PROTEK DEVICES
ANALOG PRODUCTS DIVISION

PA5910

Switching Type LED Driver.

Features

- Constant current LED driver:
- 20mA to 2A programmable
- Step-up or step-down operation
- >90 efficiency
- 2.5V to 450V
- Up to 2MHz switching frequency

Applications

- DC/DC LED Drivers
- AC/DC LED Drivers
- RGB Backlighting
- Flat Panel Backlighting
- Signs and Decorative LED Lighting

Description

The PA5910 is a high efficiency LED driver control Integrated Circuit.

It is a universal control LED driver that can be configured to operate as a step-up or step-down LED driver.

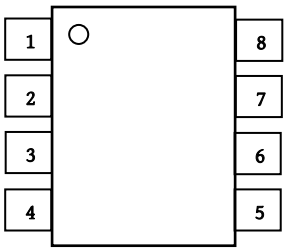
The input and output voltage can be extended beyond 450V.

The PA5910 uses a fixed off time and 2MHz switching frequency can be achieved.

The minimum off time can be set by an external capacitor and resistor. R_{OFF} and C_{OFF}

The LED current is programmable from 20mA to 2.0A and is set by an external resistor.

Pin Designation



Description	Symbol	Description	Symbol
1 : Ground	V_{SS}	8 : Power supply (2V-6.5V)	V_{DD}
2 : Chip Enable	EN	7 : Off time selection	T_{OFF}
3 : No connection	NC	6 : LED Current sensing	CS
4 : Voltage feedback	GND	5 : Driver	DRV

Absolute Maximum Ratings

Type	Symbol	Description	Value	Unit
Voltage	V_{MAX}	Maximum voltage on V_{DD} pins	8	V
	$V_{MIN-MAX}$	Voltage range on EN, CS and FB pins	-0.3-V_{DD}+0.3	V
Thermal	$T_{MIN-MAX}$	Operation temperature range	-20-85	°C
	$T_{STORAGE}$	Storage temperature range	-40-165	°C
ESD	V_{ESD}	ESD voltage for human body model	2000	V

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Block Diagram

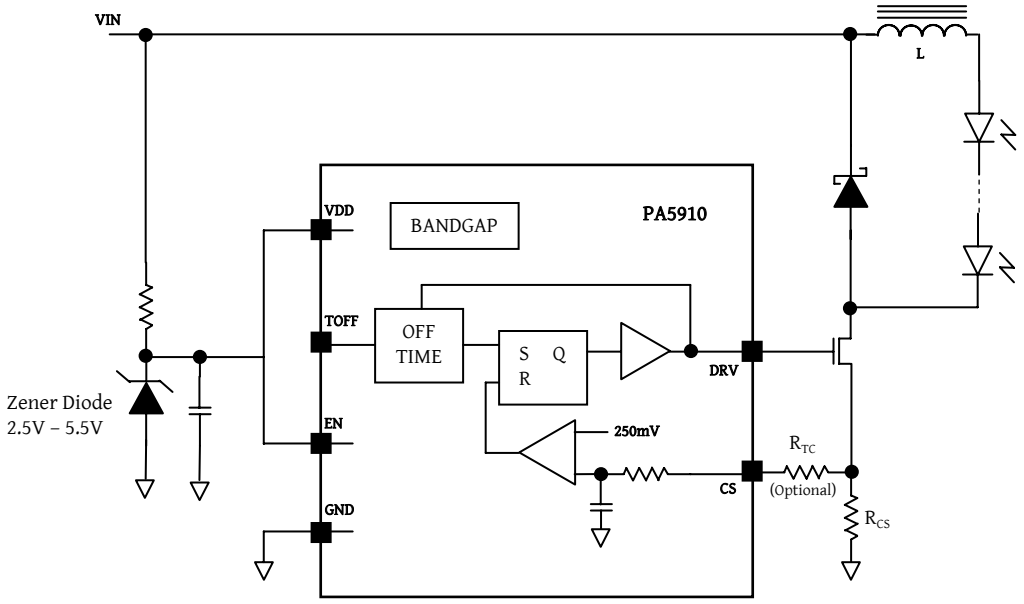

Fig.1

Electrical Characteristics.

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Power supply	V_{DD}		2.5		6.5	V
CS pin feedback voltage	V_{CS}		240	250	260	mV
Operation current	I_{DD}			0.5	1	mA
Off time (without R_{OFF} and C_{OFF})	T_{OFF}			620		nS
Standby current	I_{DDQ}				1	µA
EN pin high level voltage	V_{ENH}		2.0			V
EN pin low level voltage	V_{ENL}				0.8	V
DRV Rising Time	T_{RISE}	500pF cap on DRV pin			50	nS
DRV Falling Time	T_{FALL}	500pF cap on DRV pin			50	nS

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Typical Applications

Step-Up LED Driver without Schottky Diode

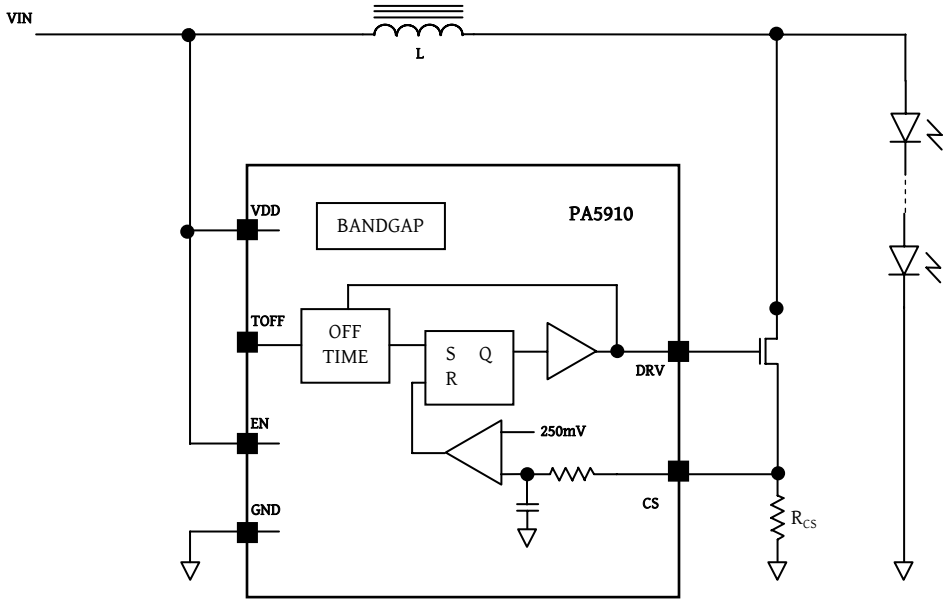

Fig.2

Step-Up LED Driver with Schottky Diode

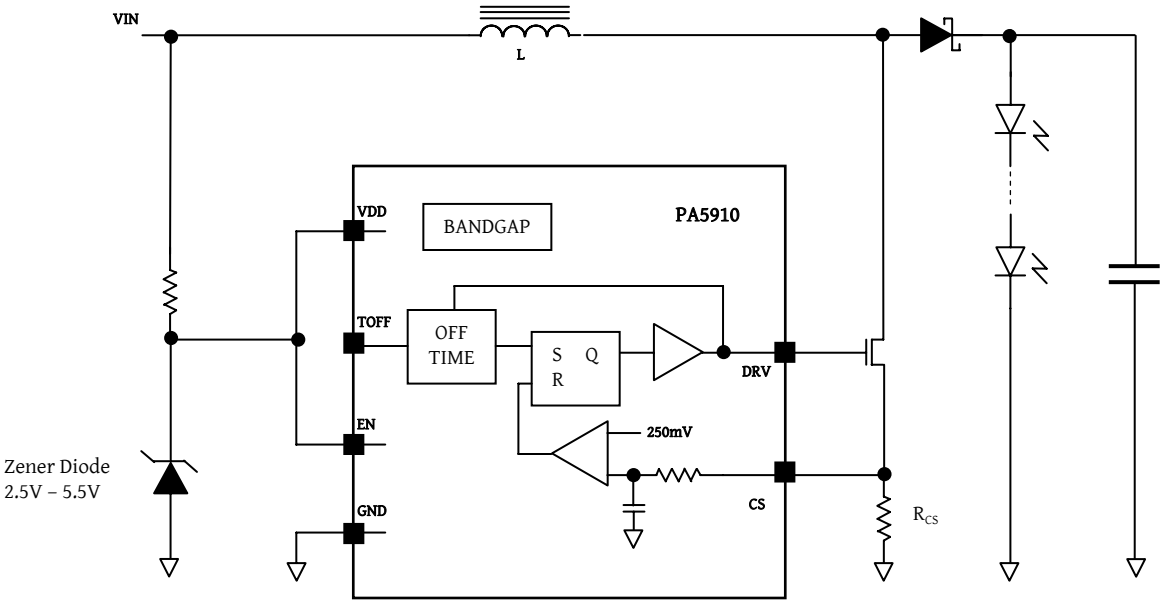

Fig.3

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220VACIN Drive 45series 6 parallel white LED's ILED = 120mA

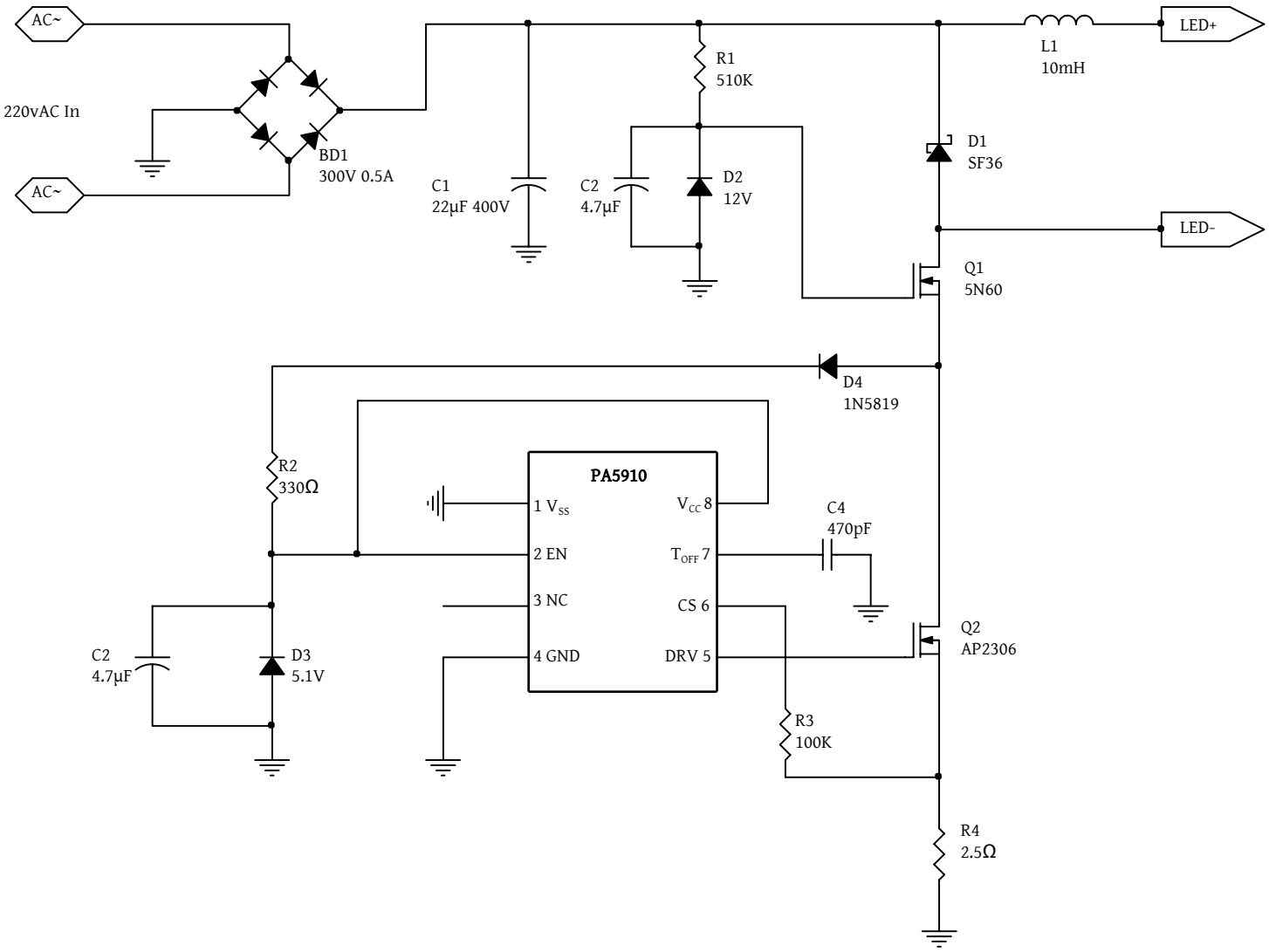

Fig.4

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220VACIN Drive 12 series connected 1WATT white LED's

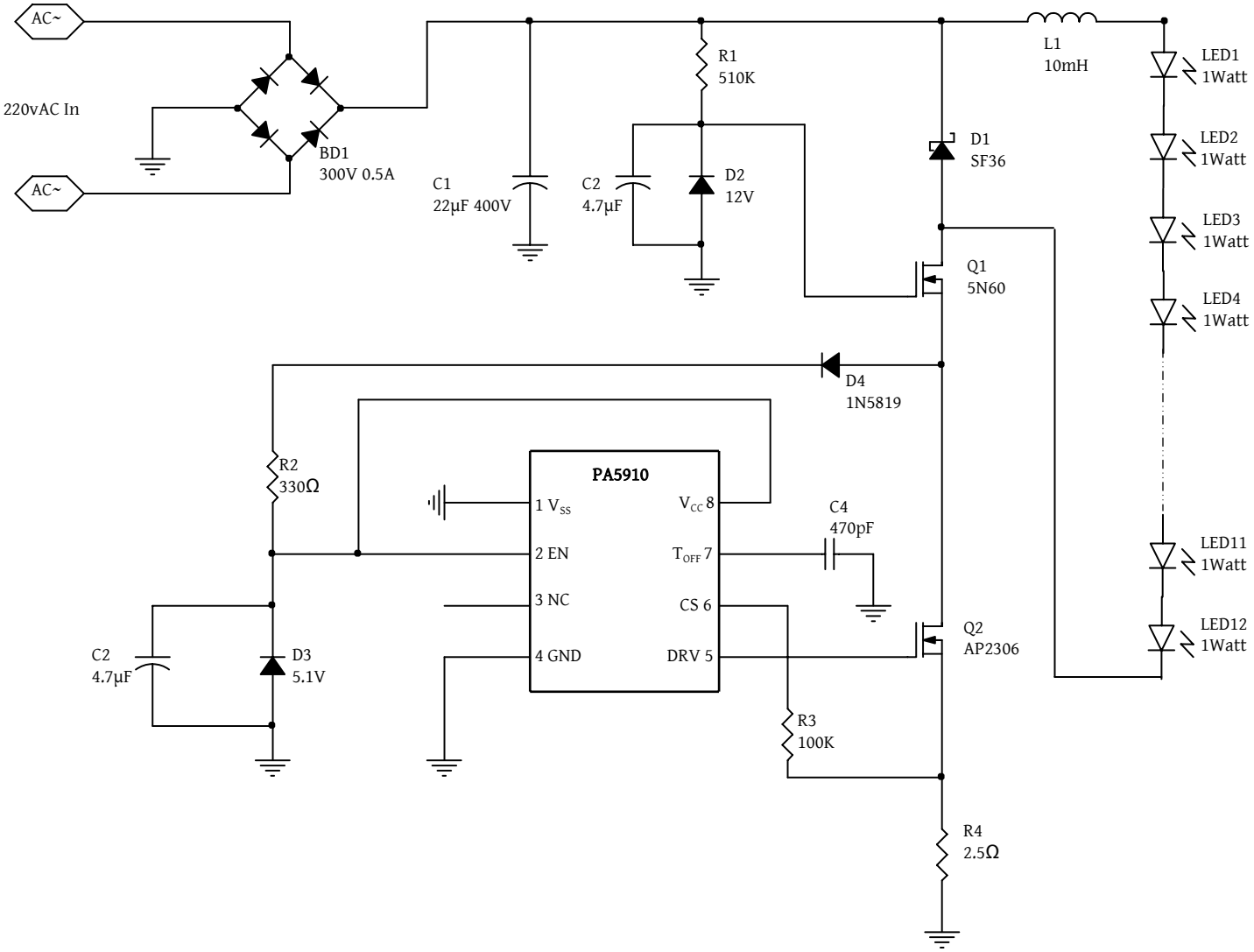

Fig.5.

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Detail Description

LED lighting applications

The PA5910 is suitable for 110 V/220VAC lighting applications as shown in Fig.5. AC 220V through bridge rectifier, will be about 310VDC. The V_{DD} supply of 5.1V is provided through a resistor and a Zener network.
When MOSFET control is high, the MOSFET conducts and the inductor L is charged until it reaches the peak current 250mV/R_{CS}.
When MOSFET control is low, the MOSFET is off, the inductor releases energy through Schottky diode circuit, thereby lighting the LED string.

Circuit parameters

LED average current

When the circuit in Fig. 1 operates in continuous mode, the LED average current is I_L
I_{LMAX} is the maximum current flowing through LED's as shown in Fig.6

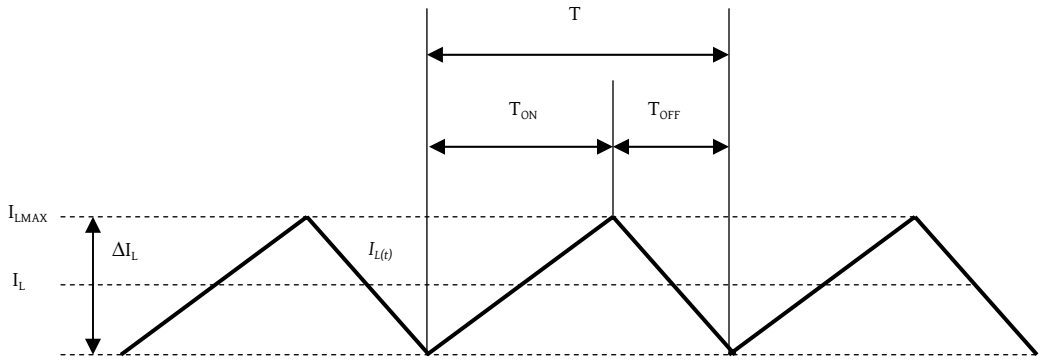

Fig.6.

Programming Operation Frequency

The switching duty ratio can be determined by D= V_{OUT} / V_{IN}
T_{ON} is on time of MOSFET
T_{OFF} is the off time of the MOSFET.
The T_{OFF} can be calculated by the formula

$$T_{OFF} = 0.51 \times \frac{100K\Omega \times R_{OFF}}{R_{OFF} + 100K\Omega} \times (C_{OFF} + 10pF)$$

If T_{OFF} pin is left open the typical value is

$$T_{OFF} = 0.51 \times 100K\Omega \times 10pF = 510nS$$

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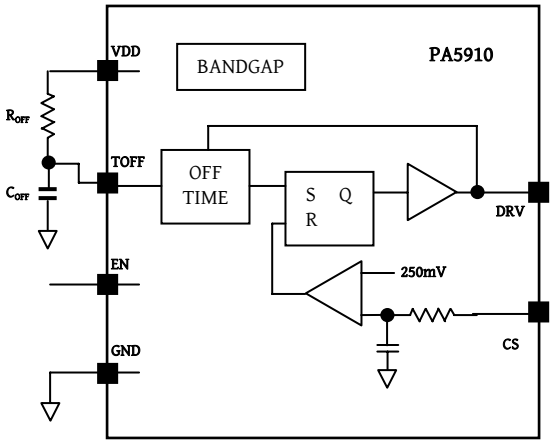

T_{OFF} can be reduced by adding R_{OFF} and increased by adding C_{OFF}

Operation Frequency can be calculated by the following formula $F = \frac{1}{T} = \frac{1-D}{T_{OFF}}$

When T_{OFF} is connected to a 1000pF capacitor, T_{OFF} =51µS, D=0.1 the resultant frequency will be 20 KHz.

Inductor Design.

Inductor selection criteria are to ensure that current flow through inductor is less than the maximum value specified.

Referring to the typical application in Fig.5 the value can be calculated from the desired peak-to-peak LED ripple current in the Inductor. Typically the ripple current is selected to be 30% of the nominal LED current. In this example the I_{LED} is 350mA

For example, when the string consists of 12 High Brightness LED's and each diode has a forward drop of 3.3V at nominal current, the total LED voltage V_{LEDS} is 39.6V

Knowing the rectified input voltage V_{IN} = 220V x 1.414 = 310V, the duty ratio can be determined as:

$$D = \frac{V_{LED}}{V_{IN}} = \frac{39.6}{310} = 0.128$$

Given the switching frequency (20KHz) the required on time of the MOSFET can be calculated by:

$$TON = \frac{D}{f_{OSC}} = 6.4\mu S$$

The required value of the inductor is given by:

$$L = (V_{IN} - V_{LED}) \times \frac{T_{ON}}{0.3 \times I_{LED}} = 16mH$$

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Setting LED Output

When the buck converter topology is used, the peak current sense (CS) is a good representation of the average current of the LED. There is a certain error associated with this CS method that needs to be accounted for. The error is introduced by the difference between the the peak and average current in the inductor:

$$R_{CS} = \frac{250mV}{I_L + 0.5\Delta I_L}$$

e.g. If the peak-to-peak ripple current in the inductor is 10.5mA, to maintain a 350mA LED current, the sense resistor should be 0.7Ω

LED Brightness.

There are two methods of adjusting the brightness of the LED's.

1. Changing the resistance of R_{CS} the lower the resistance the higher the brightness.
2. PWM dimming. The brightness of the LED's is controlled by varying the duty ratio of the output current. This is achieved by applying a PWM signal at the EN (pin 2).

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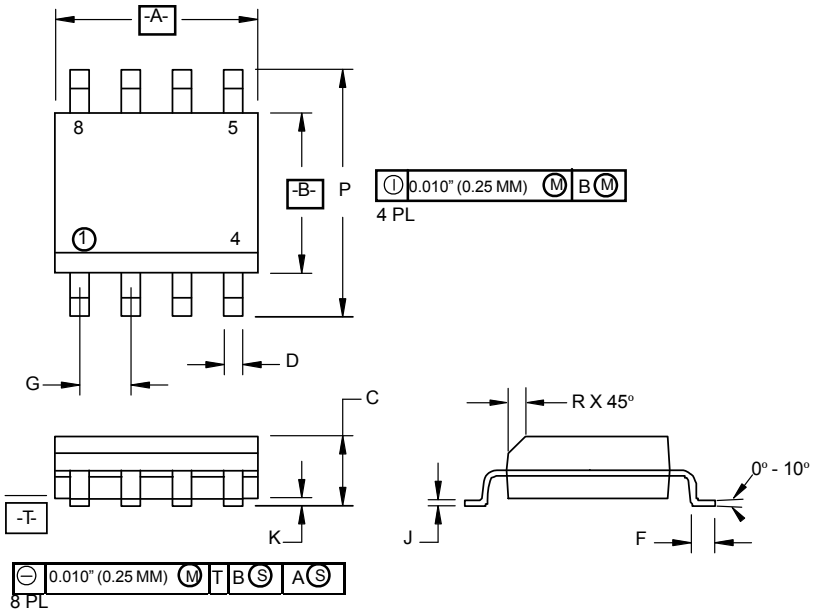
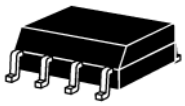
Package Outlines and Dimensions

PACKAGE OUTLINE



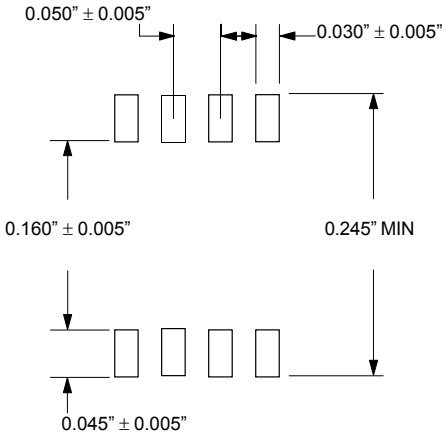
SO-8



PACKAGE DIMENSIONS

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.250	0.016	0.049
G	1.27 BSC	1.27 BSC	0.05 BSC	0.05 BSC
J	0.18	0.25	0.007	0.009
K	0.10	0.25	0.004	0.008
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

MOUNTING PAD



NOTES

1. - T - = Seating Plane and Datum Surface.
2. Dimensions "A" and "B" are Datum.
3. Dimensions "A" and "B" do not include mold protrusion.
4. Maximum mold protrusion is 0.015" (0.380 mm) per side.
5. Dimensioning and tolerances per ANSI Y14.5M, 1982.
6. Dimensions are exclusive of mold flash and metal burrs.

TAPE & REEL / BULK ORDERING NOMENCLATURE

1. Surface mount product is taped and reeled in accordance with EIA-481.
2. Suffix-T7 = 7 Inch Reel - 1,000 pieces per 12mm tape.
3. Suffix-T13 = 13 Inch Reel - 2,500 pieces per 12mm tape.
4. No Suffix = Product Shipped in Tubes of 98 pcs per Tube.

Life Support Policy

PROTEK ANALOG'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF PROTEK DEVICES.

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