6A Single-Channel Ultra-Low On-Resistance Load Switch with Slew Rate Control

Features

- Integrated single-channel NMOS load switch
- Input voltage: V_{IN}=0.6V to V_{BIAS}
- V_{BIAS} voltage: V_{BIAS}=2.5V to 5.5V
- On-resistance
  - R_{on}=18.5mΩ (Typical) at V_{BIAS}=5V and V_{IN}=0.6V to 5V
  - R_{on}=19mΩ (Typical) at V_{BIAS}=2.5V and V_{IN}=0.6V to 2.5V
- 6A continuous switch current
- Quiescent Current
  - 20μA (typical) at V_{BIAS}=5V and V_{IN}=5V
- Controlled slew rate to limit inrush currents
- Over-Temperature Protection(OTP)
- Quick Output Discharge (QOD)
- DFN 2mmX2mmX0.75mm-8L Package with Thermal Pad

General Description

The AW35141 is a single-channel NMOS load switch with slew rate control. The device integrate a typical R_{on} of 18.5mΩ and has 6A maximum continuous switch current. The device on/off is controlled by the ON pin which is suitable for interfacing directly with low voltage I/O ports.

The AW35141 features over temperature protection. The device shuts down when the junction temperature exceeds 160℃ and return on when the temperature drops 30℃. The AW35141 also has QOD function which can prevent the output from floating when the switch is disabled.

Applications

Notebook

Tablet PCs

Consumer Electronics

Typical Application Circuit

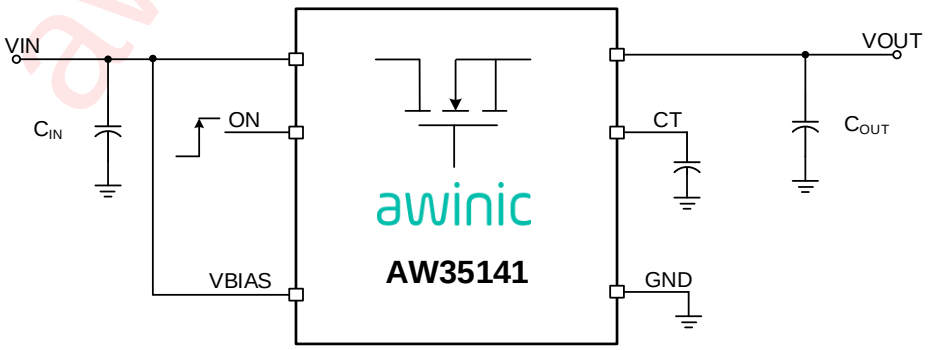


Figure 1 Typical Application Circuit of AW35141DNR

Pin Configuration And Top Mark

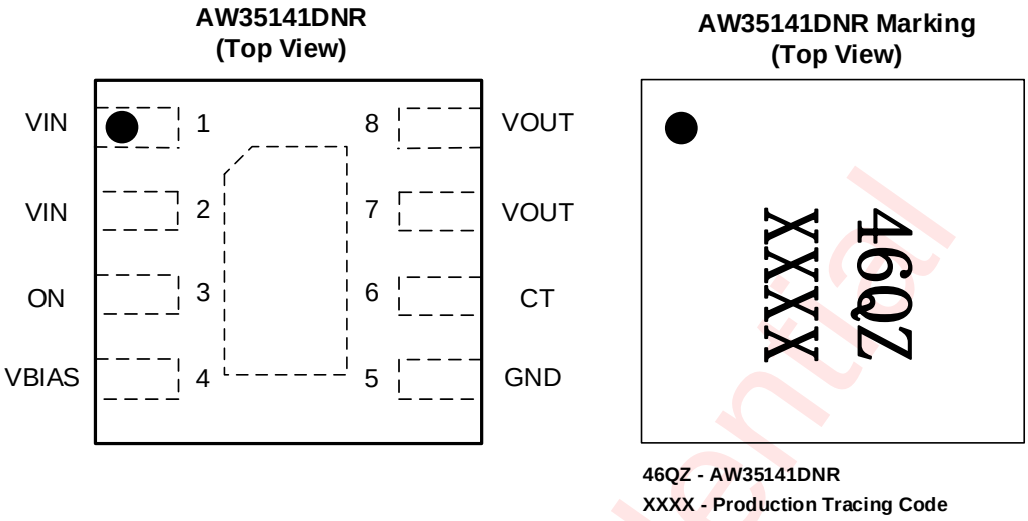


Figure 2 Pin Configuration and Top Mark

Pin Definition

Pin	Name	Description
1	VIN	Channel input
2		
3	ON	Channel enable (active high)
4	VBIAS	Power supply
5	GND	Ground
6	CT	Channel slew rate control
7	VOUT	Channel output
8		

Functional Block Diagram

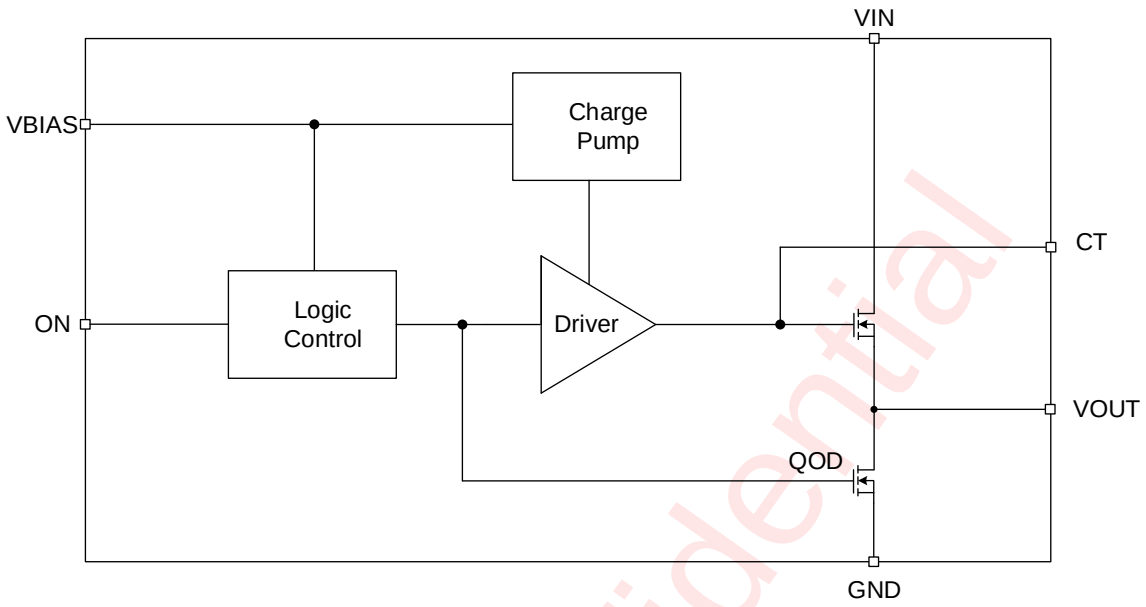


Figure 3 Functional Block Diagram

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW35141DNR	-40℃ ~ 105℃	DFN2mmX2mmX0.75mm-8L	46QZ	MSL1	ROHS+HF	3000 units/ Tape and Reel

Absolute Maximum Ratings(NOTE1)

PARAMETERS	RANGE
Input voltage range V_{IN}	-0.3V to 6V
BIAS voltage range V_{BIAS}	-0.3V to 6V
Enable control voltage range	-0.3V to 6V
Output voltage range	-0.3V to 6V
Junction-to-ambient thermal resistance θ_{JA}(NOTE2)	60°C/W
Operating free-air temperature range	-40°C to 105°C
Maximum operating 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)(NOTE3)	±2kV
CDM(Charged device model) (NOTE4)	±1kV
Latch-Up	
Latch-Up(NOTE5)	+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: Thermal resistance from junction to ambient is highly dependent on PCB layout.

NOTE3: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: ESDA/JEDEC JS-001-2017.

NOTE4: All pins. Test Condition: ESDA/JEDEC JS-002-2018.

NOTE5: Test Condition: JESD78E.

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IN}	Input voltage	0.6		V_{BIAS}	V
V_{ON}	EN voltage	0		V_{BIAS}	V
V_{OUT}	Output voltage	0		V_{IN}	V
V_{BIAS}	Power supply	2.5		5.5	V
C_T	Slew rate control	0	1000		pF
C_{IN}	Input capacitance	1			μF
C_{OUT}	Output capacitance		0.1		μF

Electrical Characteristics—V_{BIAS}=5V

Unless noted otherwise, V_{BIAS} voltage range of 2.5 V to 5.5 V, operating temperature range of –40°C to +105°C. Typical values are guaranteed for V_{BIAS}=V_{IN}=V_{ON}=5V, TA = 25°C.

PARAMETER		TEST CONDITION			MIN	TYP	MAX	UNIT
$I_{Q, VBIAS}$	V_{BIAS} quiescent current	V_{IN}=5V, V_{ON}=5V, no load				20		μA
$I_{SD, VBIAS}$	V_{BIAS} shutdown current	V_{IN}=5V, V_{ON}=0V, no load				35		nA
$I_{SD, VIN}$	V_{IN} shutdown current	V_{ON}=0V, V_{OUT}=0V		V_{IN}=5V		30		nA
				V_{IN}=3.3V		15		nA
				V_{IN}=1.8V		8		nA
				V_{IN}=0.6V		3		nA
I_{ON}	ON pin leakage current	V_{ON}=5V				1		nA
R_{on}	On-resistance	I_{OUT}=-200mA	V_{IN}= 5V	25℃		18.5	25	mΩ
				-40℃ to +85℃		18.5	30	mΩ
				-40℃ to +105℃		18.5	34	mΩ
			V_{IN}= 3.3V	25℃		18.5	25	mΩ
				-40℃ to +85℃		18.5	30	mΩ
				-40℃ to +105℃		18.5	34	mΩ
			V_{IN}= 1.8V	25℃		18.5	25	mΩ
				-40℃ to +85℃		18.5	30	mΩ
				-40℃ to +105℃		18.5	34	mΩ
			V_{IN}= 1.5V	25℃		18.5	25	mΩ
				-40℃ to +85℃		18.5	30	mΩ
				-40℃ to +105℃		18.5	34	mΩ
			V_{IN}= 1.05V	25℃		18.5	25	mΩ
				-40℃ to +85℃		18.5	30	mΩ
				-40℃ to +105℃		18.5	34	mΩ
			V_{IN}= 0.6V	25℃		18.5	25	mΩ
				-40℃ to +85℃		18.5	30	mΩ
				-40℃ to +105℃		18.5	34	mΩ

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
R_{DISC}	Output discharge resistance	V_{IN}=V_{OUT}=5V, V_{ON}=0V		220		Ω
V_{IH}	ON input high threshold level		1.2			V
V_{IL}	ON input low threshold level				0.4	V
T_{SD}	Over temperature threshold	Junction Temperature Rising		160		°C
$T_{SD, HYS}$	Over temperature hysteresis	Junction Temperature Falling		30		°C

Electrical Characteristics—V_{BIAS}=2.5V

Unless noted otherwise, V_{BIAS} voltage range of 2.5 V to 5.5 V, operating temperature range of –40°C to +105°C. Typical values are guaranteed for V_{BIAS}=V_{IN}=V_{ON}=2.5V, TA = 25°C.

PARAMETER		TEST CONDITION			MIN	TYP	MAX	UNIT
$I_{Q, VBIAS}$	V_{BIAS} quiescent current	V_{IN}=2.5V, V_{ON}=2.5V, no load				16		μA
$I_{SD, VBIAS}$	V_{BIAS} shutdown current	V_{IN}=2.5V, V_{ON}=0V, no load				10		nA
$I_{SD, VIN}$	V_{IN} shutdown current for each channel	V_{ON}=0V, V_{OUT}=0V	V_{IN}=2.5V			10		nA
			V_{IN}=1.8V			8		nA
			V_{IN}=1.2V			4		nA
			V_{IN}=0.6V			2		nA
I_{ON}	ON pin leakage current for each channel	V_{ON}=2.5V				1		nA
R_{on}	On-resistance	I_{OUT}=-200mA	V_{IN}= 2.5V	25℃		19	25	mΩ
				-40℃ to +85℃		19	31	mΩ
				-40℃ to +105℃		19	35	mΩ
			V_{IN}= 1.8V	25℃		19	25	mΩ
				-40℃ to +85℃		19	31	mΩ
				-40℃ to +105℃		19	35	mΩ
			V_{IN}= 1.5V	25℃		19	25	mΩ
				-40℃ to +85℃		19	31	mΩ
				-40℃ to +105℃		19	35	mΩ
			V_{IN}= 1.05V	25℃		20	25	mΩ
				-40℃ to +85℃		20	32	mΩ
				-40℃ to +105℃		20	36	mΩ
			V_{IN}= 0.6V	25℃		20	25	mΩ
				-40℃ to +85℃		20	32	mΩ
				-40℃ to +105℃		20	36	mΩ
R_{DISC}	Output Discharge Resistance	V_{IN}=V_{OUT}=2.5V, V_{ON}=0V				250		Ω
V_{IH}	ON input high threshold level				1.2			V
V_{IL}	ON input low threshold level						0.4	V

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
T_{SD}	Over temperature threshold	Junction Temperature Rising		160		°C
$T_{SD,HYS}$	Over temperature hysteresis	Junction Temperature Falling		30		°C

Switching Characteristics

Unless noted otherwise, V_{BIAS} voltage range of 2.5 V to 5.5 V, operating temperature range of –40°C to +105°C. Typical values are guaranteed for V_{BIAS}=V_{IN}=V_{ON}=5V, TA = 25°C.

PARAMETER		TEST CONDITION	MIN	TYP	MAX	UNIT
V_{IN}=5V, V_{BIAS}=5V						
t_D	ON Delay time	R_L=10Ω, C_L=0.1μF, CT=1nF		500		μs
t_{ON}	Turn-on time			1400		μs
t_R	Rising time			1500		μs
t_{OFF}	Turn-off time			8		μs
t_F	Falling time			5		μs
V_{IN}=0.6V, V_{BIAS}=5V						
t_D	ON Delay time	R_L=10Ω, C_L=0.1μF, CT=1nF		400		μs
t_{ON}	Turn-on time			500		μs
t_R	Rising time			400		μs
t_{OFF}	Turn-off time			12		μs
t_F	Falling time			5		μs
V_{IN}=2.5V, V_{BIAS}=2.5V						
t_D	ON Delay time	R_L=10Ω, C_L=0.1μF, CT=1nF		700		μs
t_{ON}	Turn-on time			1500		μs
t_R	Rising time			1600		μs
t_{OFF}	Turn-off time			15		μs
t_F	Falling time			5		μs
V_{IN}=0.6V, V_{BIAS}=2.5V						
t_D	ON Delay time	R_L=10Ω, C_L=0.1μF, CT=1nF		550		μs
t_{ON}	Turn-on time			800		μs
t_R	Rising time			500		μs
t_{OFF}	Turn-off time			18		μs
t_F	Falling time			5		μs

Timing Diagram

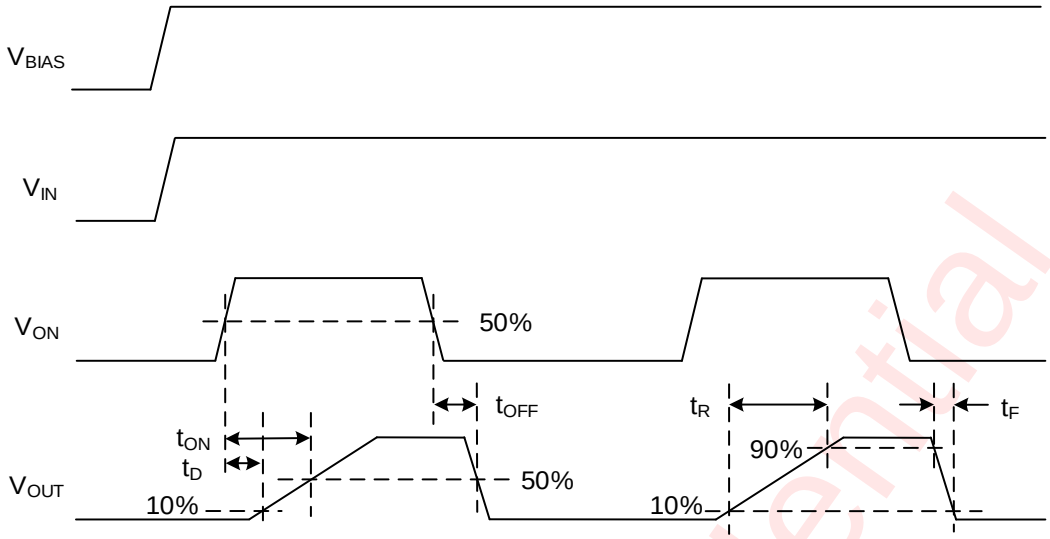


Figure 4 AW35141 Timing Diagram

Typical Characteristics

Ambient temperature is 25°C, C_{IN} =1μF, C_{OUT}=0.1μF, C_T=1nF, unless otherwise noted.

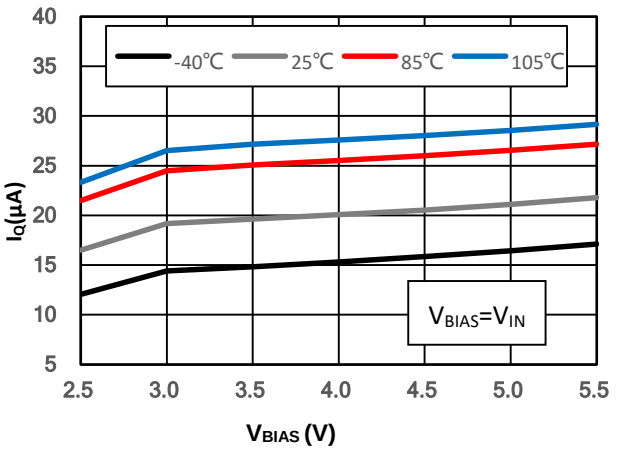


Figure 5 Quiescent Current vs. V_{BIAS}, No load

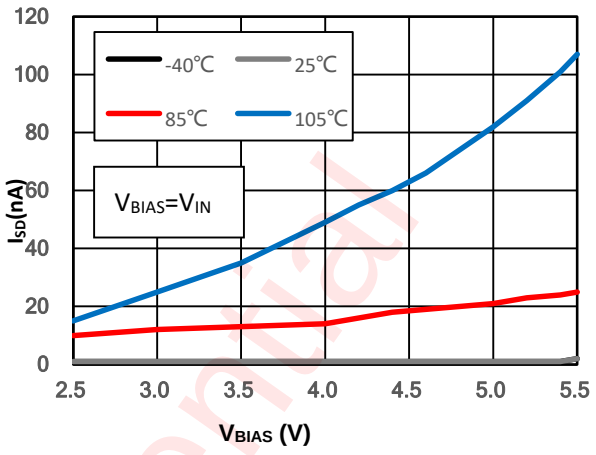


Figure 6 V_{BIAS} Shutdown Current vs. V_{BIAS}

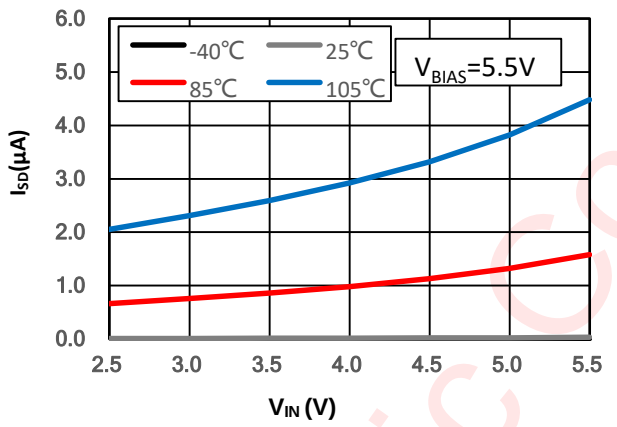


Figure 7 V_{IN} Shutdown Current vs. V_{IN}

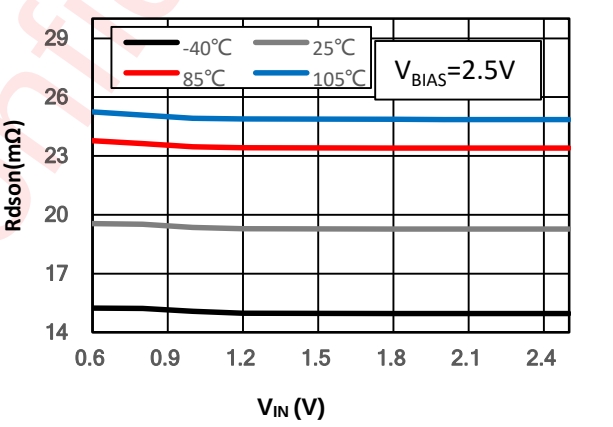


Figure 8 Rdson vs. V_{IN}

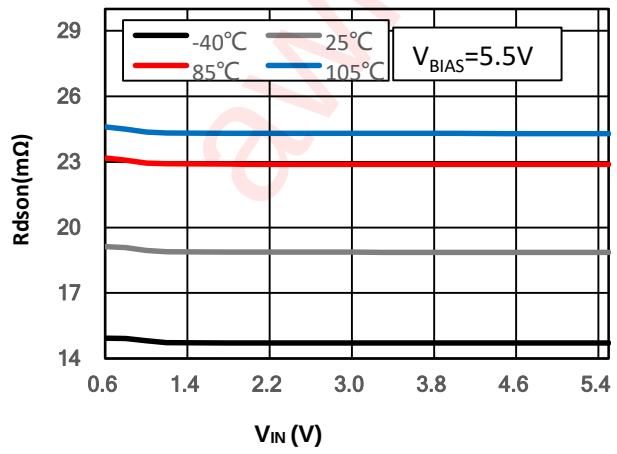


Figure 9 Rdson vs. V_{IN}

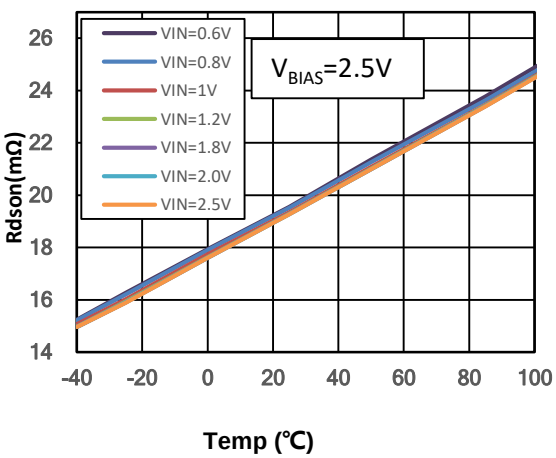


Figure 10 Rdson vs. Temp (I_{OUT}=200mA)

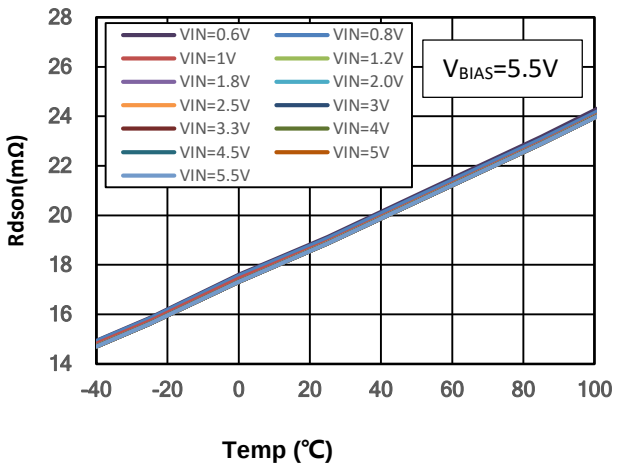


Figure 11 Rdson vs. Temp (I_{OUT}=200mA)

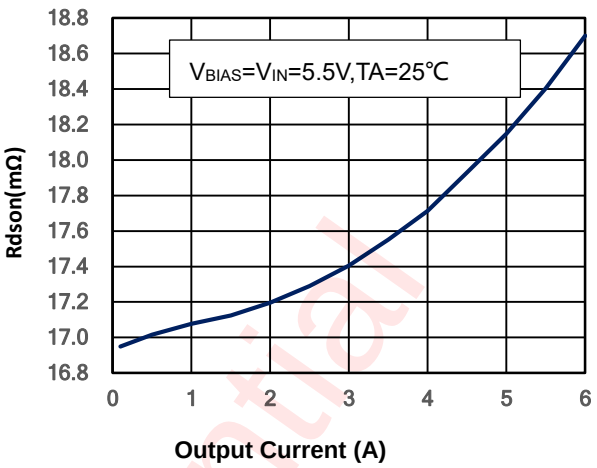


Figure 12 Rdson vs. I_{OUT}

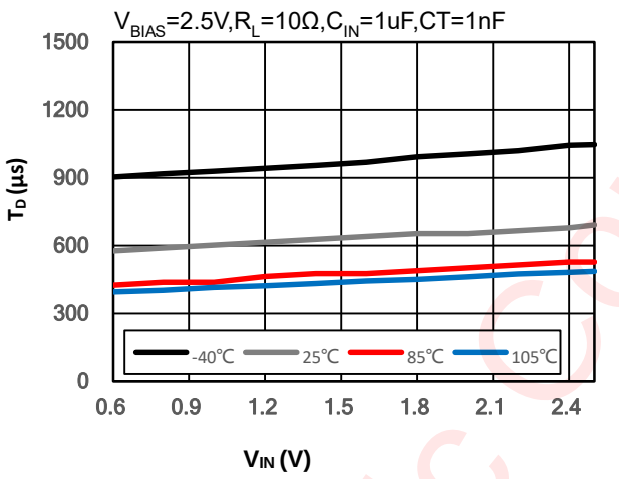


Figure 13 Turn On Delay vs. V_{IN}

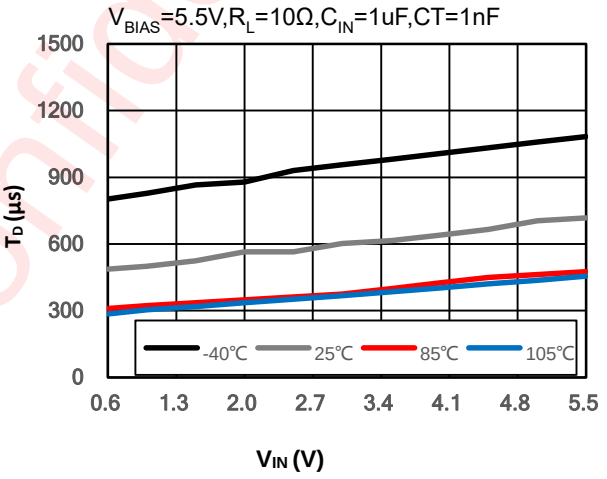


Figure 14 Turn On Delay vs. V_{IN}

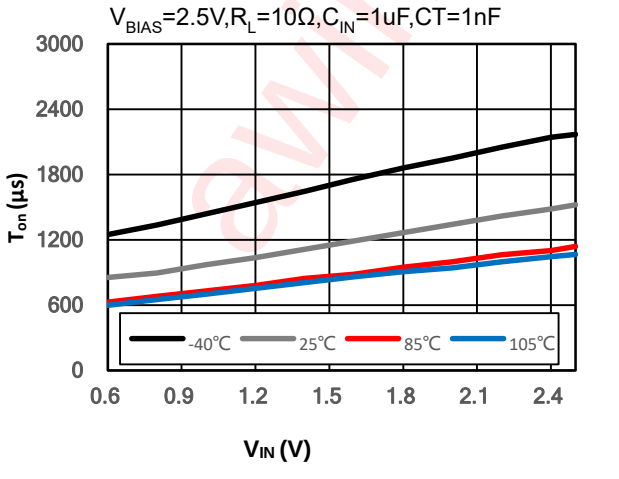


Figure 15 Turn On vs. V_{IN}

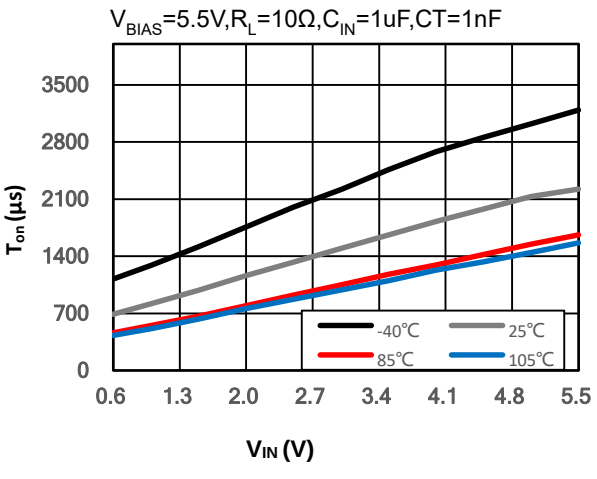


Figure 16 Turn On vs. V_{IN}

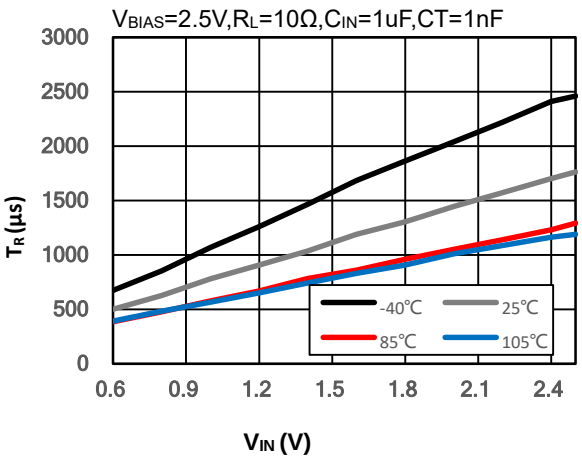


Figure 17 Rise Time vs. V_{IN}

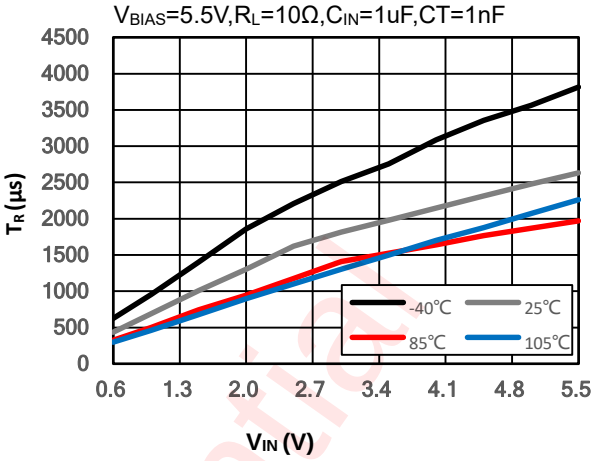


Figure 18 Rise Time vs. V_{IN}

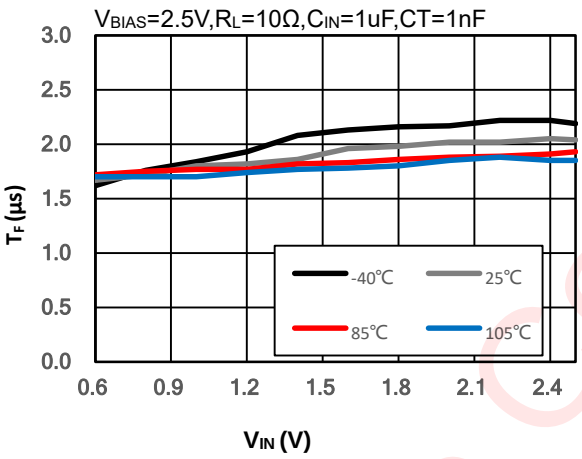


Figure 19 Fall Time vs. V_{IN}

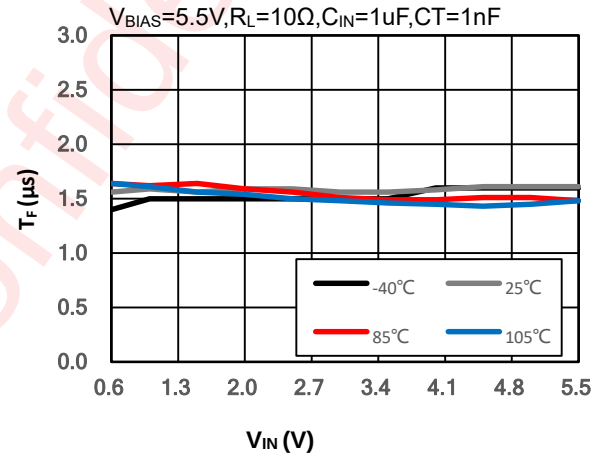


Figure 20 Fall Time vs. V_{IN}

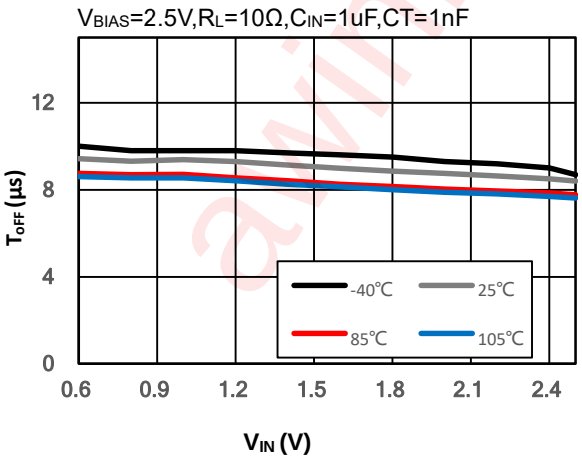


Figure 21 Turn Off vs. V_{IN}

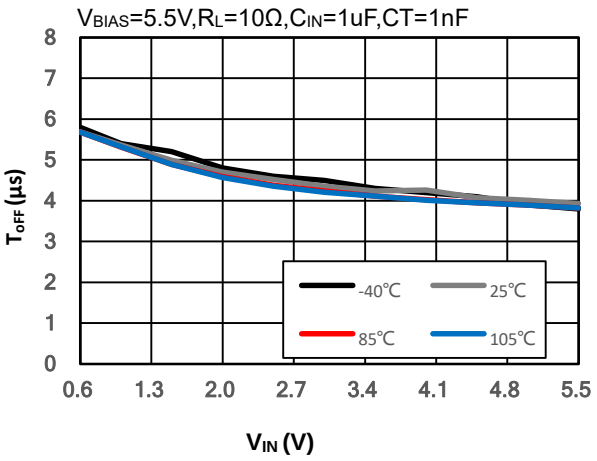
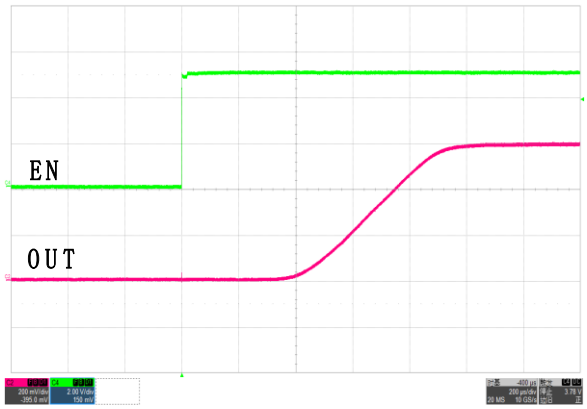
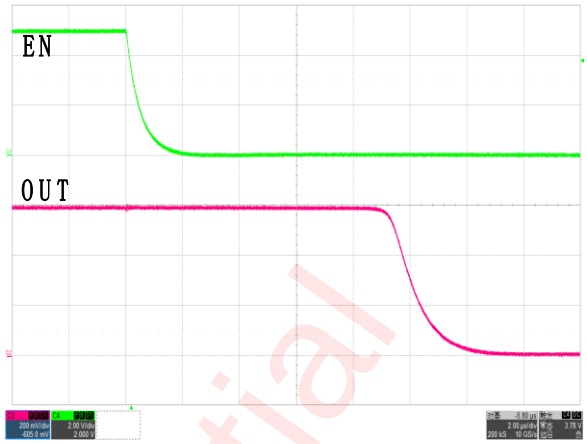


Figure 22 Turn Off vs. V_{IN}



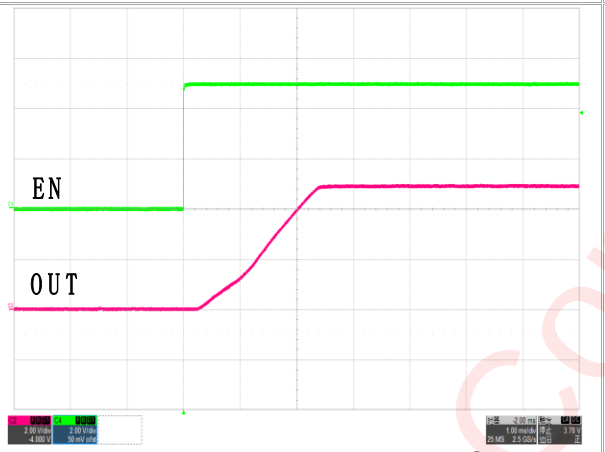
V_{BIAS}=2.5V,V_{IN}=0.6V,C_L=0.1μF,CT=1nF,R_L=10Ω

Figure 23 Turn On Response



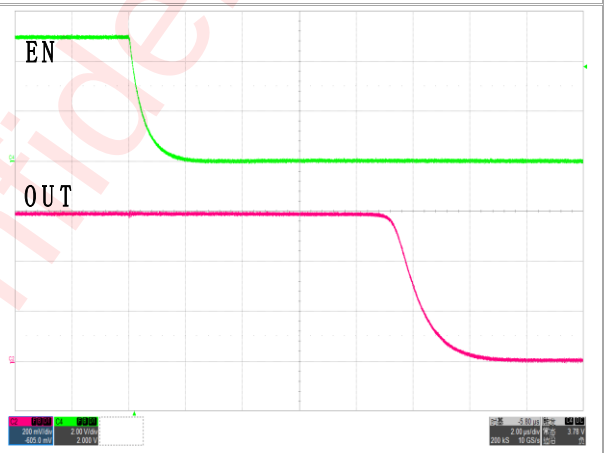
V_{BIAS}=2.5V,V_{IN}=0.6V,C_L=0.1μF,CT=1nF,R_L=10Ω

Figure 24 Turn Off Response



V_{BIAS}=V_{IN}=5V,C_L=0.1μF,CT=1nF,R_L=10Ω

Figure 25 Turn On Response



V_{BIAS}=V_{IN}=5V,C_L=0.1μF,CT=1nF,R_L=10Ω

Figure 26 Turn Off Response

Detailed Functional Description

The AW35141 is a single channel, 18.5 mΩ Ron (typical) N-type MOSFET load switch which can reduce the voltage drop in high current rails, the device can support 6A continuous current and controlled by the ON pin. In order to control the inrush current, the device has a configurable slew rate time for different applications by the CT pin.

Turn On/Off Control

The switch on/off controlled by ON pin which compatible standard GPIO logic. The device is enable or disable when the ON pin voltage higher than VIH or lower than VIL. Floating the ON pin is forbidden, it must be tied high or low.

Table 1. Functional Table

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

Slew Rate Control

The AW35141 provides an adjustable soft start time which can limit the inrush current when the switch is on. The slew rate time is controlled by the CT capacitor. This feature reduces the interference to the power supply.

Quick Output Discharge (QOD)

The AW35141 includes the Quick Output Discharge (QOD) feature, in order to discharge the application capacitor connected on OUT pin. When ON pin is set to low level (disable state), a discharge resistance with a typical value of 220Ω is connected between the output and ground, pull down the output and prevent it from floating when the device is disabled.

Over Temperature Protection (OTP)

When the junction temperature exceeds 160℃, the internal OTP circuit turn off the load switch. There is a temperature hysteresis 30℃,in other words, the OTP circuit can turn on the switch only if the junction temperature is below 130℃.

PCB Layout Consideration

AW35141 is a 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 capacitor C_{IN}, C_{BIAS} and C_T on the top layer (same layer as the AW35141) and close to IN, OUT and CT pin, and place the output capacitor C_{OUT} on the top layer (same layer as the AW35141) and close to OUT pin.

2. The AW35141 integrates an up to 6A NMOS 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 RθJA of the package can be decreased, allowing higher power dissipation. Power lines will flow large current, please route them on PCB as straight, wide and short as possible, as in figure 27.

3. Use rounded corners on the power trace from the power supply connector to AW35141 to decrease EMI coupling.

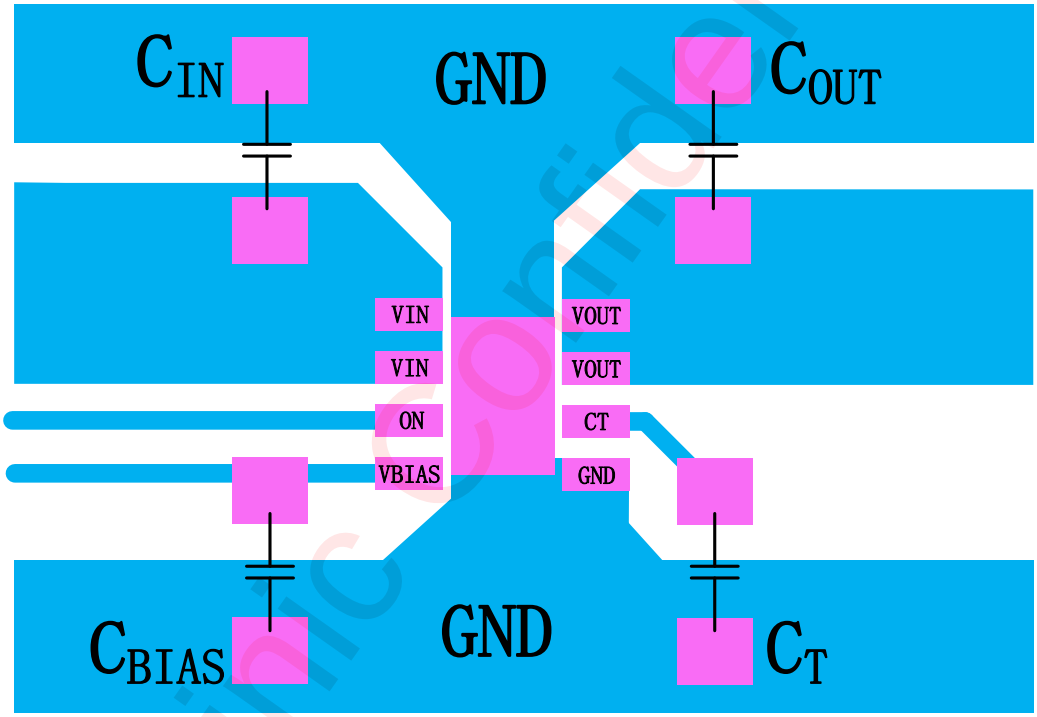
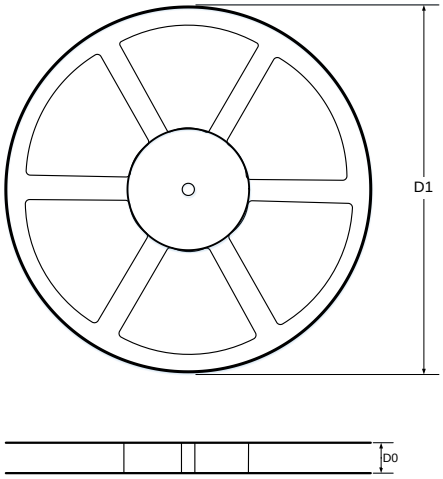


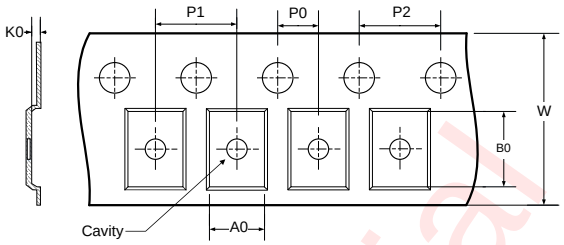
Figure 27 PCB layout example

Tape And Reel Information

REEL DIMENSIONS

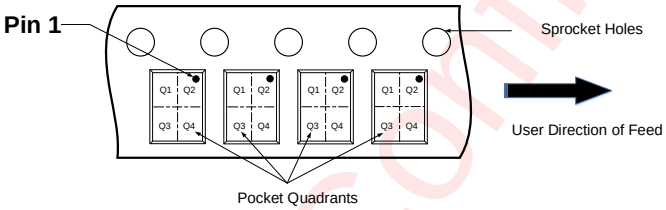


TAPE DIMENSIONS



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



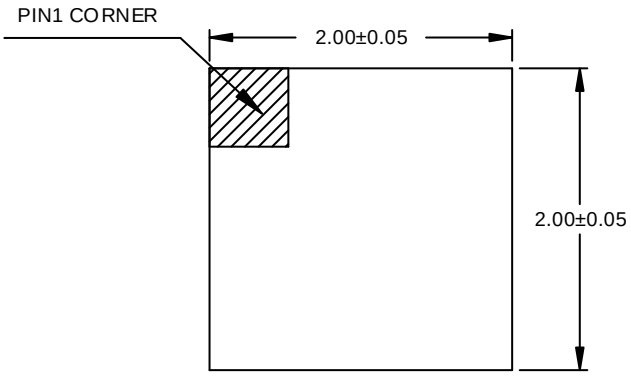
Note：The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

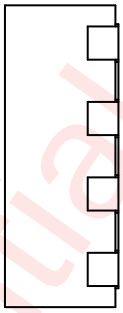
D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178	8.4	2.3	2.3	1	2	4	4	8	Q2

All dimensions are nominal

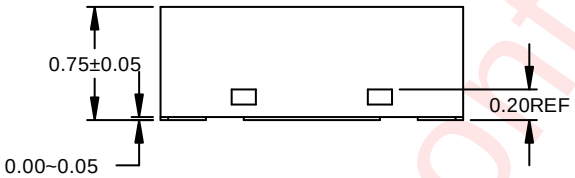
Package Description



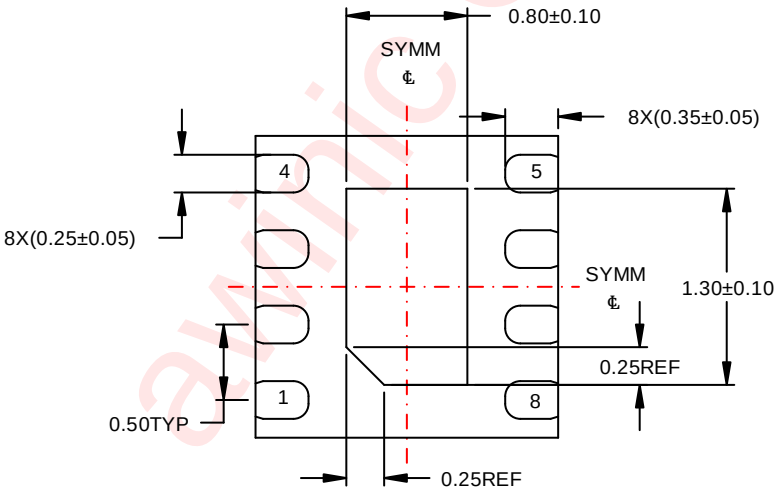
TOP VIEW



SIDE VIEW



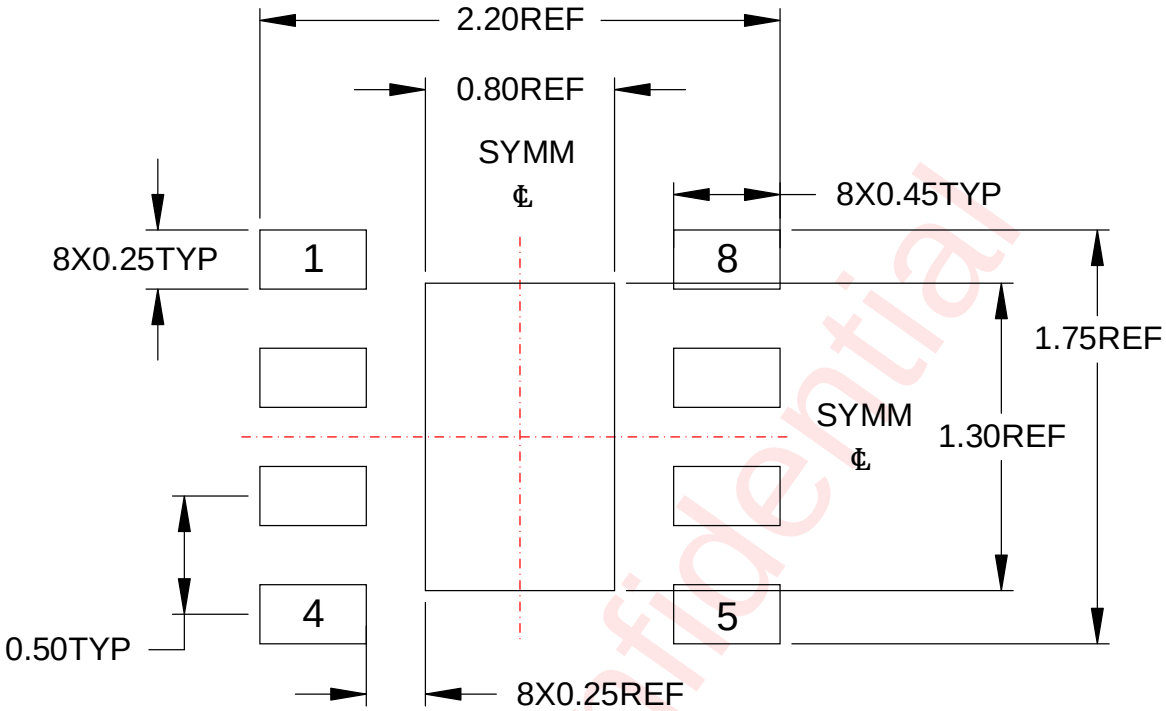
SIDE VIEW

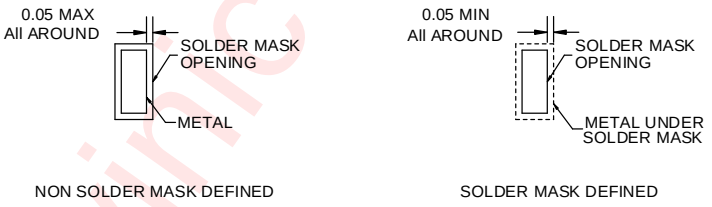


BOTTOM VIEW

Unit: mm

Land Pattern Data





Unit: mm

Revision History

Version	Date	Change Record
V1.0	May 2021	Datasheet V1.0 Released
V1.1	Mar 2022	1. Temperature range update: -40°C ~85°C to -40°C ~105°C; 2. Add Ron specifications for VBIAS=5V&VIN=5V/3.3V/1.8V/1.5V/1.05V/0.6V and VBIAS=2.5V&VIN=2.5V/1.8V/1.5V/1.05V/0.6V;

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