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

FEATURES

- Drive up to 8 LEDs with 20mA maximum current
- Q-Mirror™ technique ensuring LEDs current matching accuracy±1%(typical)
- Ultra low dropout: 50mV/20mA(typical)
- 2.8V to 5.5V operating input voltage Range
- 16-step linear scale LED brightness control
- Deglitch circuit eliminating interference at EN pin
- No EMI and switch noise
- Less than 0.1μA quiescent current in shutdown mode
- Thermal shutdown protection
- Ultra small TQFN3x3-16L packages

APPLICATIONS

- Mobile phone
- Digital camera
- PDA ,MP3

DESCRITION

The AW9358 is an 8-channel parallel white LED driver with ultra low dropout constant-current source. The AW9358 can drive 8 LEDs and each LED's maximum current is up to 20mA which is set by the internal resistor. The proprietary Q-Mirror™ technique is used in the AW9358, which makes the 8 LEDs current matching to ±1%.

The AW9358 use 1-Wire Brightness Control, 16-Step Linear Scale LED Brightness Control, which effectively avoid the interference caused by the PWM dimming mode.

The AW9358 has an internal deglitch circuit can effectively eliminate the influence of the glitch signal for EN input. The AW9358 requires only a 50mV (typical) dropout voltage at a 20mA load. The feature makes AW9358 ideal for battery-operated systems, such as personal digital assistants. The AW9358 only need one ceramic capacitor making the system design easier, and use less PCB. The shutdown current of the AW9358 is less than 0.1uA.

The AW9358 is available in a small TQFN3mmx3mm-16L package and is specified over the -40℃ to +85℃ temperature range.

TYPICAL APPLICATION CIRCUITS

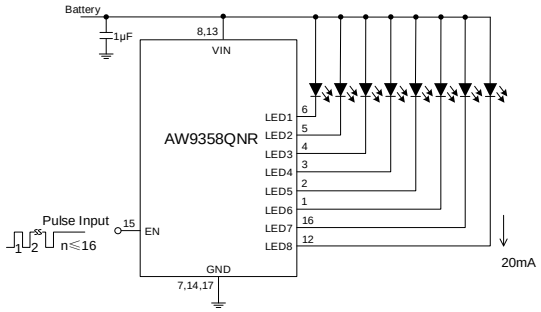
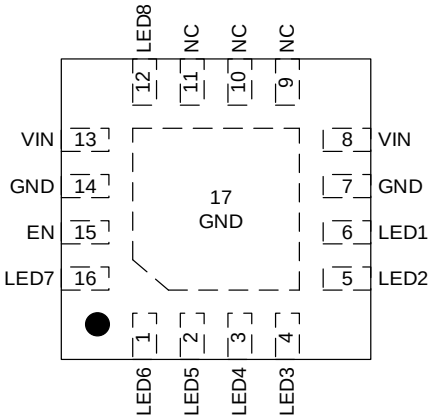


Figure 1 AW9358 Typical Application

PIN CONFIGURATION AND MARKING

AW9358QNR Top View
(TQFN3x3-16L)



AW9358QNR MARKING
(TQNR3x3-16L)

ALD58 - AW9358QNR
XY-Production Tracing Code

Figure 2 Pin Configuration of AW9358

PIN DEFINITION

PIN	Symbol	Description
1	LED6	Current sink for LED6
2	LED5	Current sink for LED5
3	LED4	Current sink for LED4
4	LED3	Current sink for LED3
5	LED2	Current sink for LED2
6	LED1	Current sink for LED1
7	GND	Ground
8	VIN	Power supply Input
9-11	NC	No connect
12	LED8	Current sink for LED8
13	VIN	Power supply Input
14	GND	Ground
15	EN	Enable pin. Active high, with an internal 100kΩ pull-down resistor.
16	LED7	Current sink for LED7
17	GND	Ground

TYPICAL APPLICATION CIRCUITS

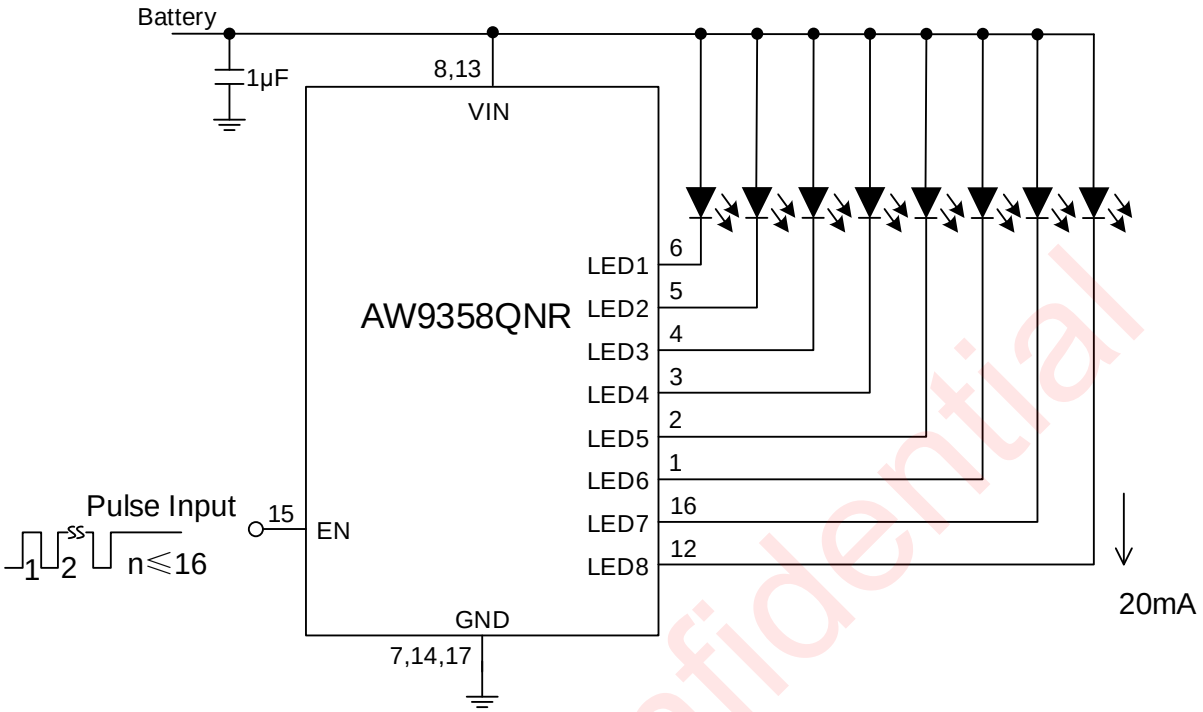
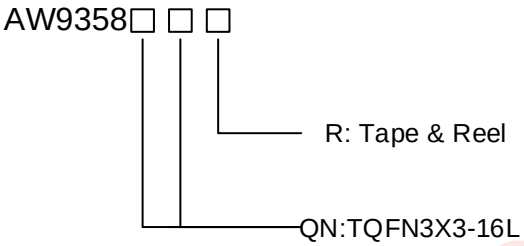


Figure 3 AW9358 Typical Application

ORDERING INFORMATION

Order Number	Temperature Range	Package	Marking	Moisture sensitivity level	Environmental Information	Packing Type
AW9358QNR	-40℃～85℃	TQFN3x3-16L	ALD58	MSL3	RoHS+HF	6000 units/Tape and Reel



ABSOLUTE MAXIMUM RATINGS(1)

Parameter	Range
Supply Voltage VIN	-0.3V to 6 V
Input Voltage EN	-0.3V to VIN
Power Dissipation, (P_{DMAX} @ T_A=25℃)	1.3 W
Package Thermal Resistance θ_{JA}	52℃/W
Maximum Junction Temperature T_{JMAX}	125℃
Storage Temperature Range	-65℃ to 150℃
Lead Temperature (Soldering 10 Seconds)	260℃
ESD Rating(2)	
Human Body Model, All Pins	±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. Test method: MIL-STD-883G Method 3015.7

Note3: Test Condition: JEDEC STANDARD NO.78A FEBRUARY 2006.

ELECTRICAL CHARACTERISTICS

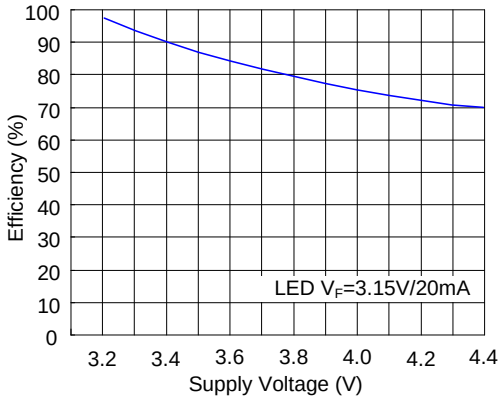
Test Condition: T_A=25℃, VIN=3.6V, EN = 1 (unless otherwise specified)

Parameter		Conditions	Min	Typ.	Max	Units
SUPPLY VOLTAGE AND CURRENT						
VIN	Input voltage range		2.8		5.5	V
I_{SD}	Shutdown current	EN=0		0.1	1	μA
I_Q	Operating quiescent current	VIN=3.6V, EN=1, LED1~LED8 Floating		350		μA
T_{ON}	Startup time			20		μs
CURRENT SINK						
I_{LED}	Setting LED current	100% current, LED1~LED8	18	20	22	mA
I_{LED_ACC}	Current matching accuracy between any two LEDs			1		%
V_{drop}	Voltage at D_X to GND	I_{LED}=20mA V_{DX}-GND		50		mV
ENABLE						
V_{IH}	High input threshold		1.3			V
V_{IL}	Low input threshold				0.3	V
R_{EN}	Internal pull-down resistor			100		kΩ
T_{LO}	EN low time for dimming		0.5		500	μs
T_{HI_MIN}	Minimum EN high time for dimming		0.5			μs
T_{SHDN}	Shutdown delay time	Delay time when EN go to GND after which the AW9358 shutdown completely	0.8		2.5	ms

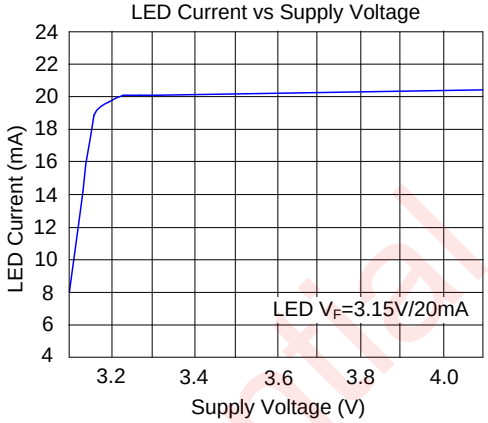
TYPICAL OPERATION CHARACTERISTICS

Test condition：T_A=25℃，VIN=3.6V, EN=1 unless otherwise specified.

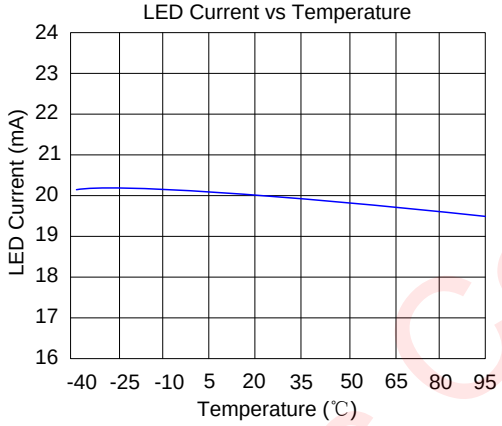
Efficiency vs Supply Voltage



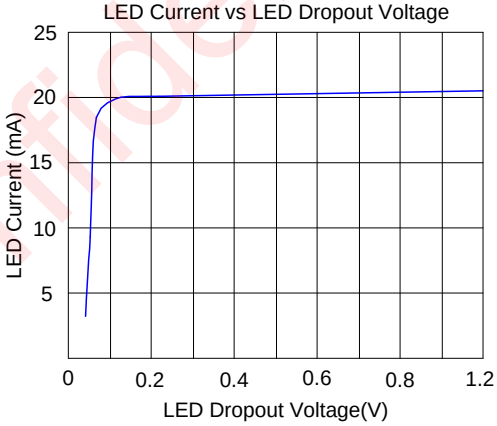
LED Current vs Supply Voltage



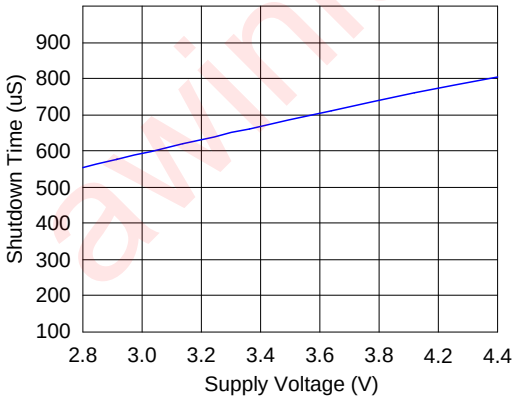
LED Current vs Temperature



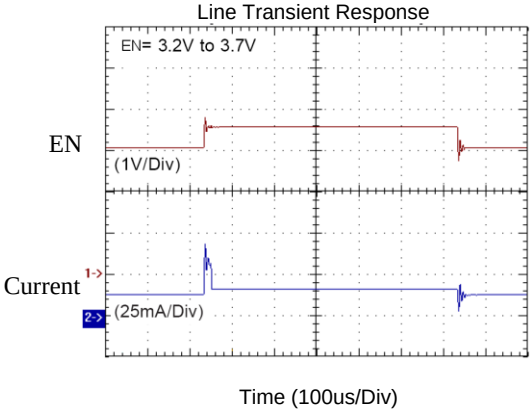
LED Current vs LED Dropout Voltage



Shutdown Time vs Supply Voltage



Line Transient Response



BLOCK DIAGRAM

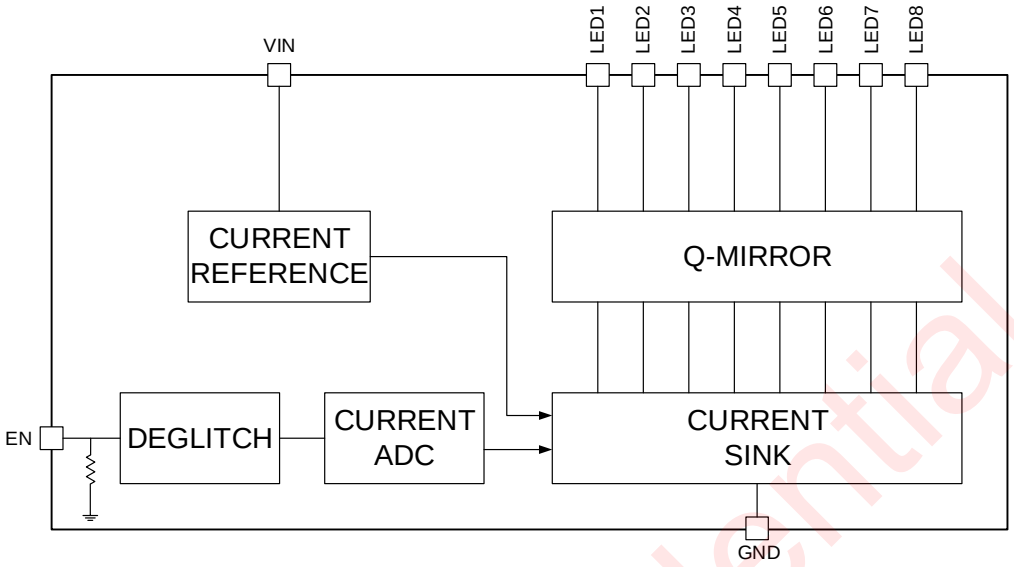


Figure 4 Functional Block Diagram of AW9358

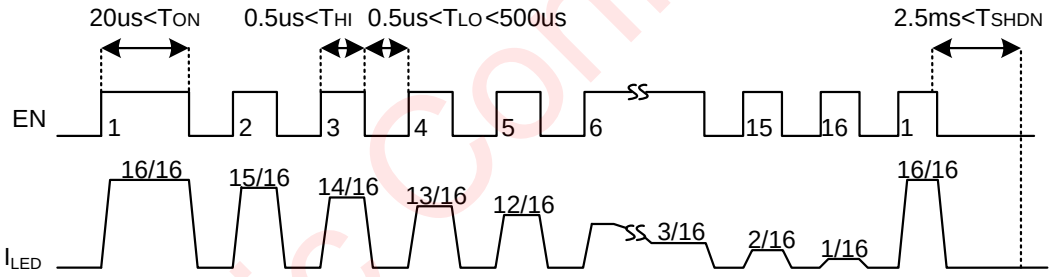


Figure 5 1-wire brightness control Interface Timing of AW9358

DETAILED DESCRIPTION

The AW9358 is an 8-channel parallel white LED driver with ultra low dropout constant-current source. The AW9358 mainly used in new generation mobile phone and portable devices which need lower dropout voltage LED. Each LED's maximum current is up to 20mA which is set by the internal resistor. The AW9358 use 1-wire pulse count dimming mode, realizing 16 step linear adjustable of LED brightness control.

Enable Input

The EN input is used to enable or disable the AW9358. Pulling the EN pin to high voltage will enable the device. The AW9358 has an internal shutdown delay circuit, when the EN pin is held low for an amount of time longer than 2.5ms (typically), the AW9358 will enter shutdown mode and draw less than 0.1μA from the input.

Deglitch Circuit

The AW9358 has an internal deglitch circuit for filtering the noise of the EN input. In portable applications such as mobile phones, digital cameras and other portable applications, the interference between the signal lines on the PCB is inevitable. AW9358 for the particularity of the EN pin, the built-in Deglitch circuit, can eliminate the EN pin is less than 80ns high level glitch, effectively avoid the interference caused by external circuit led to the false trigger of 1-wire pulse count dimming.

APPLICATION INFORMATION

LED Brightness Dimming Control

The AW9358 incorporates a 1-wire pulse count dimming to eliminate the switch noise. The principle of 1-wire pulse count dimming: the AW9358 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 5 and Table 1). En is AW9358's enable control PIN. The high level of En pin's the first pulse (T_{ON}) must greater than 20μs to make the device startup and LED current reach max, Successive rising edges decrease the LED current as shown in Table 1. En keeps high level when led current is set. The pulse high time T_{HI} is 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. When 1-wire pulse count dimming is over, the EN signal remains high.

Table 1 LED Current Setting

The number of rising edge	LED current (mA)
1	20
2	18.75
3	17.5
4	16.25
5	15
6	13.75
7	12.5
8	11.25
9	10
10	8.75
11	7.5
12	6.25
13	5
14	3.75
15	2.5
16	1.25

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 13-9=4 pulses changes the LED current from 10mA (rising edges: 9) to 5mA (rising edges: 13) as shown in Figure 6.

Since the AW9358 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 1+16-9=8 pulses changes the LED current from 10mA (rising edges: 9) to 20mA (rising edges: 1) as shown in Figure 7.

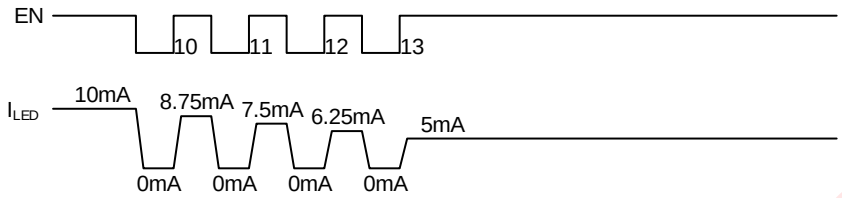


Figure 6 Programming Example for LED Current from 10mA to 5mA

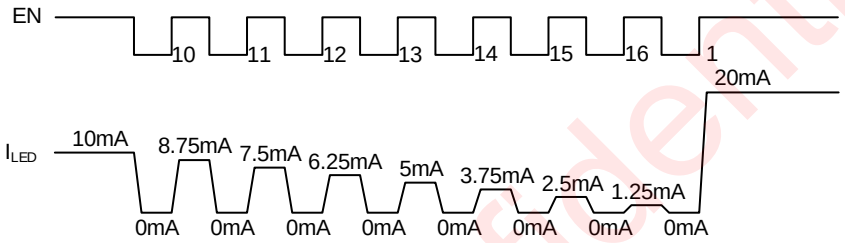


Figure 7 Programming Example for LED Current from 10mA to 20mA

Efficiency

The AW9358 is a parallel white LED driver with ultra low dropout constant-current source. Based on the 20mA current of each LED, the AW9358 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_{DO}, V_{DO} is the dropout voltage needed in the current source. For example, when V_{DO}=3.2V (20mA) VIN=3.4V, the η is about 94% --greater than other type of LED driver.

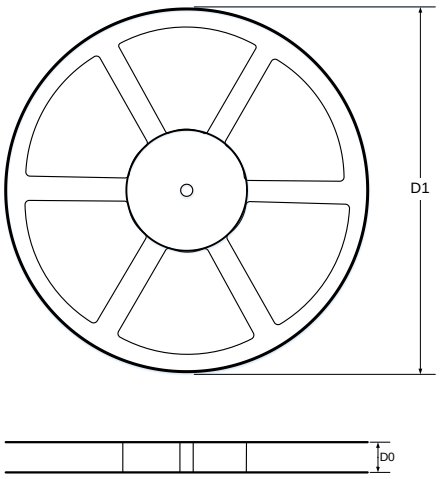
PCB Layout Consideration

The AW9358 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 AW9358:

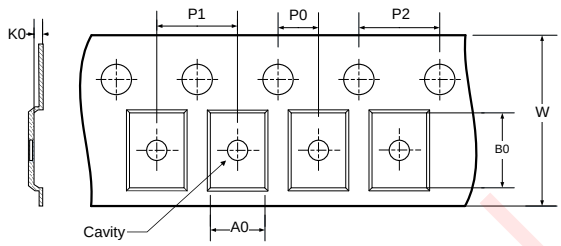
1. Place all peripheral components as close to the device as possible. Place C_{IN} close to the VIN. The device bonding pad and the chip pin should be directly connected with the same layer of copper wire to avoid two layers of copper connection through the through hole.
2. The power line contact VIN and LED anode must wide，to reduce the influence of parasitic inductance and parasitic resistance.
3. Input capacitor C_{IN} need to near AW9358, 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 heat sink and GND must be connected directly to the PCB of the large area spread formation, and in the heat sink below the floor layer through the through hole connected to the PCB of the middle layer of ground.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

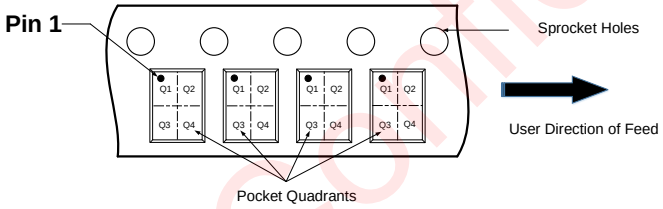


TAPE DIMENSIONS



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

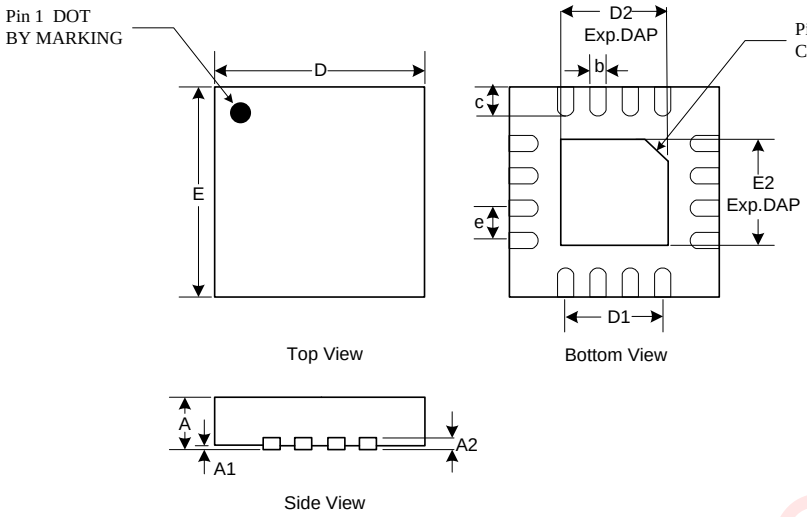


DIMENSIONS AND PIN1 ORIENTATION

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

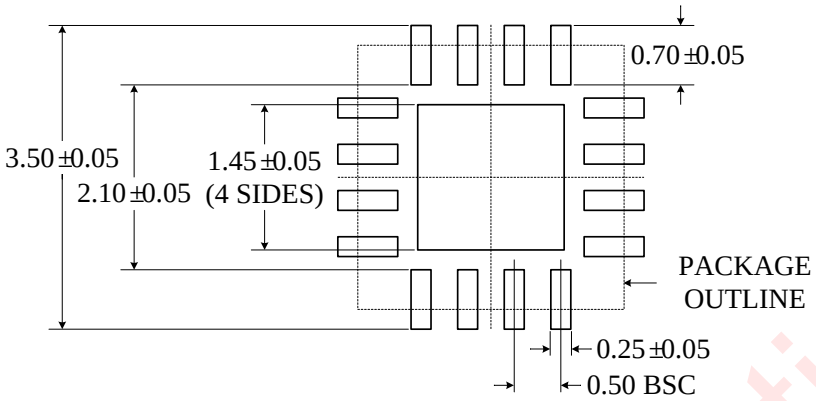
All dimensions are nominal

PACKAGE DESCRIPTION



Unit:mm	TQFN-16L		
Symbol	Min	Typ	Max
A	0.700	0.750	0.800
A1	0.000		0.050
A2	0.203 (Ref.)		
b	0.200	0.250	0.300
c	0.350	0.400	0.450
D	2.950	3.000	3.050
D1	1.500 (Ref.)		
D2	1.600	1.650	1.700
e	0.500(Bsc)		
E	2.950	3.000	3.050
E2	1.600	1.650	1.700

LAND PATTERN



REVISION HISTORY

Date	Vision	Description
Mar. 2020	V1.0	Officially released (English vision)

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