Application Circuits

- **For Enable Active High Version**

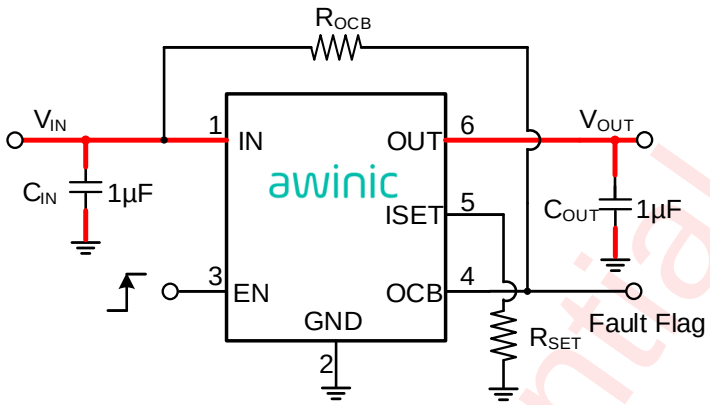


Figure 4 Typical Application Circuit of AW35013D/AW35013

- **For Enable Active Low Version**

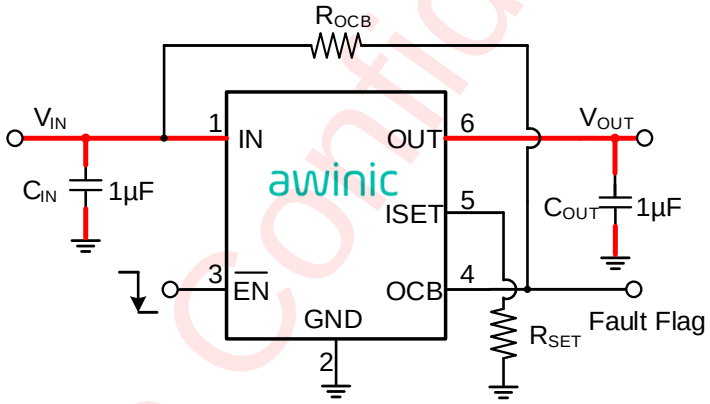


Figure 5 Typical Application Circuit of AW35003D/AW35003

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW35003DSTR	-40°C ~ 85°C	SOT23-6L	457A	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35013DSTR	-40°C ~ 85°C	SOT23-6L	3AN0	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35003STR	-40°C ~ 85°C	SOT23-6L	SZ5D	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW35013STR	-40°C ~ 85°C	SOT23-6L	JPZW	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
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 4)		±2kV
CDM(Charged Device Model) (NOTE 5)		±1.5kV
Latch-Up		
Latch-Up (NOTE 6)		+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: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: ESDA/JEDEC JS-001-2017.

NOTE5: All pins. Test Condition: ESDA/JEDEC JS-002-2018.

NOTE6: Test Condition: JESD78E.

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, V_{EN}=5.0V, I_{OUT}=0A		25	50	μA
I_{SD}	Shutdown current from IN to GND	V_{IN}=5.0V, V_{EN}=0V		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, V_{EN}=high, I_{OUT}=500mA		65		mΩ
R_{EN}	EN pin pull up/down resistor	V_{EN}=5.0V		9.2		MΩ
R_{DIS}	Output discharge resistance	V_{IN}=5.0V, V_{EN}=low， I_{OUT} Sinking 2mA (for AW35003D/AW35013D)		75		Ω
t_R	Output rise time	V_{IN}=5.0V, C_{OUT}=1μF, R_{OUT}=100Ω		130		μs
t_{ON}	Switch turn on time	V_{IN}=5.0V, C_{OUT}=1μF, R_{OUT}=100Ω		294		μs
t_F	Output fall time	V_{IN}=5.0V, C_{OUT}=1μF, R_{OUT}=100Ω		73		μs
t_{OFF}	Switch turn off time	V_{IN}=5.0V, C_{OUT}=1μF, R_{OUT}=100Ω		75		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_{LOAD}=1.5 × I_{LIMIT}		1		ms

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 and T_A = 25°C.

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	V_{EN}=High, V_{OUT} > V_{IN}		43		mV
I_{REV}	Reverse leakage current	V_{OUT}=5V,V_{IN}=0V,V_{EN}=0V		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**

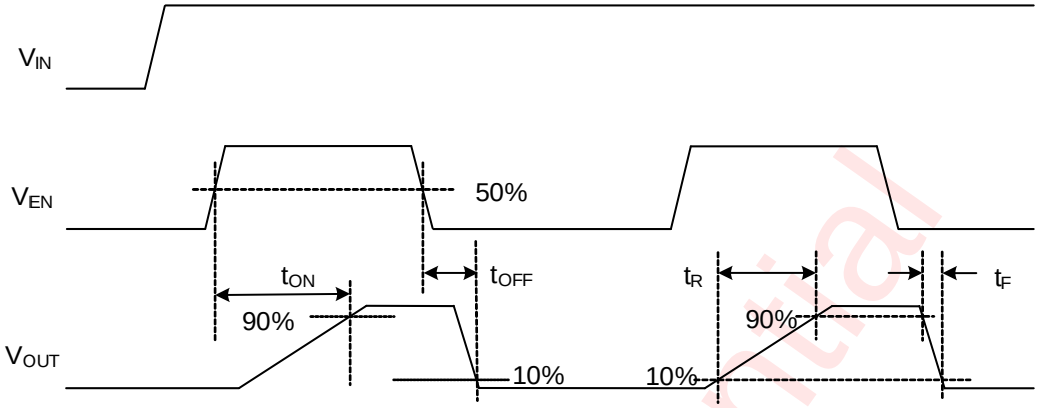


Figure 6 AW35013D/AW35013 Timing Diagram

- **For Enable Active Low Version**

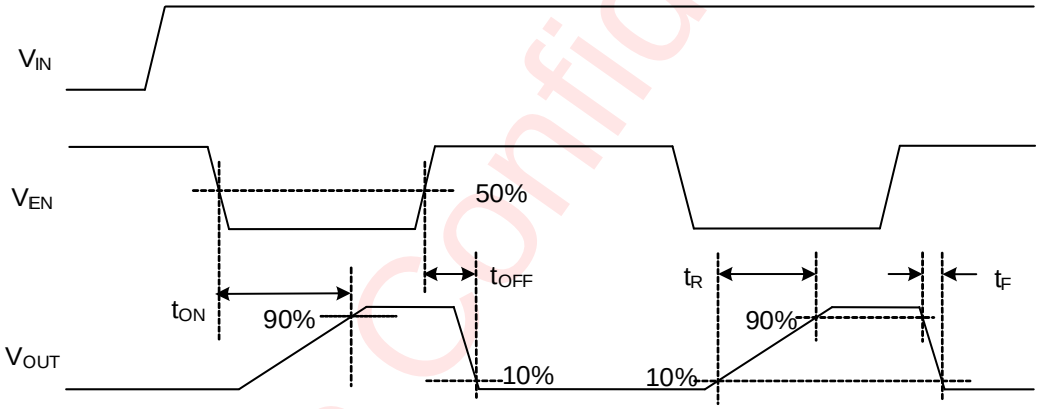


Figure 7 AW35003D/AW35003 Timing Diagram

Typical Characteristics

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

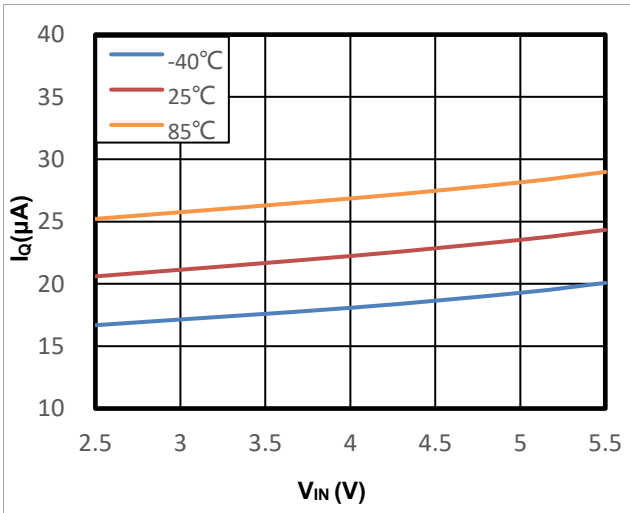


Figure 8 Quiescent Current vs. V_{IN}, No load

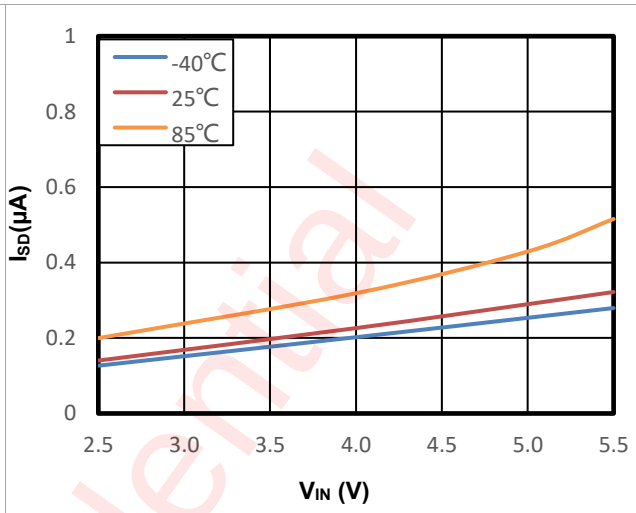


Figure 9 IN Shutdown Current vs. V_{IN}

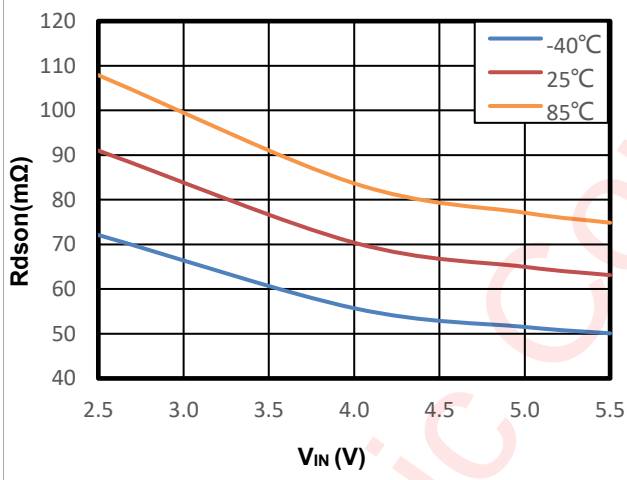


Figure 10 Rdson vs. V_{IN}(IOUT=500mA)

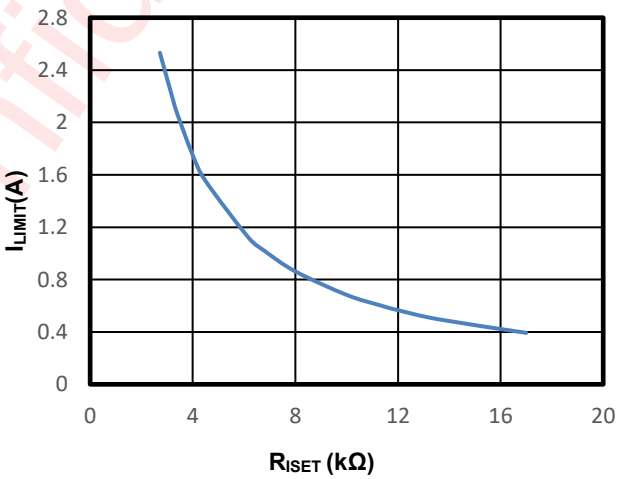


Figure 11 I_{LIMIT} vs. R_{ISET}

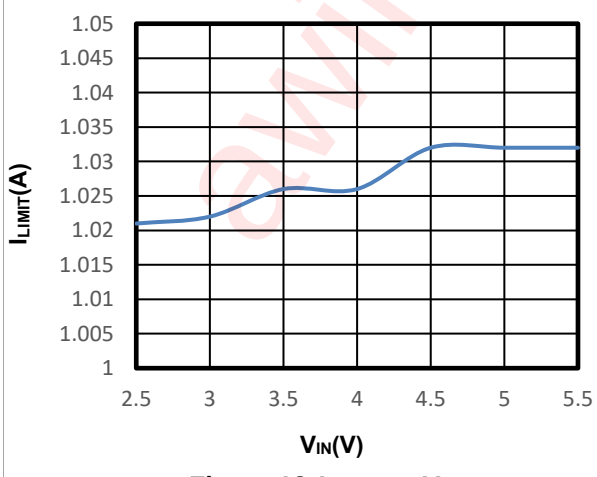


Figure 12 I_{LIMIT} vs. V_{IN}

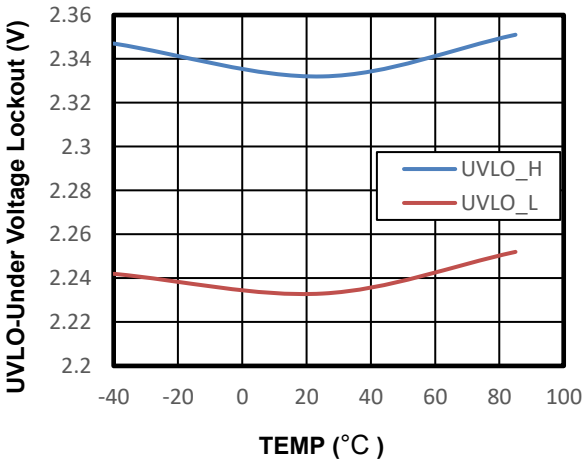
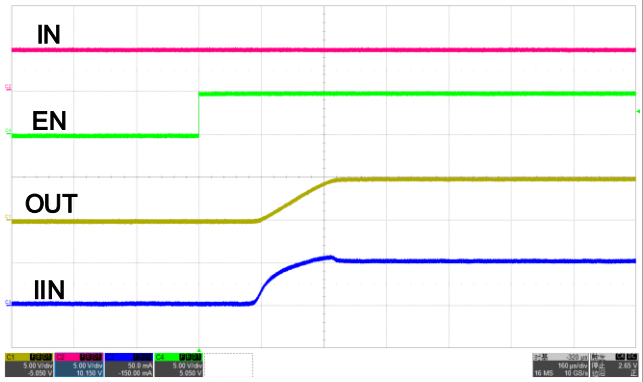


Figure 13 UVLO vs. TEMP

Typical Characteristics (continued)

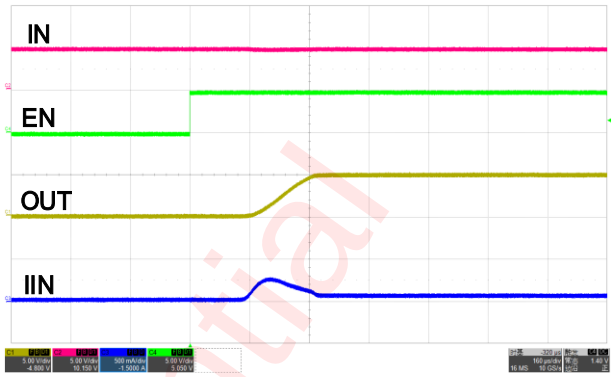
Ambient temperature is 25°C, C_{IN} = C_{OUT}=1μF, unless otherwise noted.



C1: 5.00V/div C2: 5.00V/div t=160μs/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

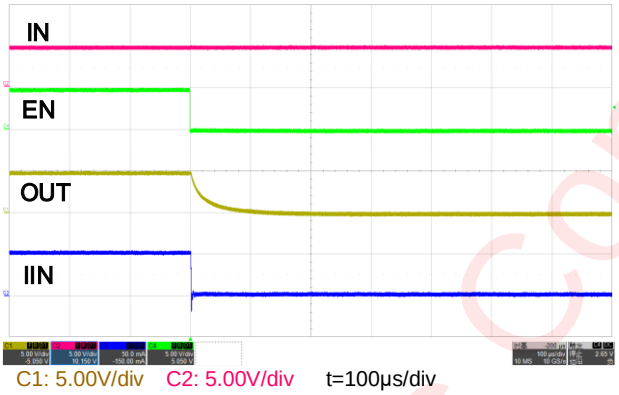
Figure 14 Turn On Response



C1: 5.00V/div C2: 5.00V/div t=160μs/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

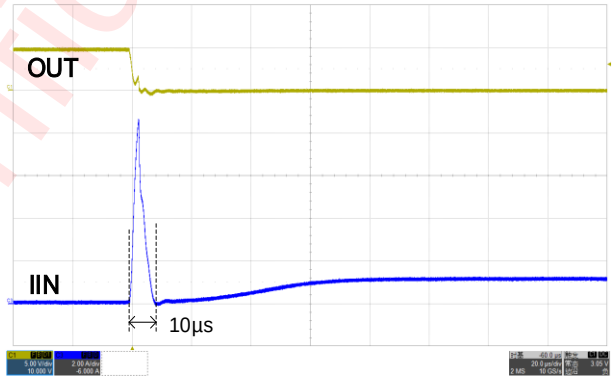
Figure 15 Turn On Response



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



C1: 5.00V/div C3: 2A/div t=20μs/div

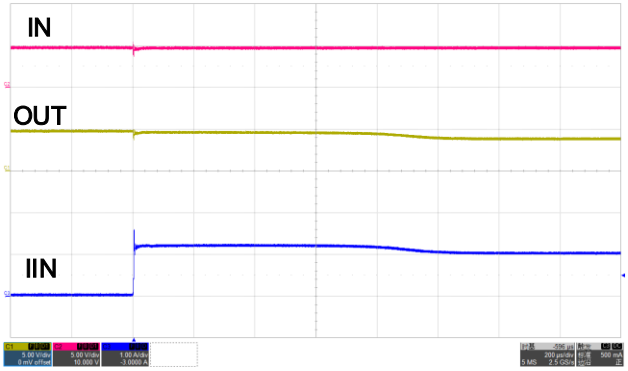
V_{IN}=5V，C_{IN}=1μF，C_{OUT}=1μF，Set I_{LIMIT}=1.0A

Figure 17 Short Circuit Response

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=200μs/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 AW35003D/AW35013D/AW35003/AW35013 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 AW35003D/AW35013D/AW35003/AW35013 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 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 AW35003D/AW35013D/AW35003/AW35013 provides short circuit protection function which can limit the output current to a safe level without damaging the switch.

UNDER VOLTAGE LOCKOUT (UVLO)

The AW35003D/AW35013D/AW35003/AW35013 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 AW35003D/AW35013D 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 AW35003D/AW35013D/AW35003/AW35013 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 AW35003D/AW35013D/AW35003/AW35013 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: $I_{REV\_ACT} = \frac{V_{REV}}{R_{dson}}$

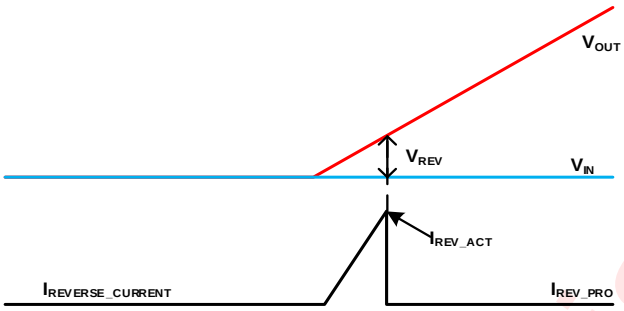


Figure 20 RCP parameter diagram

OCB OUTPUT

The AW35003D/AW35013D/AW35003/AW35013 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 AW35003D/AW35013D/AW35003/AW35013 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 AW35003D/AW35013D/AW35003/AW35013 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

AW35003D/AW35013D/AW35003/AW35013 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 AW35003D/AW35013D/AW35003/AW35013) and close to IN pin, and place the output capacitor C_{OUT} on the top layer (same layer as the AW35003D/AW35013D/AW35003/AW35013) and close to OUT pin.

2. The AW35003D/AW35013D/AW35003/AW35013 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 AW35003D/AW35013D/AW35003/AW35013 to decrease EMI coupling.

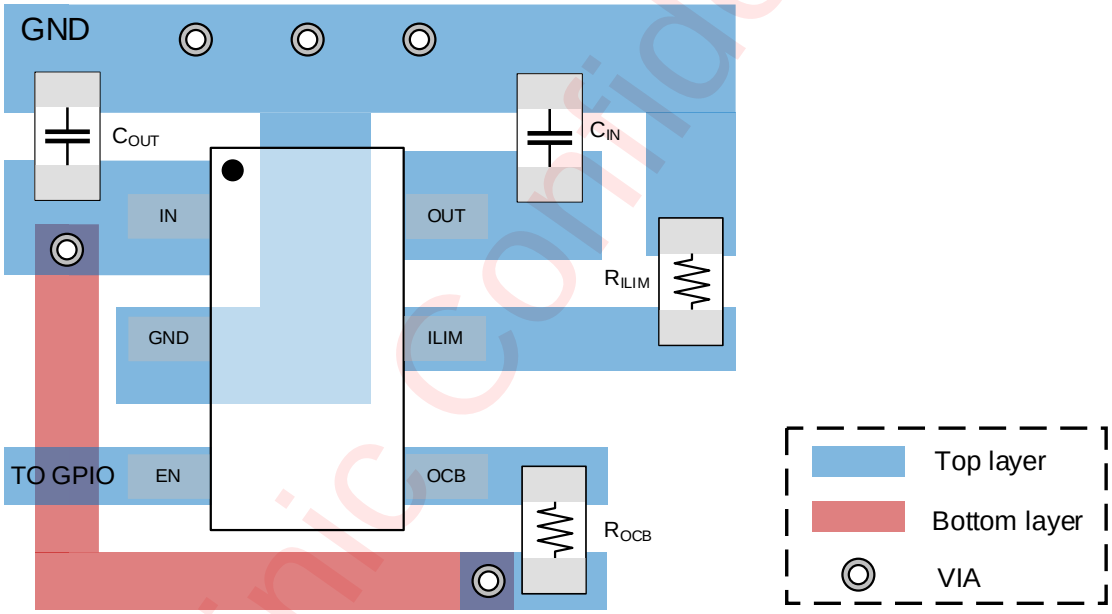
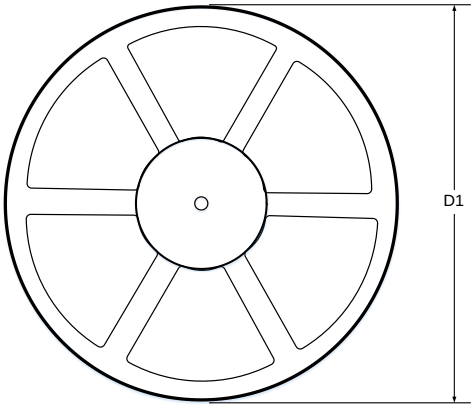
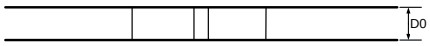


Figure 21 PCB layout example

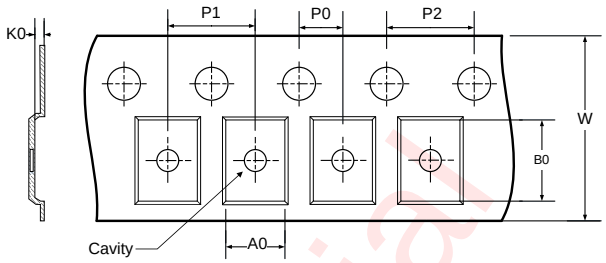
Tape And Reel Information

REEL DIMENSIONS



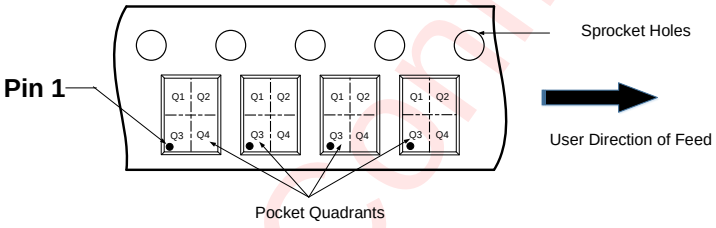


TAPE DIMENSIONS



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



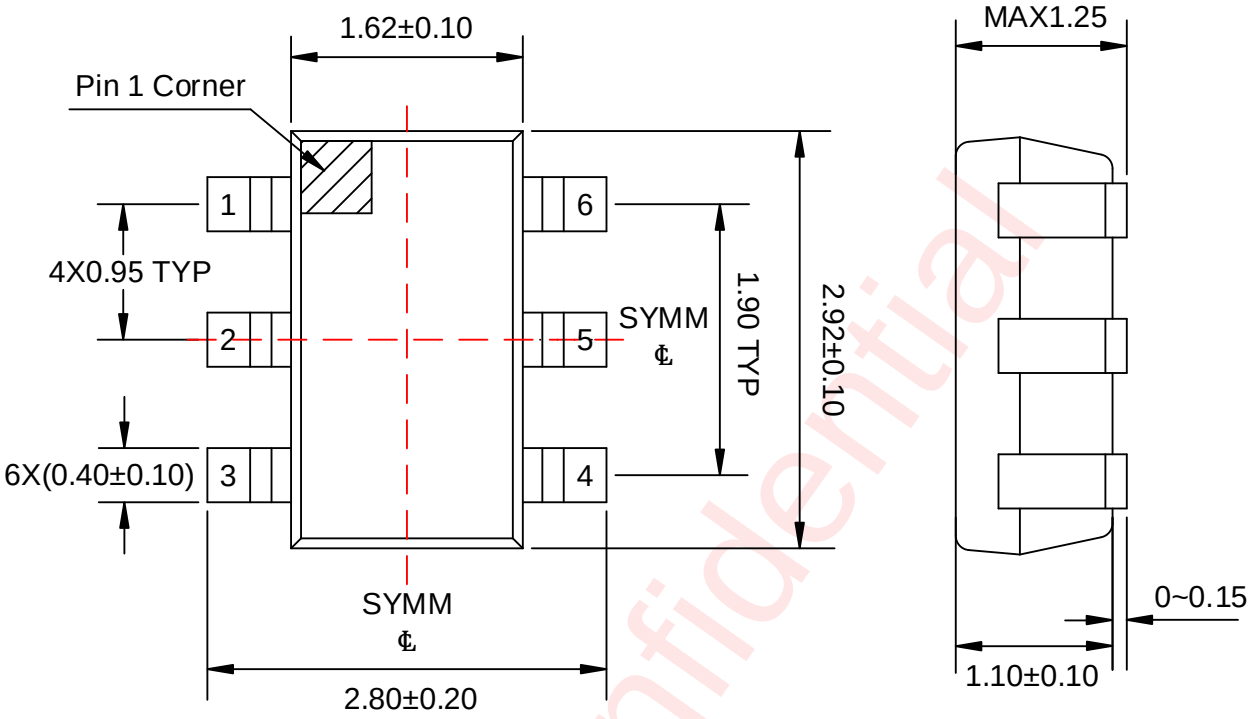
Note：The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

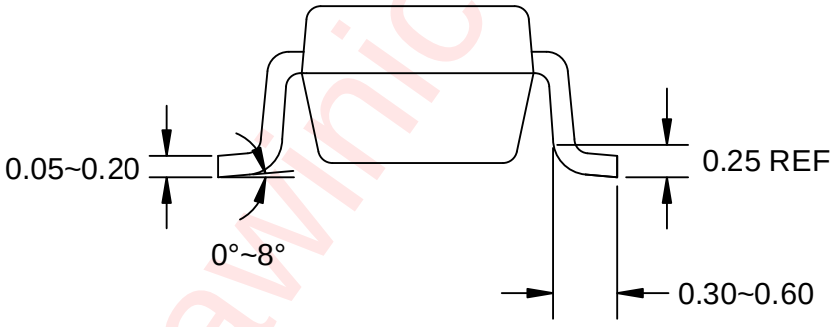
D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178	8.5	3.3	3.2	1.4	2	4	4	8	Q3

All dimensions are nominal

Package Description



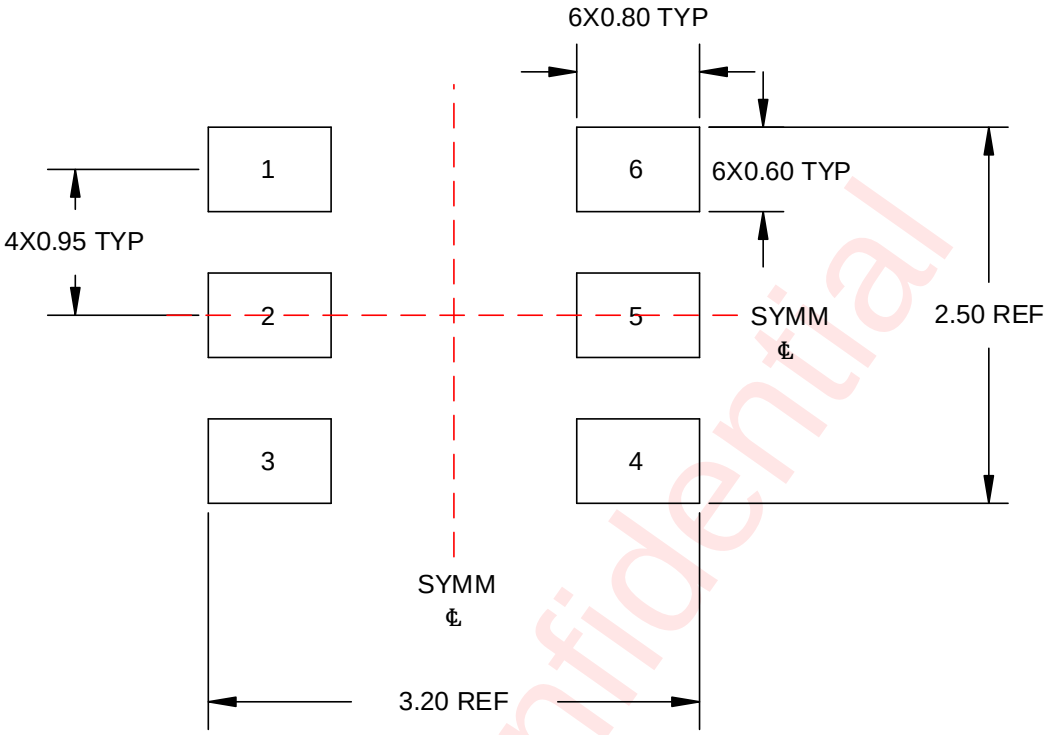
Top View **Side View**

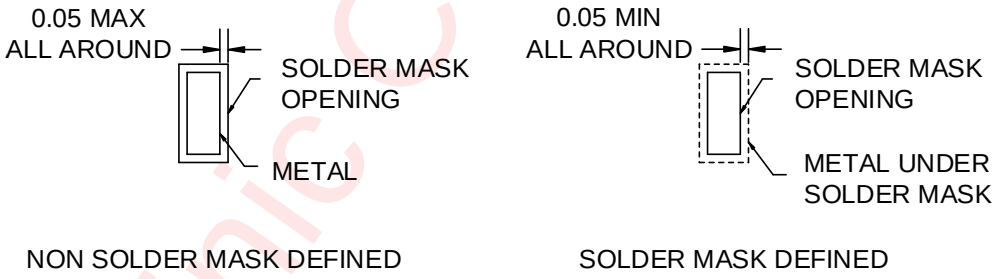


Side View

Unit: mm

Land Pattern Data





NON SOLDER MASK DEFINED

SOLDER MASK DEFINED

Unit: mm

Revision History

Version	Date	Change Record
V1.0	May 2023	Datasheet V1.0 Released

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