

Description

The AP8801 is a step-down DC/DC converter designed to drive LEDs with a constant current. The device can drive up to thirteen LEDs, depending on the forward voltage of the LEDs, in series from a voltage source of 8V to 48V. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminating the need for ballast resistors. The AP8801 switches at frequency up to 500kHz. This allows the use of small size external components, hence minimizing the PCB area needed.

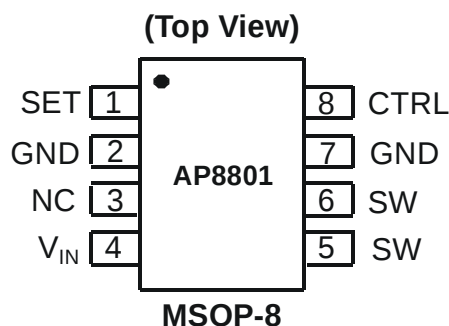
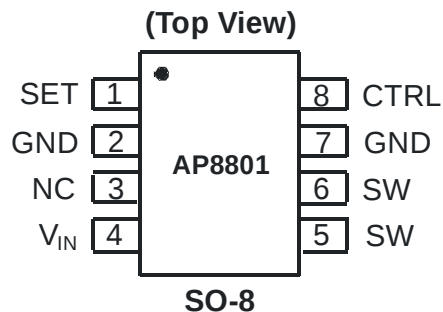
Maximum output current of AP8801 is set via an external resistor connected between the V_{IN} and SET input pins. Dimming is achieved by applying either a DC voltage or a PWM signal at the CTRL input pin. An input voltage of 0.2V or lower at CTRL shuts down the output at SW and puts the device into a low-current standby state.

Features

- LED driving current up to 500mA
- Operating input voltage up to 48V
- High efficiency up to 92%
- High switching frequency up to 500kHz
- PWM/DC input for dimming control
- Built-in output open-circuit protection
- SO-8 and MSOP-8 are 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.

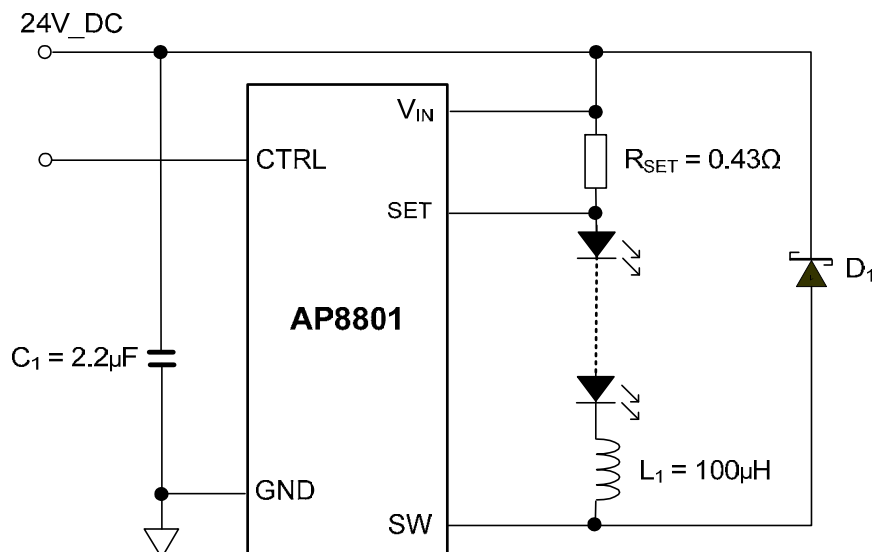
Pin Assignments



Applications

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

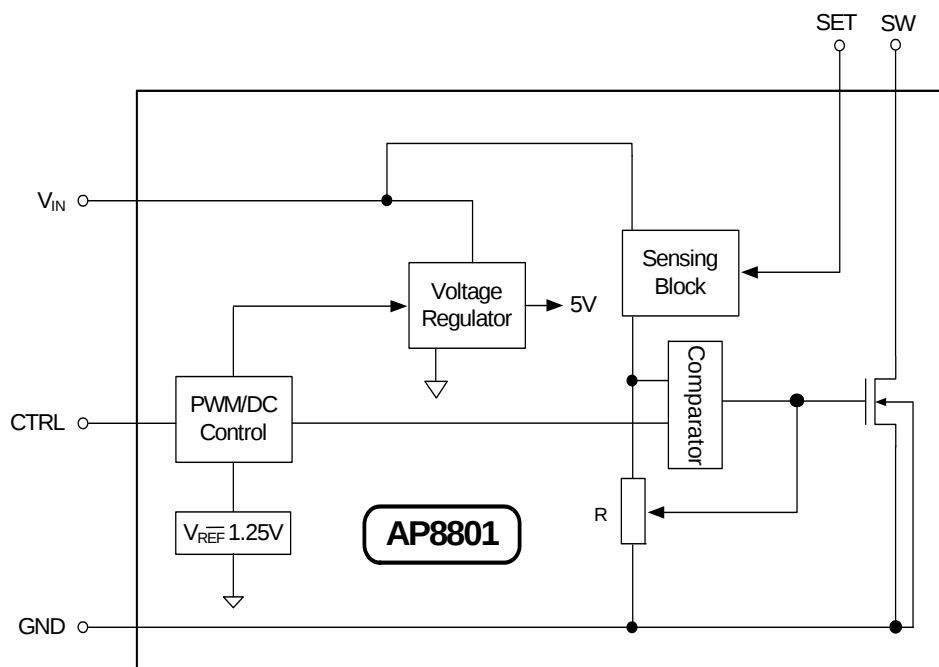
Typical Application Circuit



Pin Descriptions

Pin Name	Description
SW	Switch Pin. Connect inductor/freewheeling diode here, minimizing track length at this pin to reduce EMI.
GND	GND pin
SET	Set Nominal Output Current Pin. Configure the output current of the device.
CTRL	Dual function dimming control pin. - 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 50k Ω , and if the pin is left open $V_{CTRL} = V_{REF}$
V _{IN}	Input Supply Pin. Must be locally bypassed.
NC	No connection

Functional Block Diagram



Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{IN}	V_{IN} pin voltage	-0.3~50	V
V_{SW}	SW voltage	-0.3~50	V
T_J	Junction Temperature	150	°C
T_{LEAD}	Lead Temperature Soldering	300	°C
T_{ST}	Storage Temperature Range	-65 to +150	°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	48	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	105	°C
Duty Cycle	Using Inductor $\geq 100\mu H$ (Note 3)	0.1	0.95	

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 ($T_A = 25^\circ C$, $V_{IN} = 24V$; unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ.	Max	Unit
I_{OUT}	Continuous switch current	(Note 4)			500	mA
I_Q	Quiescent Current		-	78	120	μA
V_{THD}	Internal Threshold Voltage		184	200	216	mV
V_{REF}	Internal Reference Voltage		-	1.25	-	V
SET	SET pin input current	$V_{SET}=V_{IN}-0.2$	-	7	-	μA
$R_{ds(on)}$	On Resistance of MOSFET	$I_{SW}=0.4A$		0.7	1.15	Ω
$I_{SW_Leakage}$	Switch leakage current		-	-	8	μA
θ_{JA}	Thermal Resistance Junction-to-Ambient	SO-8 (Note 5)	-	88	-	°C/W
		MSOP-8 (Note 5)	-	128	-	°C/W
θ_{JC}	Thermal Resistance Junction-to-Case	SO-8 (Note 5)	-	58	-	°C/W
		MSOP-8 (Note 5)	-	90	-	°C/W

Notes: 4. Refer to figure 6 for the device derating curve.

5. Test condition for SO-8 and MSOP-8: 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 connected between V_{IN} and SET. The nominal average output current in the LED(s) is defined as:

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

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

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

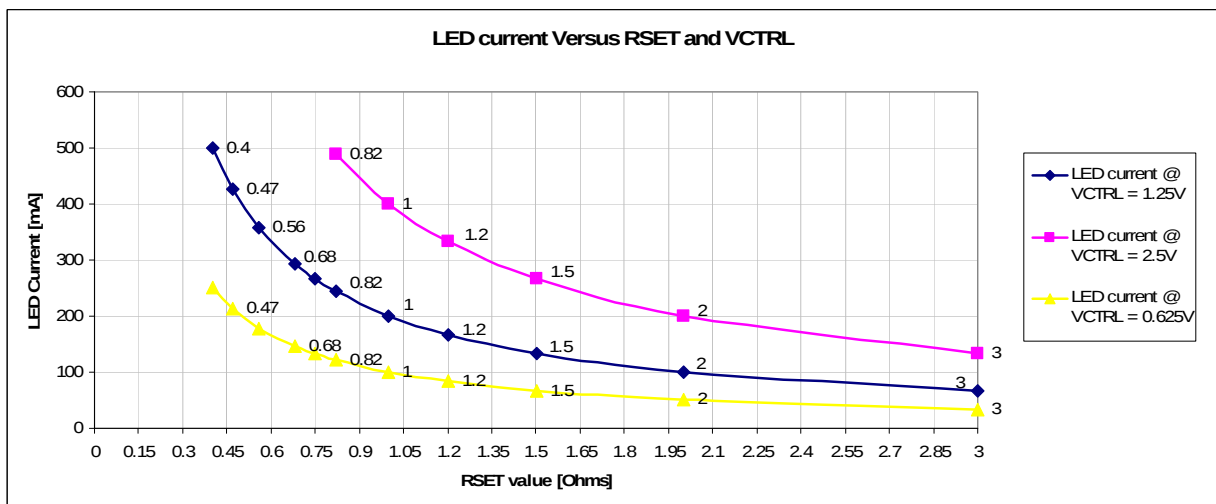


Figure 1 LED Current setting vs. R_{SET} and V_{CTRL}

Application Information (cont.)

Inductor Selection

This section highlights how to select the inductor suitable for the application requirements in terms of switching frequency, LED current accuracy and temperature.

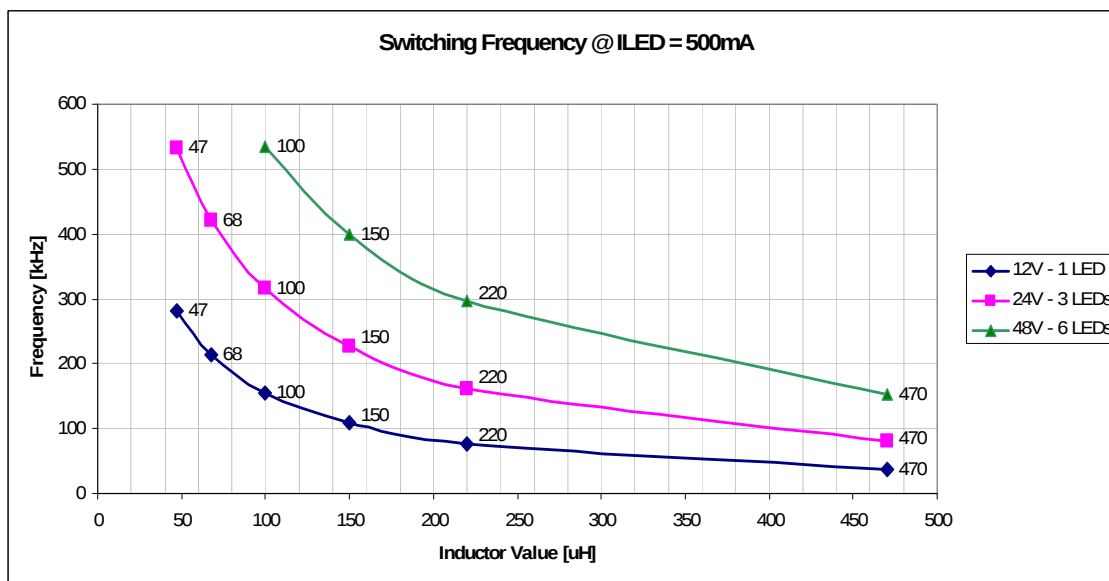


Figure 2 Switching Frequency vs. Inductor Value

The inductor influences the LED current accuracy that the system is able to provide. The following section highlights how to select the inductor in relation to the device packages and the LED current, while maintaining the chip temperature below 70°C.

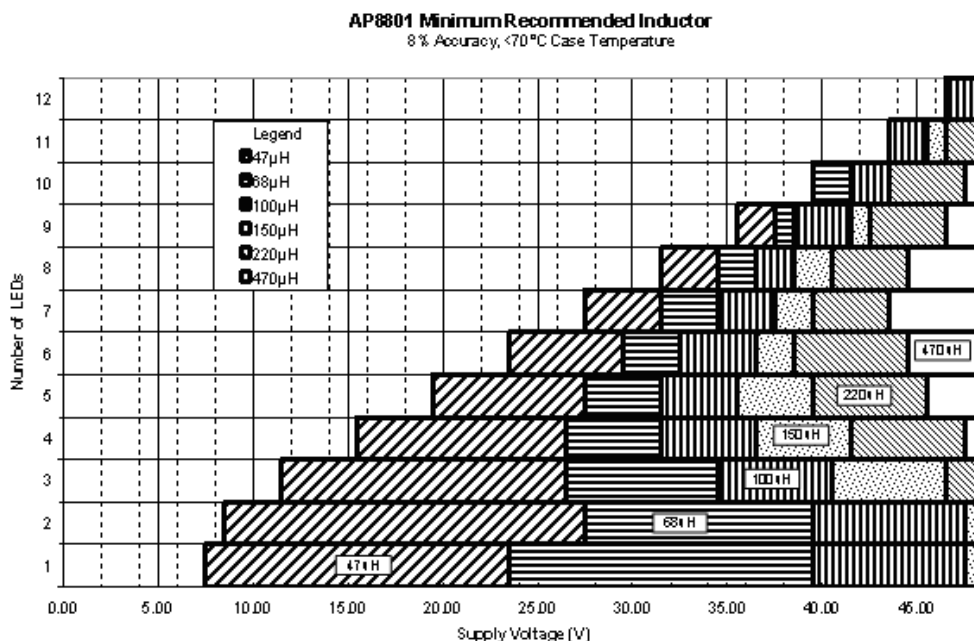


Figure 3 Minimum Recommended Inductor with 500mA LED Current

Application Information (cont.)

Capacitor Selection

The small size of ceramic capacitors makes them ideal for AP8801 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 2.2 μ F input capacitor is sufficient for most intended applications of AP8801.

A 4.7 μ F input capacitor is suggested for application with an input voltage equal or higher than 40V.

Diode Selection

Schottky diodes, e.g. B1100, with their low forward voltage drop and fast reverse recovery, are the ideal choice for AP8801 applications.

PWM Dimming

A Pulse Width Modulated (PWM) signal with a max resolution of 8bit, can be applied to the CTRL pin to change the output current to a value above or below the nominal average value set by resistor RSET. To achieve this resolution the PWM frequency has to be lower than 500Hz.

Thermal Considerations

The graph below in figure 6, gives details for power derating. This assumes the device to be on a FR-4 PCB, 2"x2", 2oz copper, minimum recommended pad layout on top layer and thermal vias to bottom layer ground plane standing in still air.

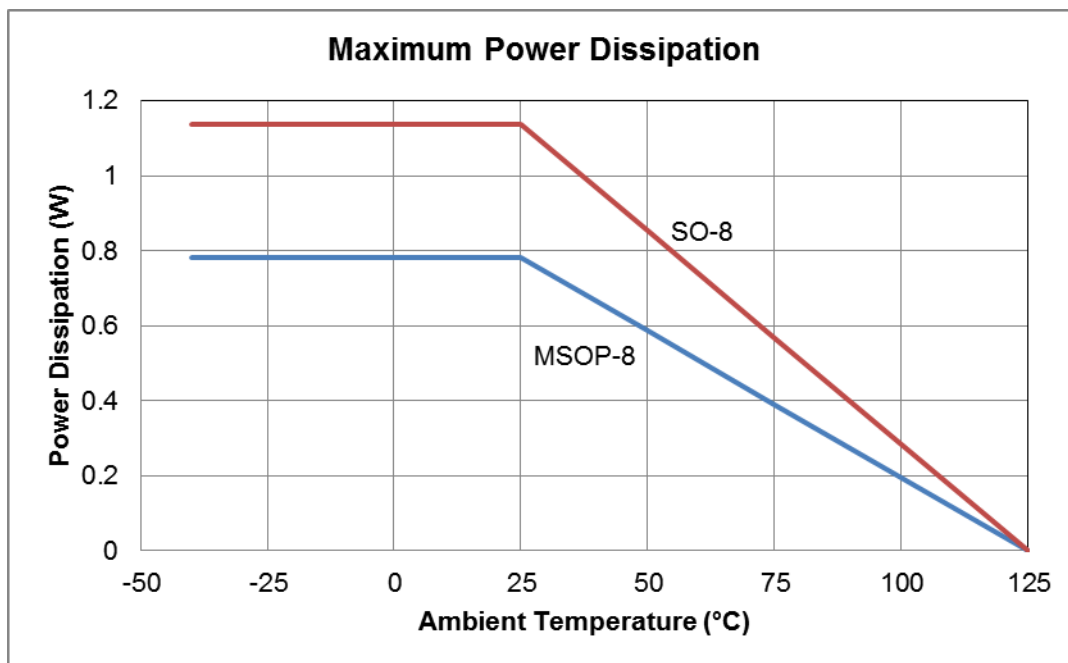


Figure 4 AP8801 Derating Curves

Application Information (cont.)

Package Selection

The device comes with a wide selection of packages. The suggested package is able to provide a case temperature below 70°C (with an ambient temperature of 25°C) for the combination of input voltage and load requested.

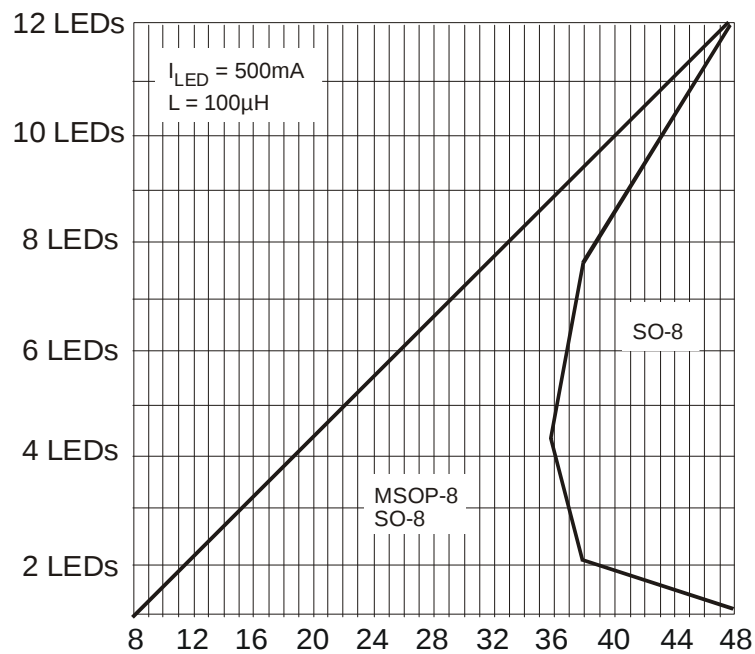
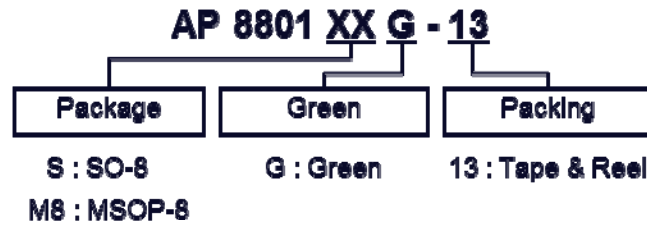


Figure 5 Suggested package for $I_{LED} = 500mA$ Application

Ordering Information

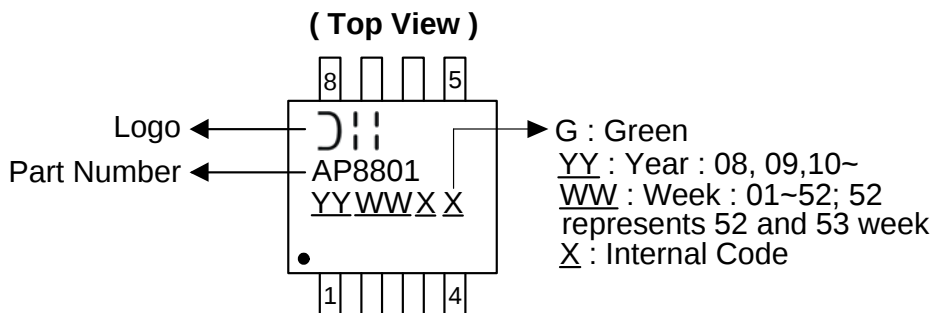


Device	Package Code	Packaging (Note 6)	13" Tape and Reel	
			Quantity	Part Number Suffix
AP8801SG-13	S	SO-8	2500/Tape & Reel	-13
AP8801M8G-13	M8	MSOP-8	2500/Tape & Reel	-13

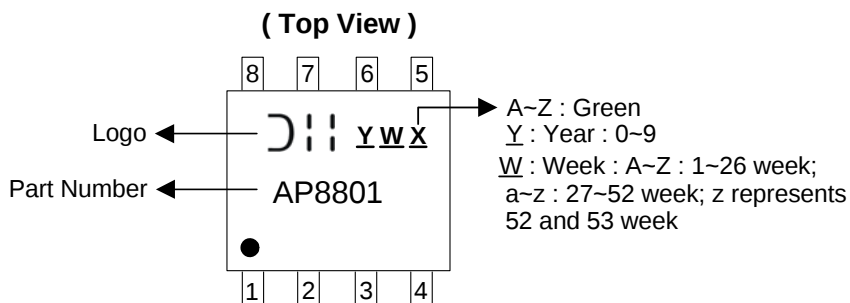
Note: 6. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

Marking Information

(1) SO-8

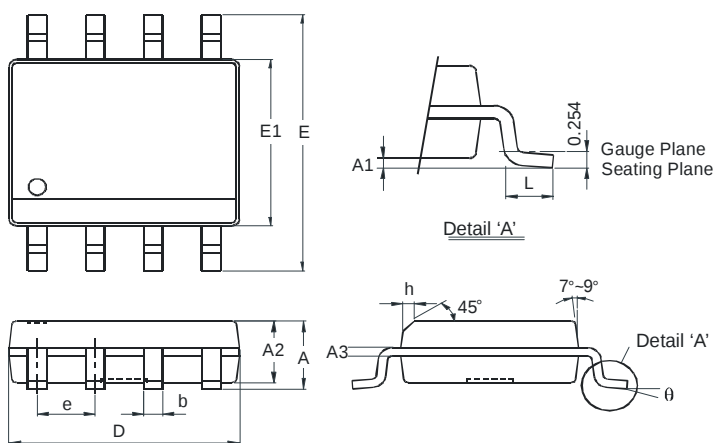


(2) MSOP-8



Package Outline Dimensions

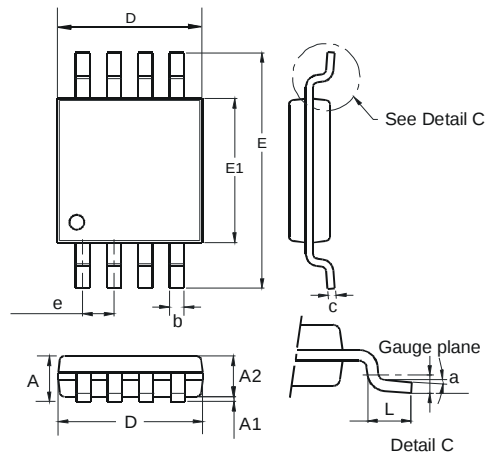
(1) SO-8



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 (cont.)

(2) 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			

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