6-Channel 1-wire Dimming LED Driver with Ultra Low Dropout Current Source

FEATURES

- Ultra low dropout: 50mV/20mA(typical)
- Support up to 6 LEDs
- LED sink current up to 20mA
- ±1% LED current matching(typical)
- En Pin Deglitch circuit
- Thermal shutdown protection
- 16-step brightness control
- ESD protection: ±8kV(HBM)
- No EMI and switch noise
- Packages: QFN3×3-16L

APPLICATIONS

- Mobile phone
- Digital camera
- PDA MP3

DESCRITION

The AW9356 is a 6-channel ultra low dropout constant-source parallel LED driver. With the proprietary Q-Mirror™ technique, the AW9356 uses an internal resistor to set the bias current for four LEDs, which are matched to ±1%. The AW9356 incorporates a single wire interface to program the output current at 16 continuous steps. The AW9356 has an internal deglitch circuit for filtering the noise of the EN input. The AW9356 requires only a 40mV dropout voltage at a 20mA load. The feature makes AW9356 ideal for battery-operated systems, such as personal digital assistants.

The AW9356 is specified over the -40℃ to +85℃ temperature range.

PIN CONFIGURATION AND MARKING

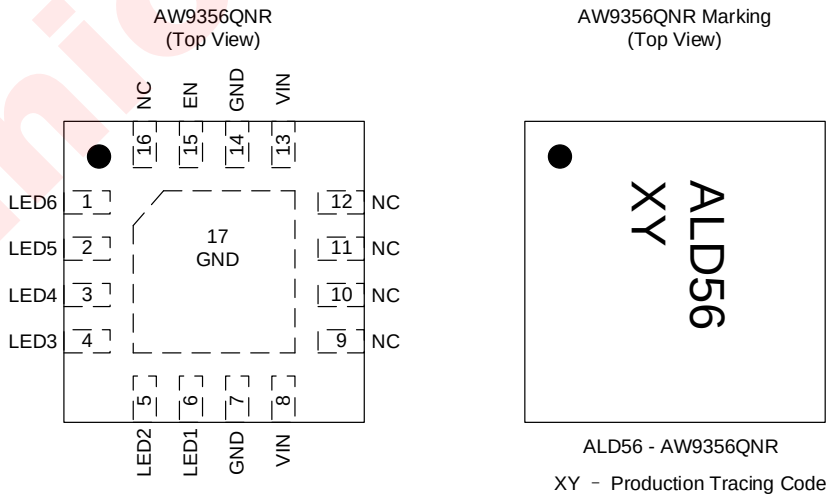


Figure 1 Pin Configuration of AW9356

TYPICAL APPLICATION CIRCUIT

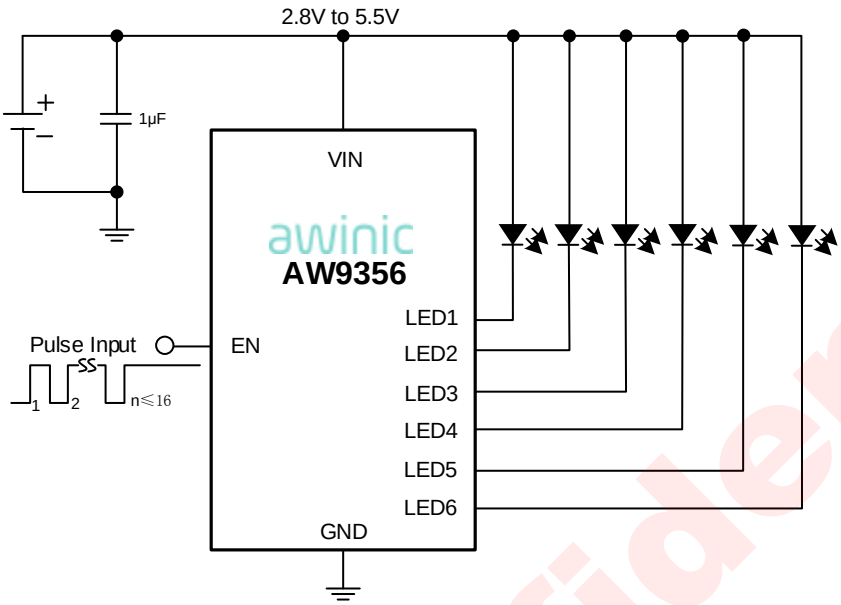


Figure 2 AW9356 Typical Application

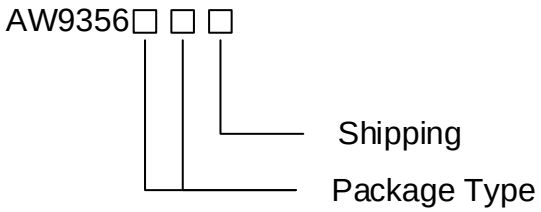
PIN DEFINITION

PIN	Symbol	Description
1	LED6	LED6 Pin, Connect to the LED cathode, leave it to connect GND or open if unused.
2	LED5	LED5 Pin, Connect to the LED cathode, leave it to connect GND or open if unused.
3	LED4	LED4 Pin, Connect to the LED cathode, leave it to connect GND or open if unused.
4	LED3	LED3 Pin, Connect to the LED cathode, leave it to connect GND or open if unused.
5	LED2	LED2 Pin, Connect to the LED cathode, leave it to connect GND or open if unused.
6	LED1	LED1 Pin, Connect to the LED cathode, leave it to connect GND or open if unused.
7	GND	Ground.
8	VIN	Supply Input.
9	NC	Not connected.
10	NC	Not connected.
11	NC	Not connected.
12	NC	Not connected.
13	VIN	Supply Input.

14	GND	Ground.
15	EN	Enable Pin. Active high, with an internal 100kΩ pull-down resistor.
16	NC	Not connected.
17	GND	Exposed pad, should be connected to ground.

ORDERING INFORMATION

Part Number	Temperature	Package	Marking	Moisture sensitivity level	Environmental Information	Delivery Form
AW9356QNR	-40℃～85℃	QFN3×3-16L	ALD56	MSL3	RoHS+HF	6000 units/Tape and Reel



Package Type	Shipping
QN: QFN3×3-16L	R :Tape & Reel

ABSOLUTE MAXIMUM RATINGS(1)

Parameter	Range
Supply Voltage VDD	-0.3V to 6 V
Input Voltage EN	-0.3V to VIN
Power Dissipation, (P_D@ T_A=25℃)	1.3 W
Maximum Junction Temperature	125℃
Storage Temperature Range	-65℃ to 150℃
Lead Temperature (Soldering 10 Seconds)	260℃
Package Thermal Resistance θ_{JA}	52℃/W
ESD Rating(2)	
Human Body Model	±2000 V
Latch-up(3)	
Latch-up current maximum rating per JEDEC standard	+IT:450mA -IT:-450mA

NOTE1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE2: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin.

NOTE3: Test condition: JEDEC STANDARD NO.78A FEBRUARY 2006.

ELECTRICAL CHARACTERISTICS

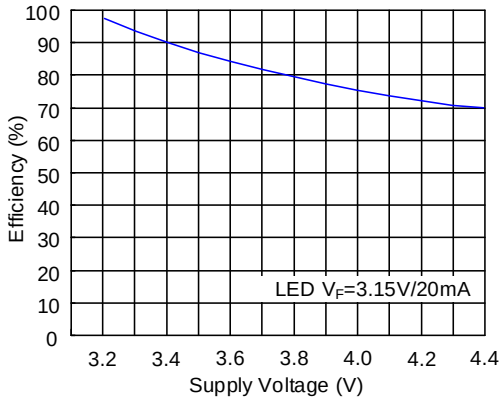
Test Condition: T_A=25℃, VIN=3.6V, C_{IN} = 1μF (unless otherwise specified)

Parameter	Symbol	Condition	Min	Typ.	Max	Units
Supply Voltage	VIN		2.8		5.5	V
Output Current	I_{LED}	All LEDs 100% setting	16.5	20	23.5	mA
Current Matching		All LEDs 100% setting	-5		5	%
LED Dropout Voltage	V_{DO}	I_{LED}=20mA		50	170	mV
Quiescent Current	I_Q	I_{LED}=0		330		μA
Shutdown Current	I_{SD}	V_{EN}=0V，VIN=5.5V		0.1	1	μA
Startup Time	T_{ON}			20		μs
Enable High Level Input Voltage	V_{IH}		1.3			V
Enable Low Level Input Voltage	V_{IL}				0.3	V
EN Low Time for Dimming	T_{LO}		0.5		500	μs
EN High Time for Dimming	T_{HI}		0.5			μs
Shutdown Delay Time	T_{OFF}	EN from 1 to 0	800		2500	μs

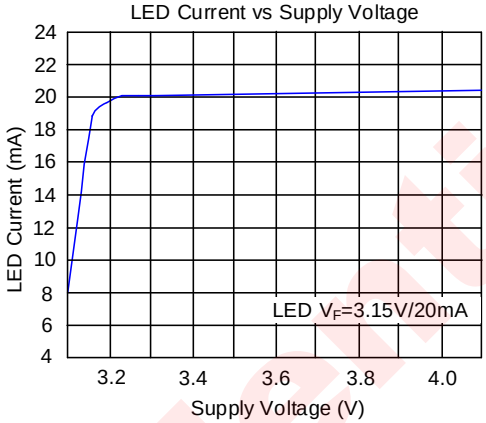
TYPICAL OPERATION CHARACTERISTICS

Test condition：T_A=25℃，VIN=3.6V, C_{IN}=1μF unless otherwise specified.

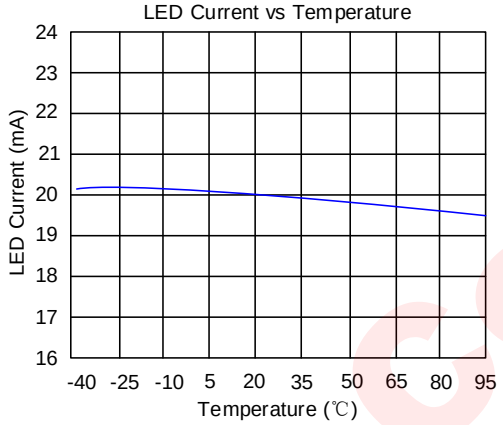
Efficiency vs Supply Voltage



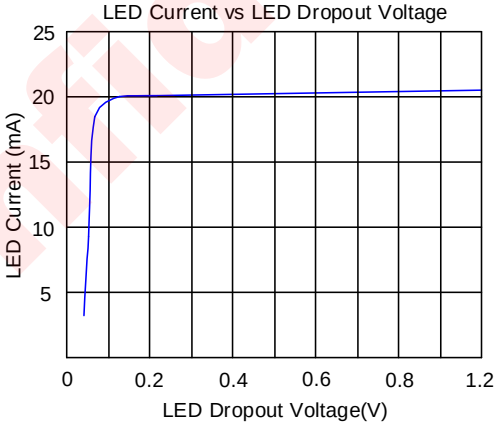
LED Current vs Supply Voltage



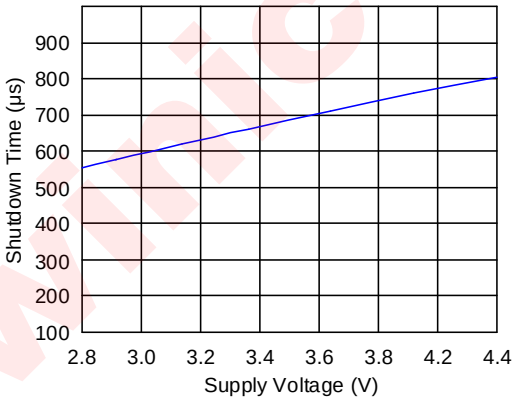
LED Current vs Temperature



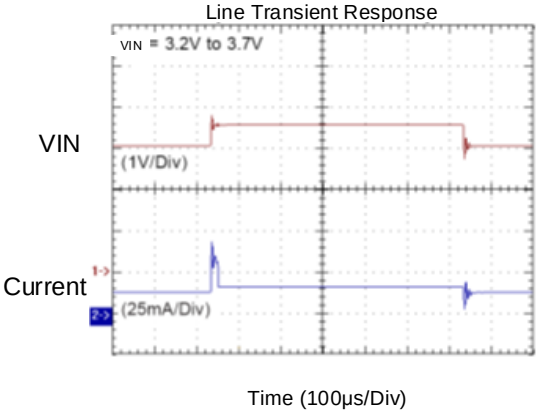
LED Current vs LED Dropout Voltage



Shutdown Time vs Supply Voltage



Line Transient Response



BLOCK DIAGRAM

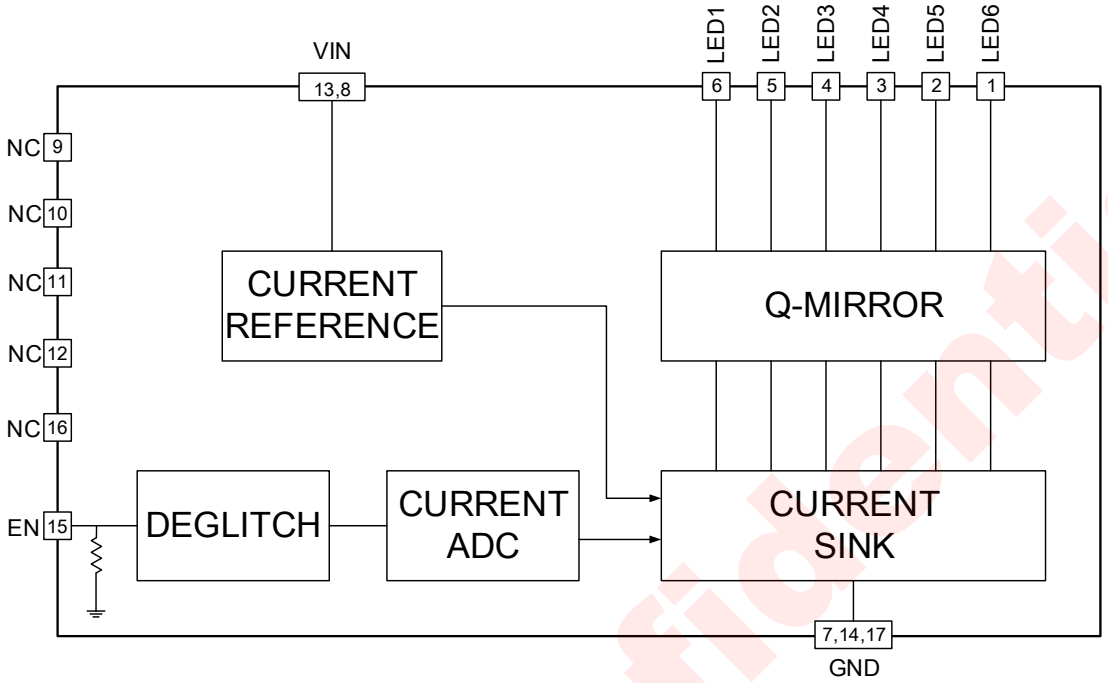


Figure 3 Functional Block Diagram of AW9356

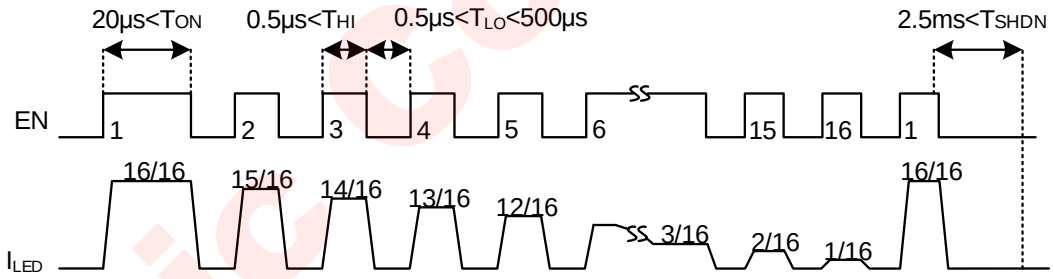


Figure 4 16-steps brightness control of AW9356

DETAILED DESCRIPTION

The AW9356 is a high efficiency, no noise LED driver which powering up to 6-channel LED's at 20mA. Figure 2 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 AW9356 requires only 40mV dropout voltage at a 20mA load on each output to match the LED brightness.

Enable Input and 1-wire Dimming Pulse

The EN input is used to enable or disable the AW9356. Pulling the EN pin higher than 1.3V will enable the device. For producing constant, non-pulsating output current compare to conventional pulse width modulation (PWM) dimming scheme, the AW9356 incorporates a 4-bit DAC for brightness control to program the output current at 16 continuous steps: 20mA~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 4 shows the detail operation of 16-steps brightness control. When 1-wire pulse counting dimming is used, the ready time is recommended to be greater than 20μs for enabling the device, the pulse high time THI 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.

For decreasing the LED current, the number of the pulses is obtained using the following equation:

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

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

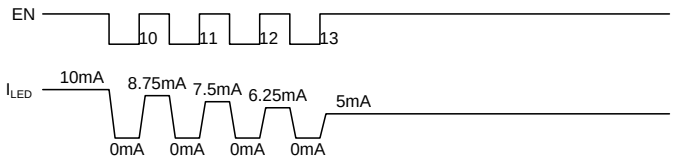


Figure 5 EN pulse dimming from 10mA to 5mA

Since the data in Table 1 automatically circles around after 16 pulses. For increasing the LED current, the number of the pulses is obtained using the following equation:

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

For example, adding 1+16-9=8 pulses changes the LED current from 10mA (rising edges: 9) to 20mA (rising edges: 1) as shown in Figure 6

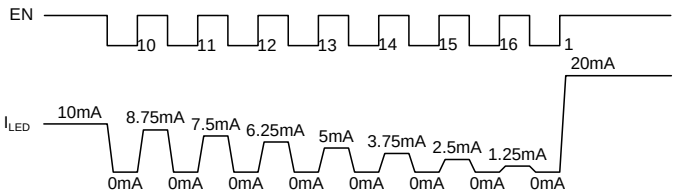


Figure 6 EN pulse dimming from 10mA to 20mA

Deglitch Circuit

The AW9356 has an internal deglitch circuit for filtering the noise of the EN input. For example, the EN pin is sometimes superimposed with noise, or a so-called glitch, and the glitch may be greater than the enable high level input voltage V_{IH}. In such a case, the deglitch circuit is used as a filter circuit for removing the glitch.

Efficiency

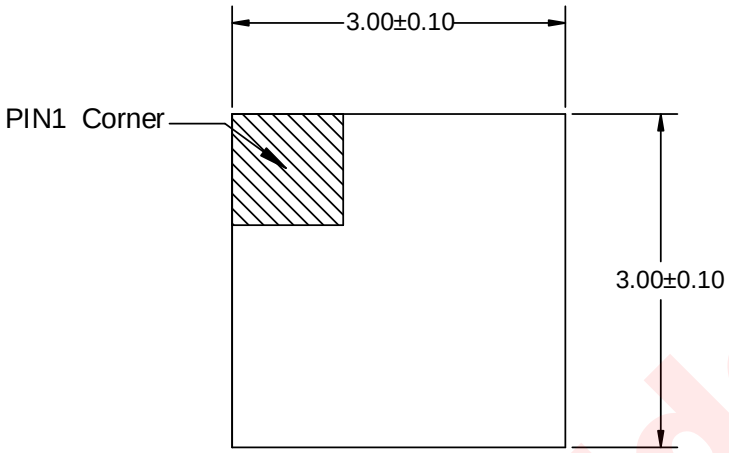
The AW9356 offers superior efficiency performance. Due to the ultra low-dropout current sinks and direct connection to the supply, higher average efficiency and higher peak efficiency is obtained.

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

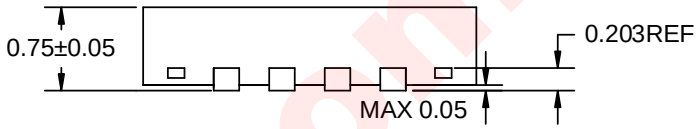
Efficiency= ($V_{F1}\times I_{LED1}$+ $V_{F2}\times I_{LED2}$+ $V_{F3}\times I_{LED3}$+ $V_{F4}\times I_{LED4}$+ $V_{F5}\times I_{LED5}$+ $V_{F6}\times I_{LED6}$)/($V_{IN}\times I_{IN}$)

V_F is the LED forward voltage, V_{IN}= V_F+V_{DO}, V_{DO} is the dropout voltage needed in the current source.

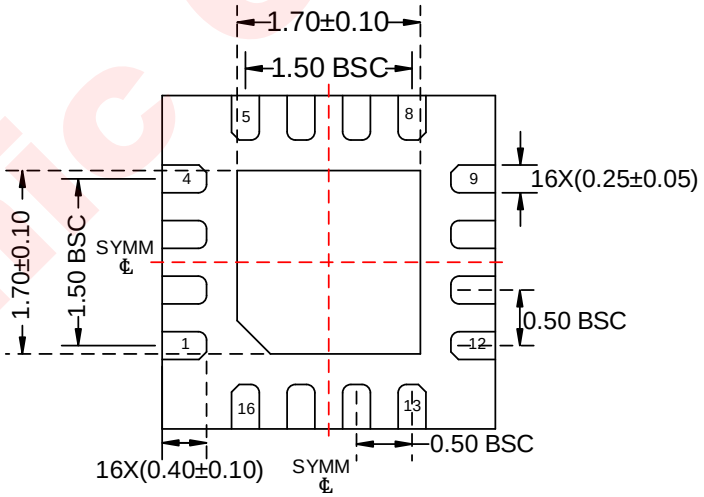
PACKAGE DESCRIPTION



TOP VIEW



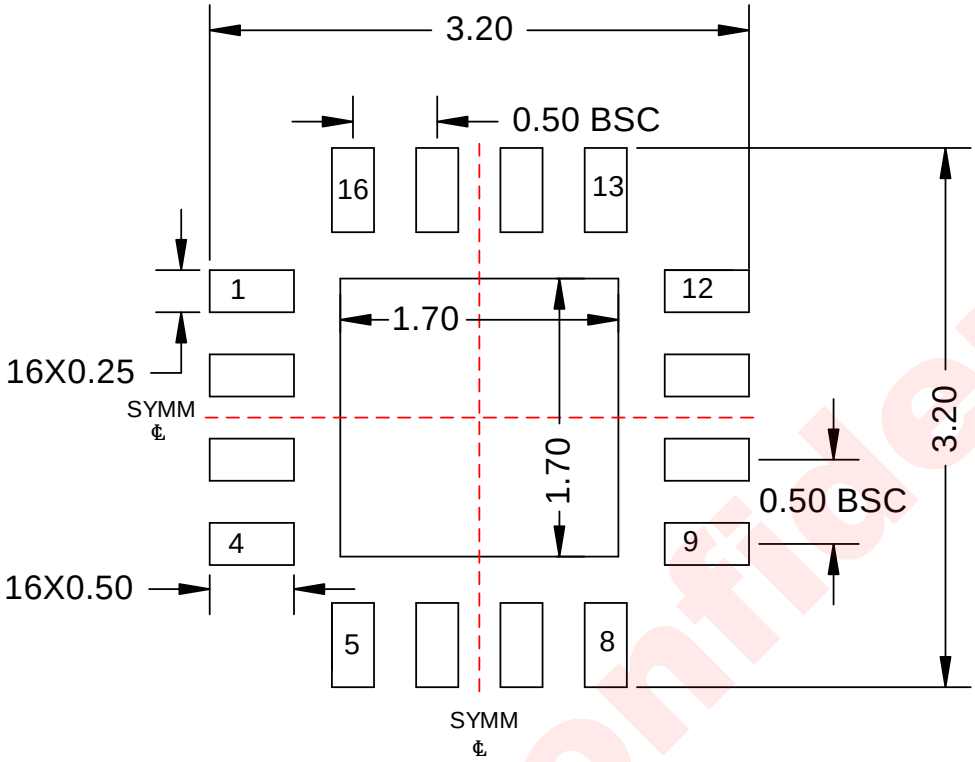
SIDE VIEW

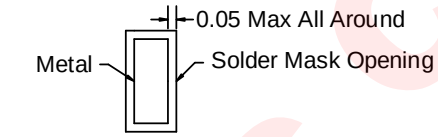


BOTTOM VIEW

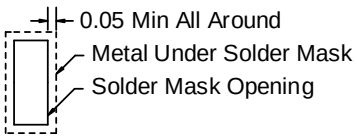
Unit: mm

LAND PATTERN





Non-solder Mask Defined

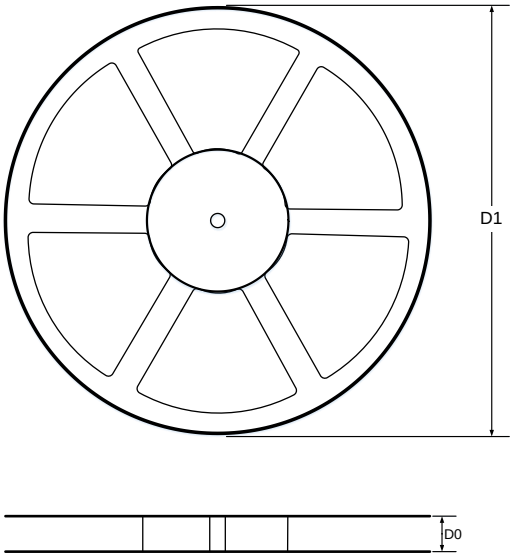


Solder Mask Defined

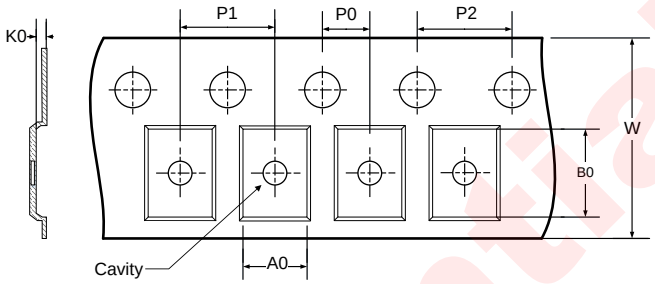
Unit: mm

TAPE AND REEL INFORMATION

REEL DIMENSIONS

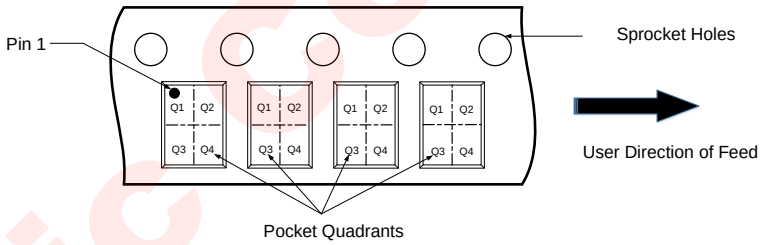


TAPE DIMENSIONS



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



All Dimensions are nominal

D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
330	12.4	3.35	3.35	1.13	2	8	4	12	Q1

REVISION HISTORY

Date	Vision	Description
2018-9	V1.0	Officially Released

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