4-Channel 1-wire Dimming Parallel White LED Driver with Ultra Low Dropout Current Source

Features

- Ultra low dropout: 50mV/20mA(typical)
- Support up to 4 LEDs
- LED sink current up to 20mA
- ±5% LED current matching(typical)
- EN Pin Deglitch circuit
- Thermal shutdown protection
- 16-step linear scale LED brightness control
- Less than 0.1μA quiescent current in shutdown mode
- No EMI and switch noise
- WBDFN 2mmx2mmx0.75mm-8L package

Applications

- Mobile phone
- Digital camera
- PDA MP3

Description

The AW9364B is a 4-channel ultra low dropout constant-source parallel LED driver. With the proprietary Q-Mirror™ technique, the AW9364B uses an internal resistor to set the bias current for four LEDs, which are matched to ±5%. The AW9364B incorporates a single wire interface to program the output current at 16 continuous steps. The AW9364B has an internal deglitch circuit for filtering the noise of the EN input.

The AW9364B requires only a 50mV dropout voltage at a 20mA load. The feature makes AW9364B ideal for battery-operated systems, such as personal digital assistants.

The AW9364B is available in DFN 2mm x2mm x0.75mm-8L package and is specified over the -40°C to +85°C temperature range.

Typical Application Circuits

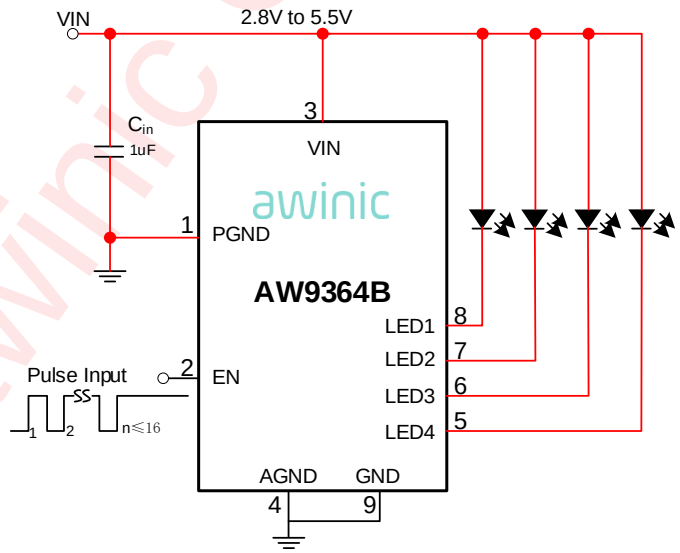
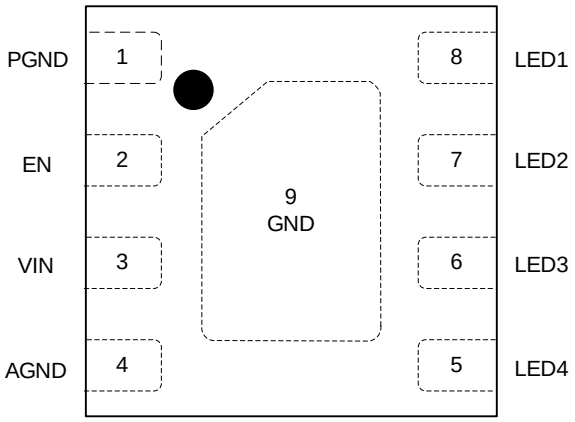


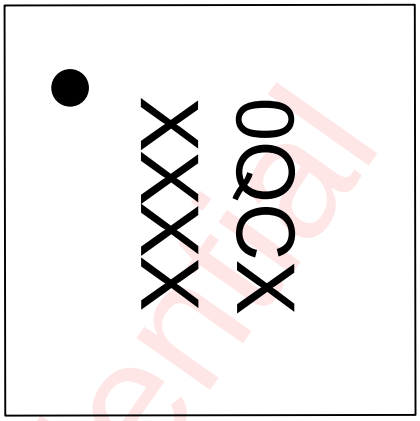
Figure 1 AW9364B Typical Application

Pin Configuration And Top Mark

AW9364BDNR
(Top View)



AW9364BDNR Marking
(Top View)



0QCX - AW9364BDNR
XXXX - Production Tracing Code

Figure 2 Pin Configuration of AW9364B

Pin Definition

No.	NAME	DESCRIPTION
1	PGND	Power Ground
2	EN	Enable Pin. Active high, with an internal 150kΩ pull-down resistor
3	VIN	Power Supply
4	AGND	Analog Ground
5	LED4	LED4 Pin, Connect to the LED cathode, connect it to GND or open if unused
6	LED3	LED3 Pin, Connect to the LED cathode, connect it to GND or open if unused
7	LED2	LED2 Pin, Connect to the LED cathode, connect it to GND or open if unused
8	LED1	LED1 Pin, Connect to the LED cathode, connect it to GND or open if unused
9	GND	Exposed pad, should be connected to ground

AWINIC LED Driver Series

Product	Channels	Type	Description	Package
AW9364B	4	Current Sink	4 Independent 1-wire Configurable 20mA LED Driver	DFN-8L
AW9358B	8	Current Sink	8 Independent 1-wire Configurable 20mA LED Driver	QFN-16L
AW9364	4	Current Sink	4 Independent 1-wire Configurable 20mA LED Driver	DFN-8L

Functional Block Diagram

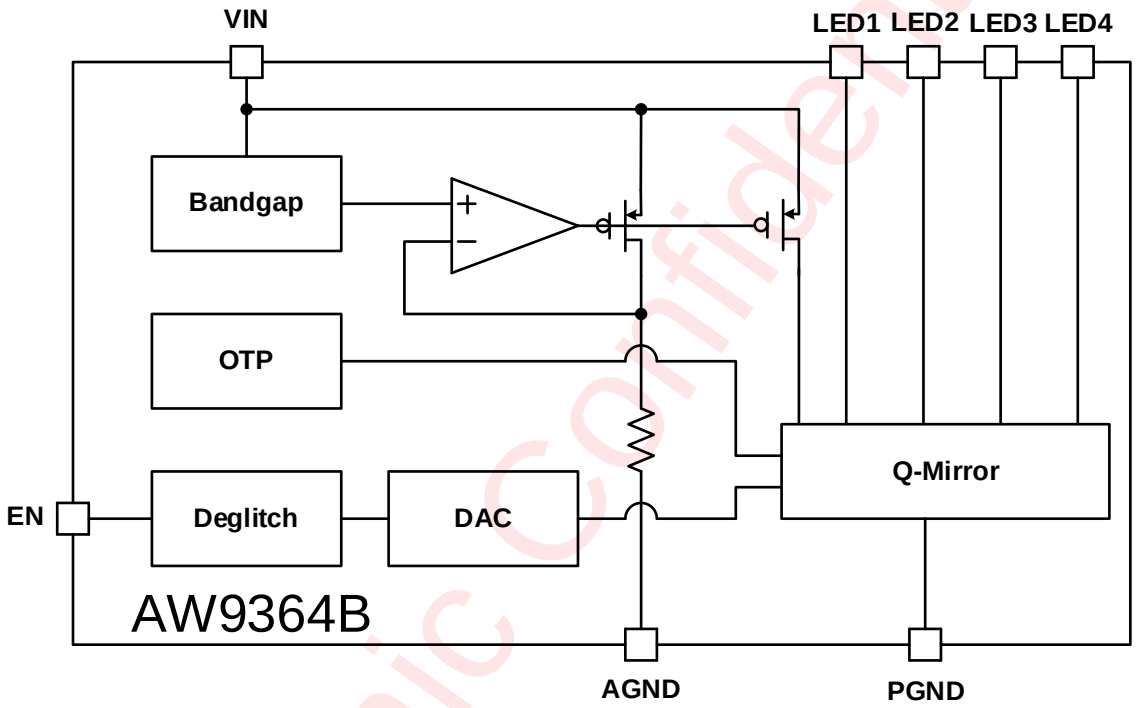


Figure 3 Function Block Diagram of AW9364B

Typical Application Circuits

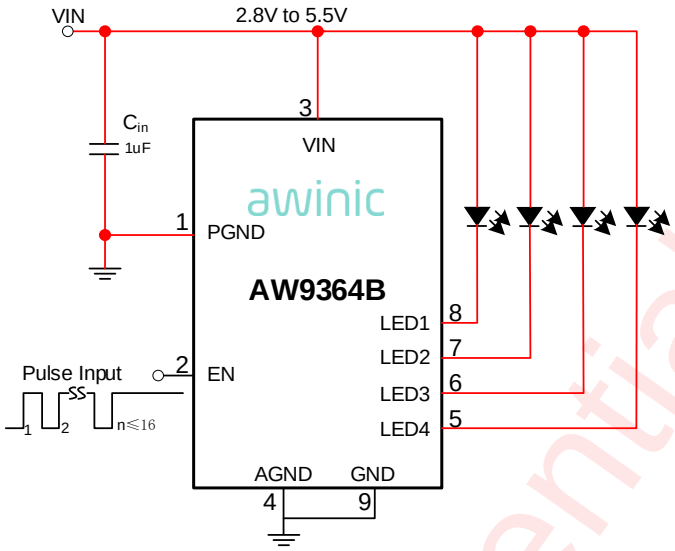


Figure 4 AW9364B Typical Application

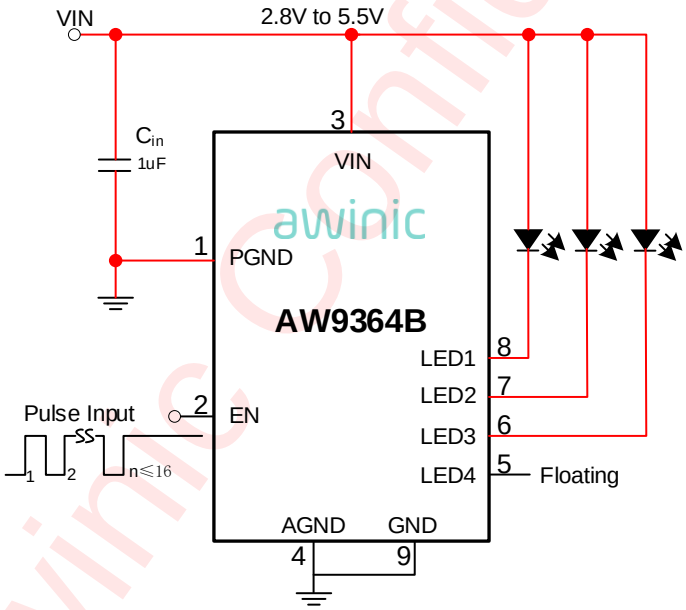


Figure 5 3-LED Application

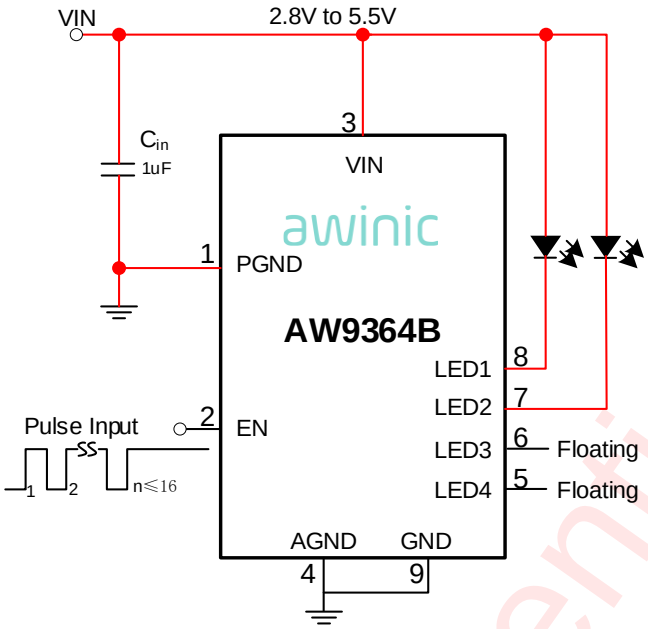


Figure 6 2-LED Application

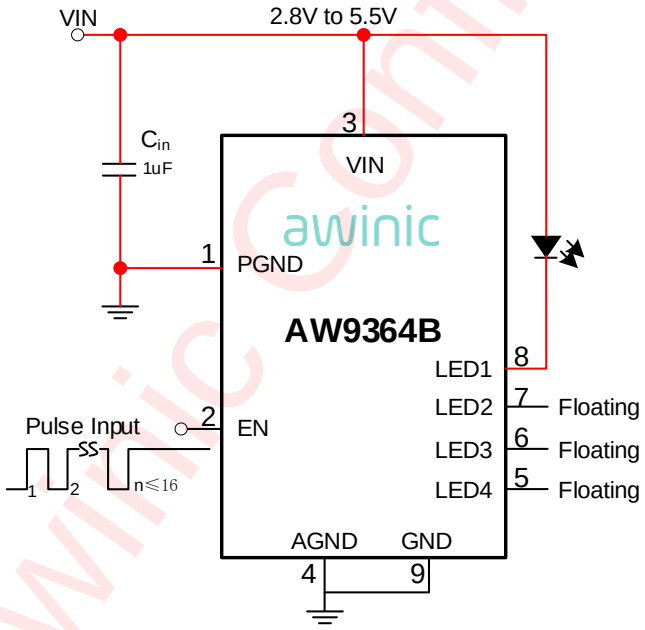


Figure 7 1-LED Application

Notice for Typical Application Circuits:

1: Please place C_{in} as close to the chip as possible.

2: For the sake of driving capability, the power lines and the connection lines of LED should be short and wide as possible.

3: The power path marked in red as shown in the figures above.

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW9364BDNR	-40°C～85°C	DFN 2mm×2mm× 0.75mm-8L	0QCX	MSL3	ROHS+HF	3000 units/ Tape and Reel

Absolute Maximum Ratings(NOTE1)

PARAMETERS		RANGE
Supply voltage range VIN		-0.3V to 6V
Input voltage range	EN	-0.3V to 6V
Output voltage range	LED1~LED4	-0.3V to 6V
Junction-to-ambient thermal resistance θ_{JA}		86 °C /W
Maximum operating junction temperature T_{JMAX}		125°C
Storage temperature T_{STG}		-65°C to 150°C
Lead temperature (soldering 10 seconds)		260°C
ESD (NOTE 2)		
HBM		±2kV
CDM		±1.5kV
Latch-Up		
Test method: JEDEC JESD78F-2022		+IT：200mA -IT：-200mA

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
VIN	Power Supply voltage	2.8	3.6	5.5	V
T_A	Operating free-air temperature range	-40	25	85	°C
Cin	Input capacitor	0.1	1	100	μF

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 human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: ANSI/ESDA/JEDEC JS-001-2017. CDM test method:* ANSI/ESDA/*JEDEC JS-002-2018.*

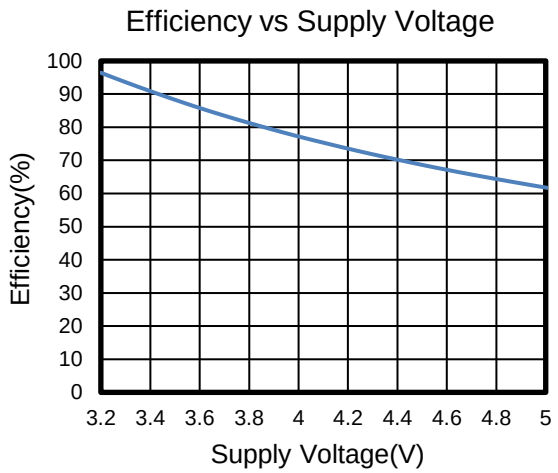
Electrical Characteristics

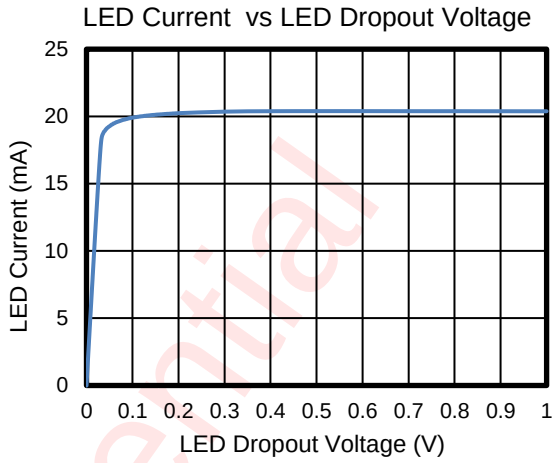
Test Condition: T_A=25°C, VIN=3.6V, C_{in} = 1μF (unless otherwise specified)

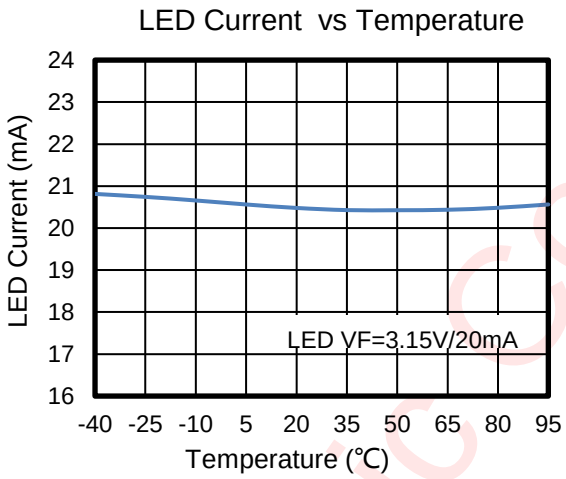
Symbol	Description	Test Condition	Min	Typ	Max	Units
SUPPLY VOLTAGE AND CURRENT						
VIN	Power Supply Voltage		2.8		5.5	V
I_{SD}	Shutdown Current	V_{EN}=0V，VIN=5.5V		0.1	1	μA
I_Q	Quiescent Current	V_{EN}=VIN, LED Pin floating		267	400	μA
$I_{LEAKAGE}$	Output leakage current	V_{EN}=0V, V_{LEDx}=5.5V		0.1	1	μA
CURRENT SINK						
I_{LED}	Output Current	All LEDs 100% setting	18.5	20	21.5	mA
ΔI_{LED}	Channel to channel current error	All LEDs 100% setting	-5		5	%
$V_{DROPOUT}$	LED Dropout Voltage	I_{LED}=20mA		50	170	mV
ENABLE						
V_{IH}	Enable High Level Input Voltage		1.3			V
V_{IL}	Enable Low Level Input Voltage				0.3	V
R_{PD}	Pull down resistor of EN Pin	V_{EN}=0.4V	50	150	250	kΩ
T_{ON}	Startup Time			10	20	μs
T_{LO}	EN Low Time for Dimming		0.5		500	μs
T_{HI}	EN High Time for Dimming		0.5			μs
T_{OFF}	Shutdown Delay Time	Delay time when pin EN go to low level after which the AW9364B shutdown completely		800	2500	μs
T_{SD}	Thermal shutdown threshold			150		°C
	Thermal shutdown hysteresis			20		°C

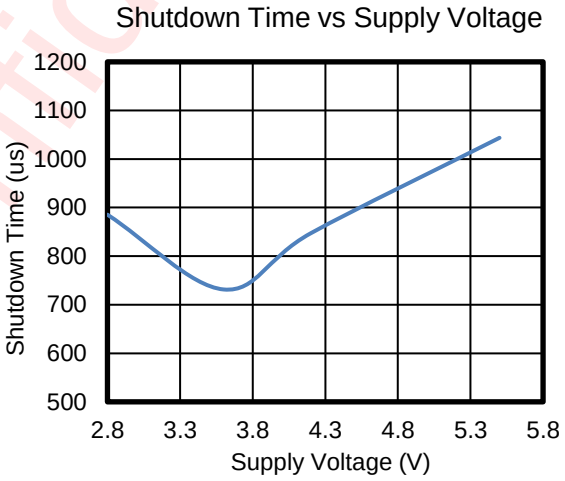
Typical Operation Characteristics

Test condition: T_A = 25°C, VIN = 3.6 V, C_{in} = 1 µF, unless otherwise noted .









Detailed Description

The AW9364B is a high efficiency, no noise LED driver which powering up to 4-channel LED's at 20mA. Figure 1 shows a typical application circuit for four LEDs. In order to maintain LED constant current, the input voltage must provide the required LED forward voltage and current source dropout voltage. The AW9364B requires only 50mV dropout voltage at a 20mA load on each output to match the LED brightness.

1-wire Interface Timing

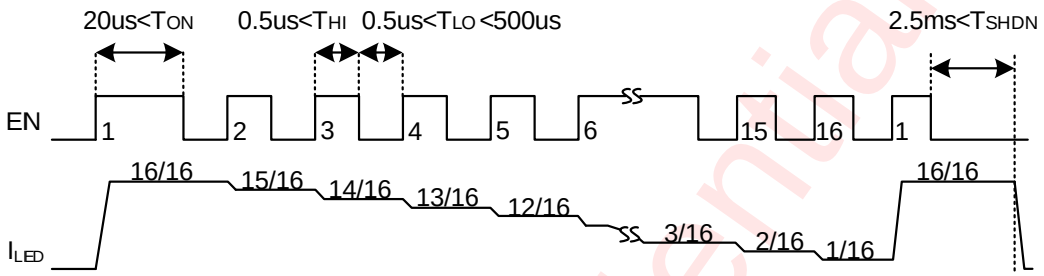


Figure 1 16-steps brightness control of AW9364B

Enable Input

The EN input is used to enable or disable the AW9364B. Pulling the EN pin to high voltage will enable the device. For producing constant, non-pulsating output current compare to conventional pulse width modulation (PWM) dimming scheme, the AW9364B incorporates a 4-bit DAC for brightness control to program the output current at 16 continuous steps: 20~1.25mA. Table 1 shows detail for current setting.

Table 1 Current Setting

EN Rise Edge Number	Current (mA)	EN Rise Edge Number	Current (mA)
1	20	9	10
2	18.75	10	8.75
3	17.5	11	7.5
4	16.25	12	6.25
5	15	13	5
6	13.75	14	3.75
7	12.5	15	2.5
8	11.25	16	1.25

The figure 8 shows the detail operation of 16-steps brightness control. When 1-wire pulse counting dimming is used, the startup time T_{ON} is recommended to be greater than 20μs for enabling the device, the pulse high time T_{HI} recommended to be greater than 0.5μs, and the pulse low time T_{LO} is recommended to be greater than 0.5μs and less than 500μs. A constant current is sourced as long as the EN signal remains high. The shutdown feature reduces quiescent current to less than 0.1μA.

Deglitch Circuit

In portable applications such as mobile phones, digital cameras and other portable applications, the interference between the signal lines on the PCB is inevitable. The AW9364B has an internal deglitch circuit for filtering the noise of the EN input. Internal Deglitch circuit can eliminate EN pin less than 80ns high level glitch, effectively avoid the false trigger of 1-wire pulse counting dimming caused by the interference of external circuit.

Over Thermal Protection

The AW9364B has an internal over thermal protection circuit. The over temperature circuit will turn off the output current to decrease the power dissipation when the junction temperature exceeds 150°C and will resume the output circuit when the junction temperature falls below 130°C

Application Information

LED Brightness Dimming Control

The AW9364B incorporates a 1-wire pulse count dimming to eliminate the switch noise. The principle of 1-wire pulse count dimming: the AW9364B has 4 internal DAC circuit, which are used to count the number of rising edges of the EN pin pulse signal to set the LED current(Figure 8 and Table 1).

1-wire pulse dimming adjust the LED current method: when the present current is more than the target current, two corresponding pulse number subtraction can be from the current LED current adjustment to the target current:

$$n = N_{to} - N_{from}.$$

For example, adding 4(13-9=4) pulses changes the LED current from 10mA (rising edges: 9) to 5mA (rising edges: 13) as shown in Figure 9.

Since the AW9364B is a 16 step linear dimming, one cycle per 16 pulse. For the current less than the target current, the number of pulses needed to increase is calculated by adding the 16 pulse and then the callback method:

$$n = N_{to} + 16 - N_{from}.$$

For example, adding 8(1+16-9=8) pulses changes the LED current from 10mA (rising edges: 9) to 20mA (rising edges: 1) as shown in Figure 10.

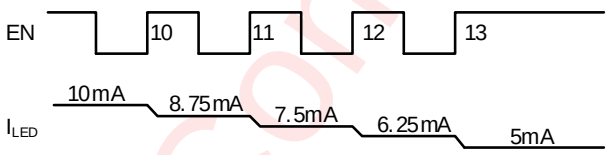


Figure 2 Programming Example for LED Current from 10mA to 5mA

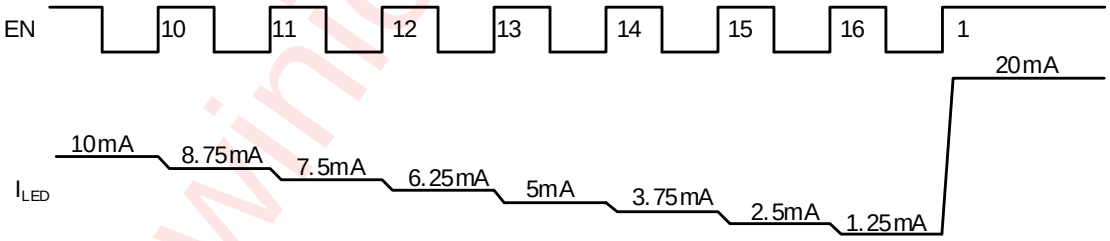


Figure 3 Programming Example for LED Current from 10mA to 20mA

Efficiency

The AW9364B is a parallel white LED driver with ultra low dropout constant-current source. Based on the 20mA current of each LED, the AW9364B only need 50mV (typical) dropout voltage at least. Compared with other LED driver device, higher efficiency is obtained.

The system efficiency, defined as the ratio between the LED's power and the input power can be calculated simply as the following:

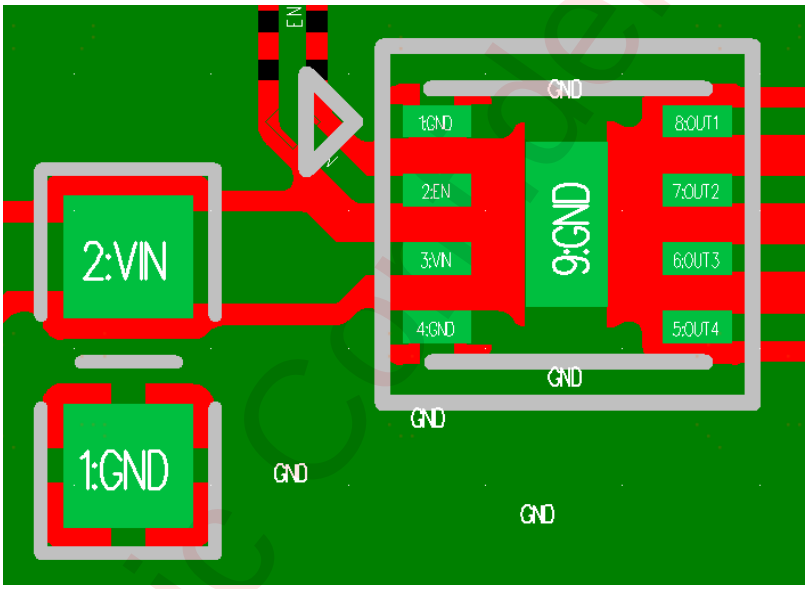
$$\eta = \frac{P_{OUT}}{P_{IN}} = \frac{V_F * I_{OUT}}{V_{IN} * I_{IN}} \approx \frac{V_F * I_{OUT}}{V_{IN} * I_{OUT}} = \frac{V_F}{V_{IN}}$$

Where V_F is the LED forward voltage, V_{IN}= V_F+$V_{DROPOUT}$, $V_{DROPOUT}$ is the dropout voltage needed in the current source. For example, when V_F=3.2V (20mA) VIN=3.4V, the η is about 94% --greater than other type of LED driver.

PCB Layout Consideration

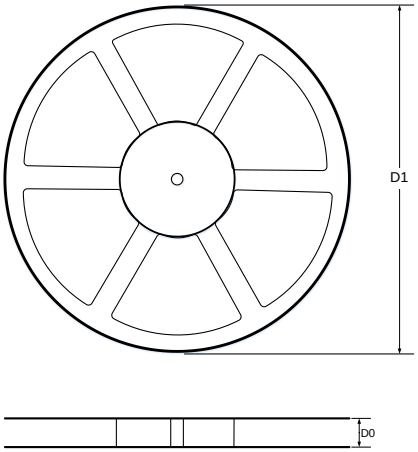
The AW9364B is a parallel white LED driver with ultra low dropout constant-current source. The following guidelines should be strictly followed for the layout of the AW9364B:

1. Place all peripheral components as close to the device as possible. Place C_{IN} close to the VIN and GND.
2. The power line contact VIN and LED anode must wide，to reduce the influence of parasitic inductance and parasitic resistance.
3. Input capacitor C_{IN} need to near pin3 of AW9364B, At the same time, the line between the IC corresponding pins and capacitor pad as wide as possible, to reduce noise and EMI interference.
4. In order to obtain a better thermal performance and noise performance, the chip thermal pad AGND and PGND must be connected directly to the PCB of the large area spread formation, and in the thermal pad below the floor layer through the through hole connected to the PCB of the middle layer of ground.

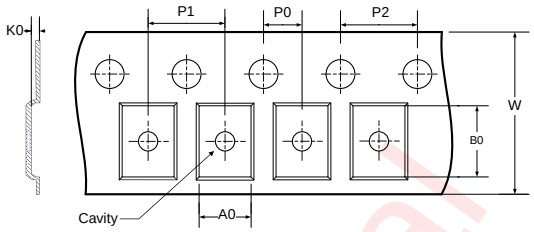


Tape And Reel Information

REEL DIMENSIONS

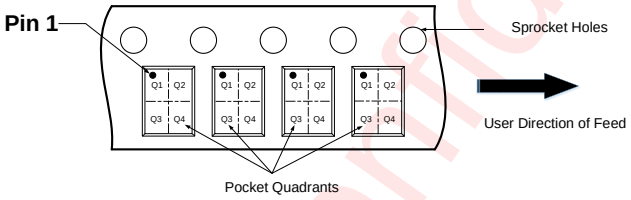


TAPE DIMENSIONS



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



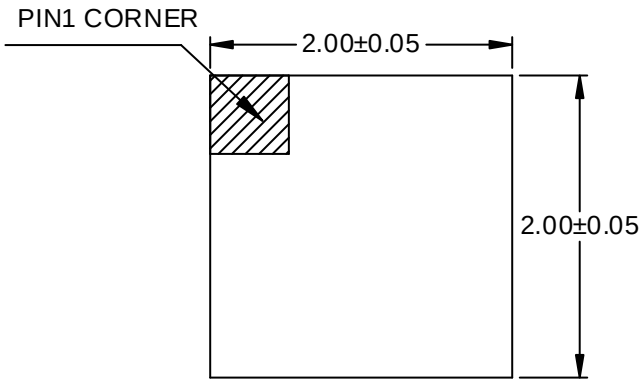
Note：The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

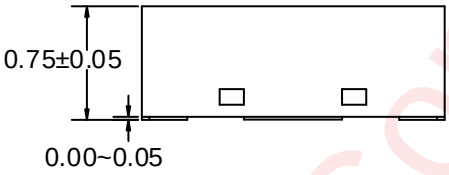
D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178	8.4	2.25	2.25	0.95	2	4	4	8	Q1

All dimensions are nominal

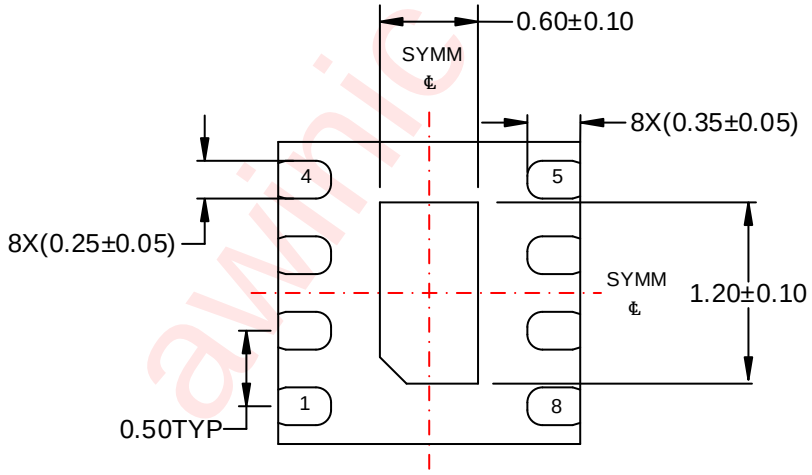
Package Description



TOP VIEW



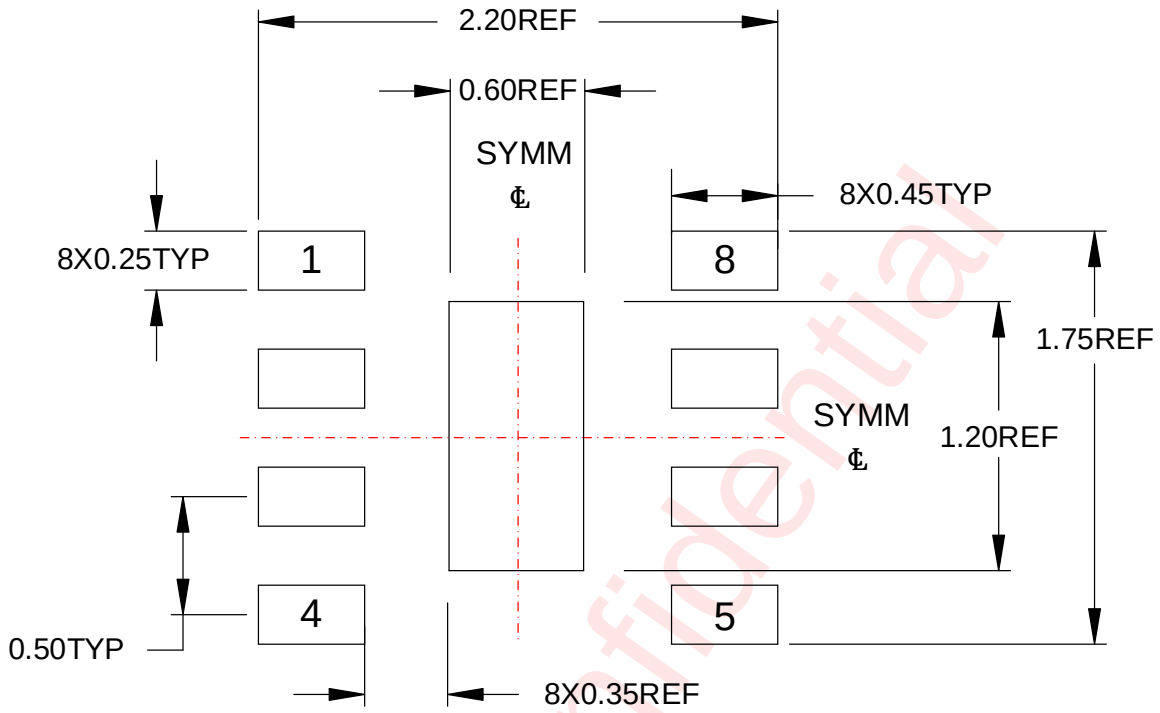
Side View

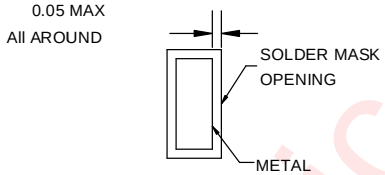


Unit: mm

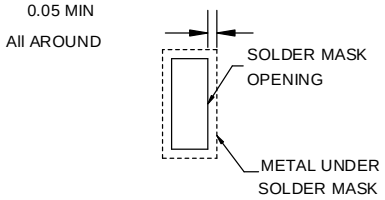
BOTTOM VIEW

Land Pattern





NON SOLDER MASK DEFINED



SOLDER MASK DEFINED

Unit: mm

Revision History

Version	Date	Change Record
Dec 2021	V1.0	Officially released.

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