

Description

The AP8800 is a step-down DC/DC converter designed to drive LEDs with a constant current. The device can drive up to seven LEDs, depending on the forward voltage of the LEDs, in series from a voltage source of 8V to 28V. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminates the need for ballast resistors. The AP8800 switches at frequency up to 0.6MHz. This allows the use of small size external components, hence minimizing the PCB area needed.

Maximum output current of AP8800 is set via an external resistor connected between the V_{IN} and SET input pins. Dimming is achieved by applying either a DC voltage or a PWM signal at the CTRL input pin. An input voltage of 0.2V or lower at CTRL shuts down the output at SW and puts the device into a low-current standby state.

Features

- LED driving current up to 350mA
- Compatible with 12V & 24V standard systems
- High efficiency up to 92%
- High switching frequency up to 0.6MHz
- PWM/DC input for dimming control
- Built-in soft-start function
- Built-in output open-circuit protection
- SO-8, MSOP-8 and DFN3030-10 are available in "Green" Molding Compound (No Br, Sb)
- Lead Free Finish/RoHS Compliant (Note 1)

Note: 1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at http://www.diodes.com/products/lead_free.html.

Applications

- Commercial & Industrial lighting
- Small LCD panel backlight
- Architecture Detail lighting
- Appliances interior lighting

Typical Application Circuit

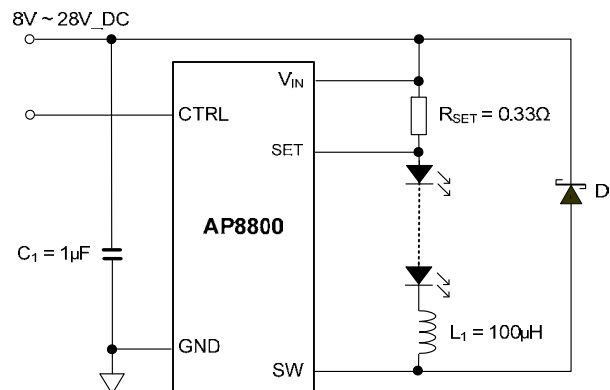
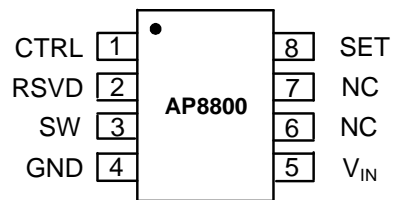


Fig. 1 Typical Application Circuit

Pin Assignments

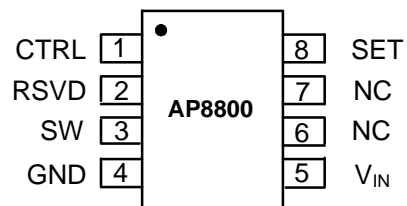
SO-8

(Top View)



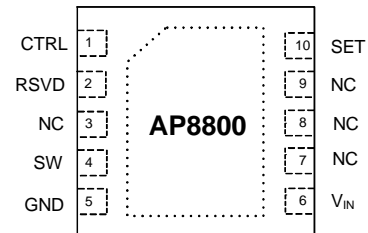
MSOP-8

(Top View)



DFN3030-10

(Top View)



Pin Descriptions

Pin Name	Pin number			Description
	SO-8	MSOP-8	DFN3030-10	
SW	3	3	4	Switch Pin. Connect inductor/freewheeling diode here. Minimize trace area at this pin to reduce EMI.
GND	4	4	5	GND pin
SET	8	8	10	Set Nominal Output Current Pin. To configure the output current of the device.
CTRL	1	1	1	Dual function dimming control pin. <ul style="list-style-type: none"> Input voltage of 0.2V or lower forces the device into low current standby mode and shuts off the output. A PWM signal (driven by an open-drain/collector source) allows the output current to be adjusted over a wide range up to 100%. An analog voltage between 0.3V and 2.5V adjusts the output current between 25% and 200% of the current set by $0.2V/R_S$. The input impedance is about 200k Ω , and if the pin is left open $V_{CTRL} = V_{REF}$
V _{IN}	5	5	6	Input Supply Pin. Must be locally bypassed.
RSVD	2	2	2	Reserved. Normally connected to Ground
NC	6, 7	6, 7	2, 7, 8, 9	No Connection.

Functional Block Diagram

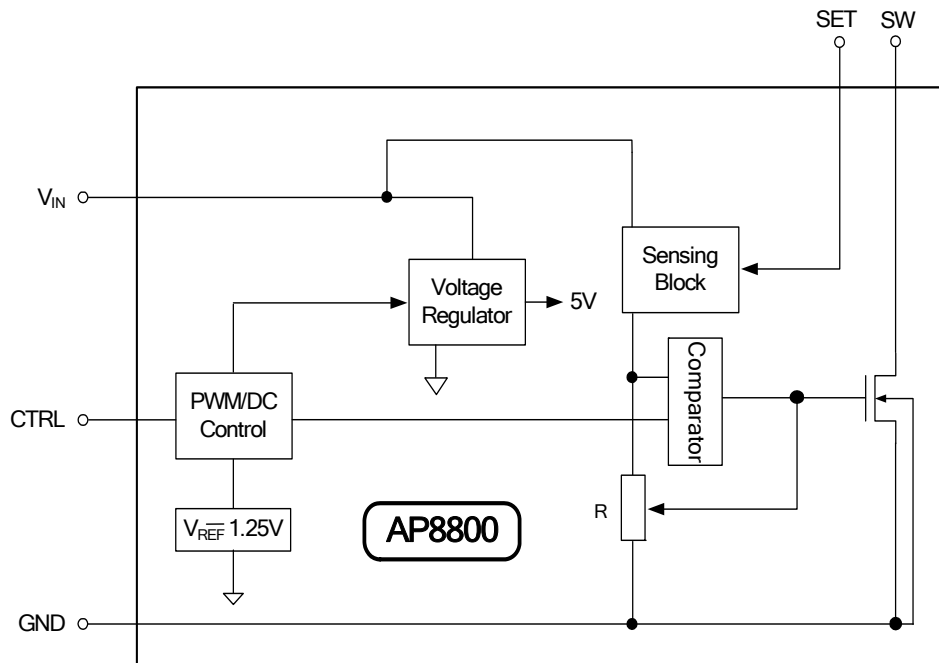


Fig. 2 AP8800 Block Diagram

Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{IN}	VIN pin voltage	-0.3~30	V
V_{SET}	Set voltage relative to V_{IN}	$V_{IN} -5 \sim V_{IN} +0.3$	V
V_{SW}	SW voltage	-0.3~30	V
V_{CTRL}	CTRL pin input voltage	-0.3 ~ 5	V
T_J	Maximum Junction Temperature	125	°C
T_{LEAD}	Maximum Lead Temperature	300	°C
T_{ST}	Storage Temperature Range	-55 to +125	°C

Caution: Stresses greater than the 'Absolute Maximum Ratings' specified above, may cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.

Semiconductor devices are ESD sensitive and may be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Operating Input Voltage relative to GND	8.0	28	V
V_{CTRLDC}	Voltage range for 24% to 200% DC dimming relative to GND (Note 2)	0.3	2.5	V
V_{CTRLLL}	Voltage Low for PWM dimming relative to GND	0	0.2	V
f_{OSC}	Maximum Switching Frequency		500	kHz
T_A	Ambient Temperature Range	-40	85	°C
Duty Cycle	Using Inductor $\geq 100\mu H$ (Note 3)	0.1	0.95	
V_{ENH}	CTRL input voltage to attain 100% LED current	1.25		V
V_{ENL}	CTRL input voltage below which device turns off		0.2	

Notes: 2. For 100% brightness either leave floating or connect to 1.25V relative to GND.

3. For most applications the LED current will be within 8% over the duty cycle range specified. Duty cycle accuracy is also dependent on propagation delay. Smaller size inductors can be used but LED current accuracy may be greater than 8% at extremes of duty cycle. This is most noticeable at low duty cycles (less than 0.1) or when the input voltage is high and only one LED is being driven.

Electrical Characteristics ($V_{IN} = 12V$, $T_A = 25^\circ C$, unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ.	Max	Unit
I_{OUT}	Continuous switch current	(Note 4)	-	-	350	mA
I_Q	Quiescent current		-	20	30	μA
V_{THD}	Internal current sense threshold voltage	$V_{IN} - V_{SET}$	92	100	108	mV
V_{REF}	Internal reference voltage		-	1.25	-	V
SET	SET pin input current	$V_{SET} = V_{IN} - 0.1$	-	1.3	-	μA
$R_{DS(on)}$	On-resistance of internal switch			1.7	2.2	Ω
$I_{SW Leakage}$	Switch pin leakage current		-	-	5	μA
θ_{JA}	Thermal resistance junction-to-ambient	SO-8 (Note 5)	-	92	-	$^\circ C/W$
		MSOP-8 (Note 5)	-	120	-	$^\circ C/W$
		DFN3030-10 (Note 5)	-	46	-	$^\circ C/W$
θ_{JC}	Thermal resistance junction-to-case	SO-8 (Note 5)	-	60	-	$^\circ C/W$
		MSOP-8 (Note 5)	-	98	-	$^\circ C/W$
		DFN3030-10 (Note 5)	-	32	-	$^\circ C/W$

- Notes:
4. Refer to figure 5 for the device derating curve.
 5. Test condition for SO-8, MSOP-8 and DFN3030-10: Device mounted on FR-4 PCB, 2"x2", 2oz copper, minimum recommended pad layout on top layer and thermal vias to bottom layer ground plane. For better thermal performance, larger copper pad for heat-sink is needed.

Application Information

LED Current Control

The LED current is controlled by the resistor R_{SET} in Figure 1.

If the CTRL pin is floating and at a nominal voltage of V_{REF} , the external current sense resistor R_{SET} (greater than 0.3 Ω) is connected between V_{IN} and SET and defines the nominal average output current in the LED(s) as:

$$I_{LED} = \frac{V_{THD}}{R_{SET}} \quad \text{where } V_{THD} = 100\text{mV}$$

If the CTRL pin is driven by an external voltage (lower than 2.5V), the average LED current in this case is:

$$I_{LED} = \frac{V_{CTRL}}{V_{REF}} \frac{V_{THD}}{R_{SET}}$$

The graph in figure 3 gives values of nominal average output current for several values of current setting resistor (R_{SET}) in the typical application circuit shown on Figure 1, for different voltages applied on the CTRL pin.

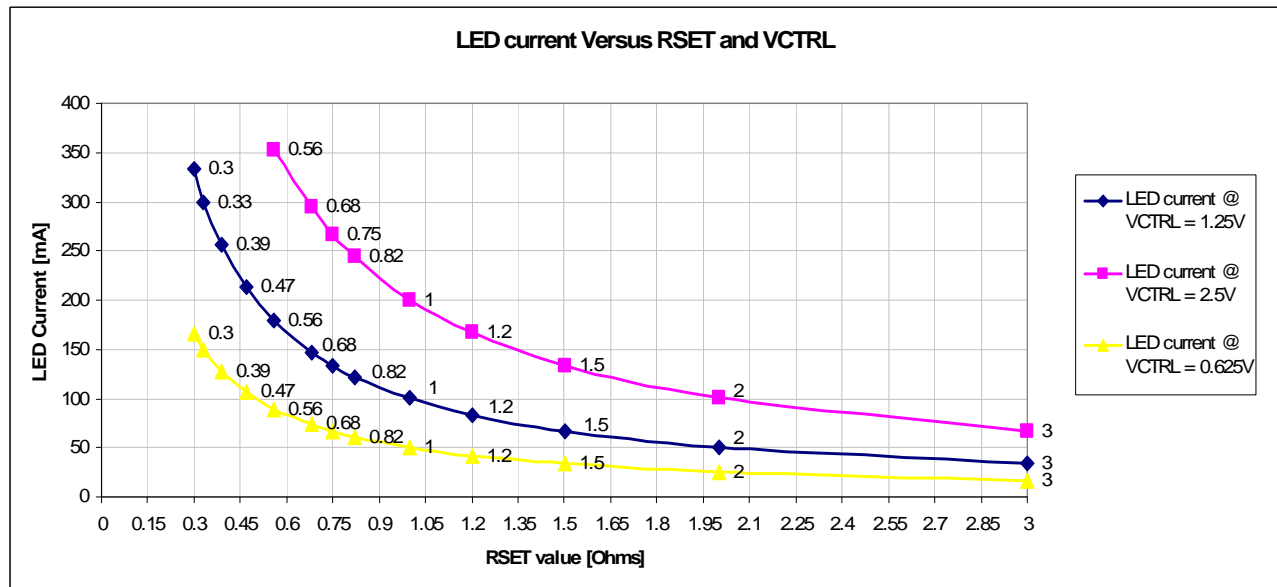


Fig. 3 LED Current setting vs. R_{SET} and V_{CTRL}

Application Information (cont.)

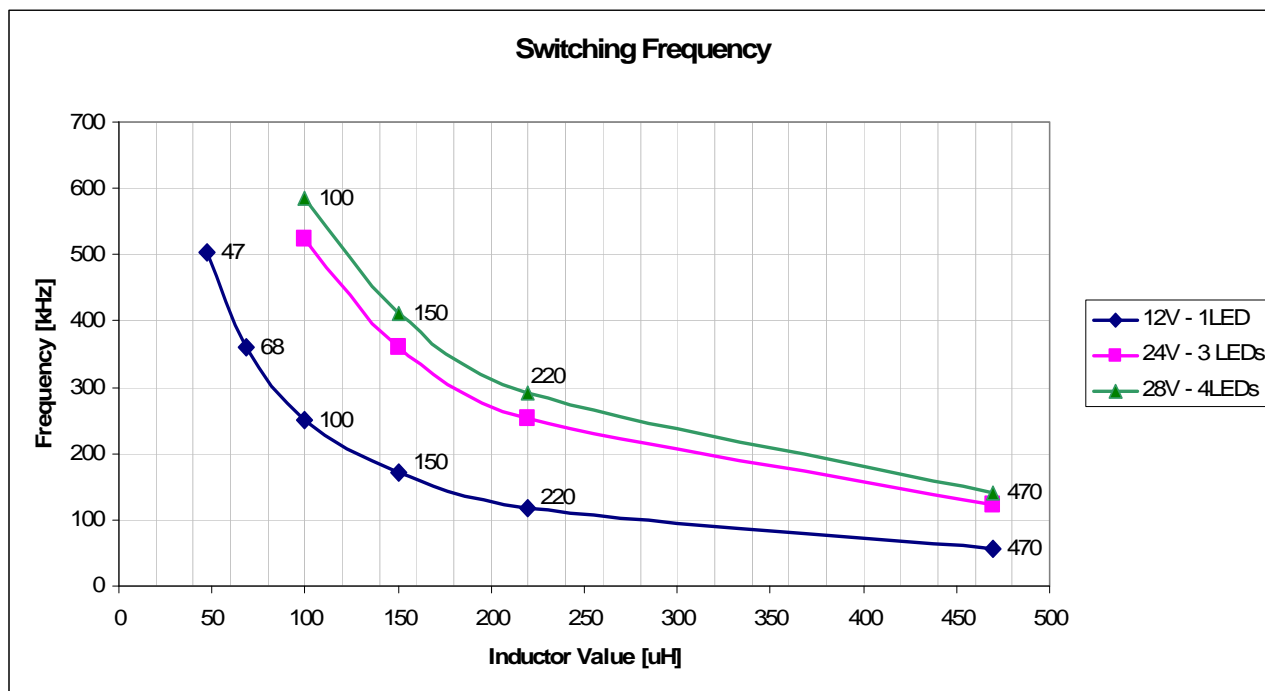


Fig 4. Switching Frequency vs. Supply voltage, Inductor, and number of LEDs

Capacitor Selection

The small size of ceramic capacitors makes them ideal for AP8800 applications. X5R and X7R types are recommended because they retain their capacitance over wider voltage and temperature ranges than other types such as Z5U. A 1µF input capacitor is sufficient for most intended applications of AP8800.

Diode Selection

Schottky diode, e.g. B140, with their low forward voltage drop and fast reverse recovery, is the ideal choice for AP8800 applications.

PWM Dimming

A Pulse Width Modulated (PWM) signal with a max resolution of 8bit can be applied to the CTRL pin to regulate the output current to a value above or below the nominal average value set by resistor RSET.

Miscellaneous

To ensure optimal performance, RSVD pin should be connected to the GND pin with the shortest trace length.

Inductor Selection

A 100µH inductor is recommended for most AP8800 applications with input voltage at 24V. Figure 4 displays the resulting switching frequency varying the main circuit parameters: Supply voltage, Inductor value and number of LEDs to be driven.

Thermal Considerations

The graph below in figure 5, gives details for power derating. This assumes the device to be mounted on a 25x25mm PCB with 1oz copper standing in still air.

Application Information (cont.)

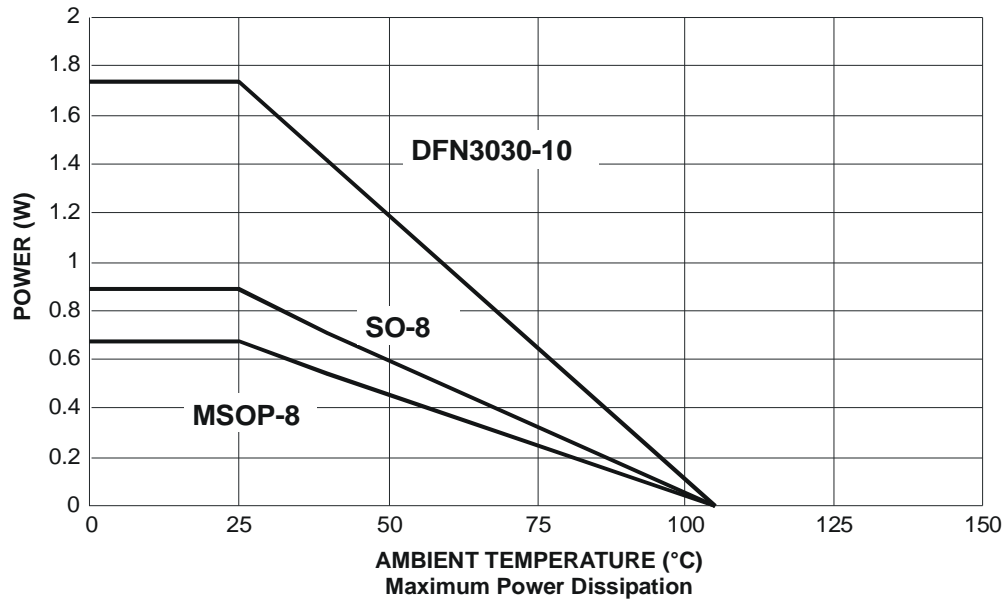
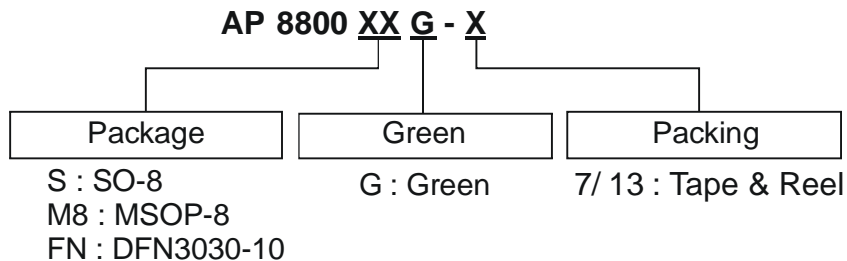


Fig. 5 Derating curve

Ordering Information

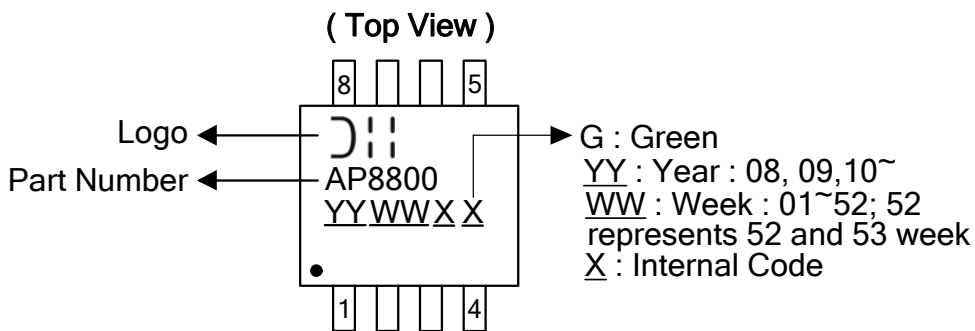


Device	Package Code	Packaging (Note 6)	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
AP8800SG-13	S	SO-8	2500/Tape & Reel	-13
AP8800M8G-13	M8	MSOP-8	2500/Tape & Reel	-13
AP8800FNG-7	FN	DFN3030-10	3000/Tape & Reel	-7

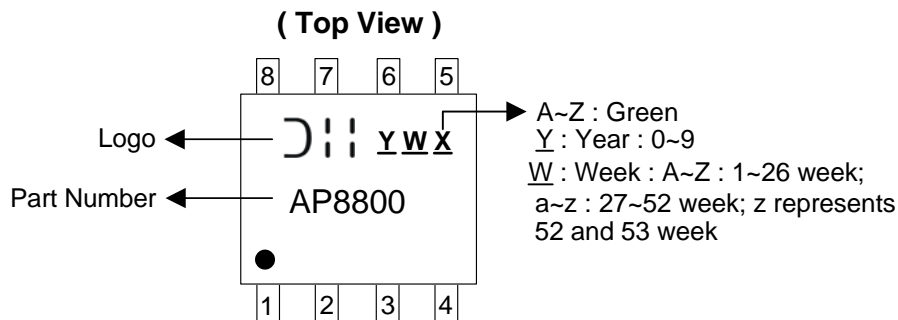
Notes: 6. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

Marking Information

SO-8



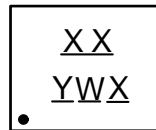
MSOP-8



Marking Information (cont.)

DFN3030-10

(Top View)

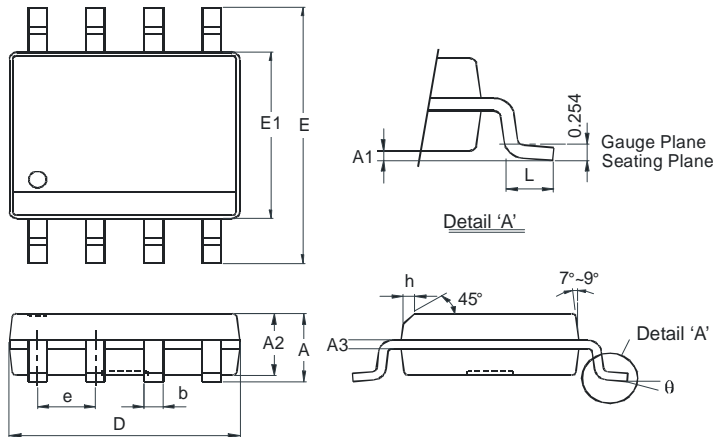


XX : Identification Code
Y : Year : 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : Green

Part Number	Package	Identification Code
AP8800FNG-7	DFN3030-10	A4

Package Outline Dimensions (All Dimensions in mm)

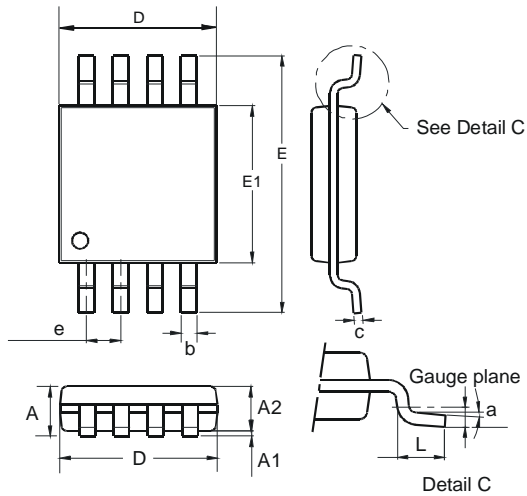
Package Type: SO-8



SO-8		
Dim	Min	Max
A	-	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27 Typ	
h	-	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

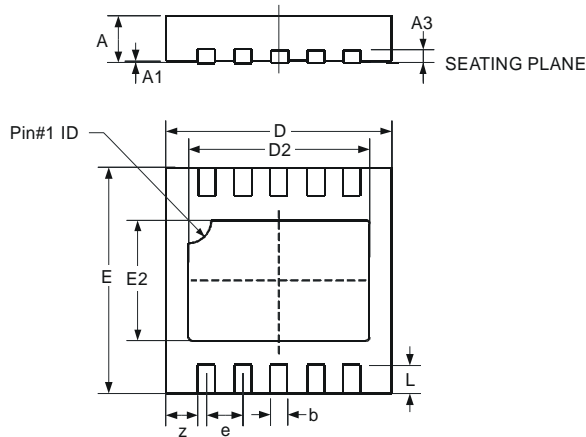
Package Outline Dimensions (All Dimensions in mm) (cont.)

Package Type: MSOP-8



MSOP-8			
Dim	Min	Max	Typ
a	0°	6°	4°
A	—	1.10	—
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.05	3.00
e	—	—	0.65
E	4.80	5.00	4.90
E1	2.90	3.00	3.10
L	0.40	0.80	0.60
All Dimensions in mm			

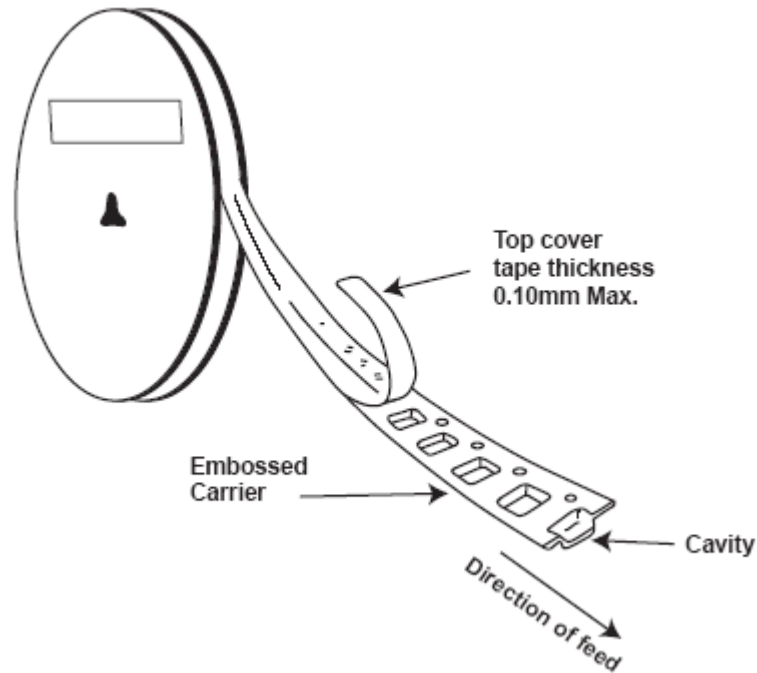
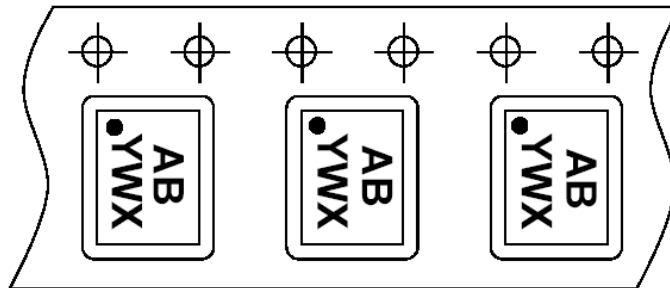
Package Type: DFN3030-10



DFN3030-10			
Dim	Min	Max	Typ
A	0.57	0.63	0.60
A1	0	0.05	0.02
A3	—	—	0.15
b	0.20	0.30	0.25
D	2.90	3.10	3.00
D2	2.30	2.50	2.40
e	—	—	0.50
E	2.90	3.10	3.00
E2	1.50	1.70	1.60
L	0.25	0.55	0.40
z	—	—	0.375
All Dimensions in mm			

Tape Orientation (Note 7)

For DFN3030-10



Notes: 7. The taping orientation of the other package type can be found on our website at <http://www.diodes.com/datasheets/ap02007.pdf>.

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