# LD1610

High Power LED Driver

Ver. 1.2 / DEC. 2011





LDT Inc. Mplaza 3F, 538, Dujeong-dong, Seobuk-gu, Cheonan, Chungnam, 331-958, Korea
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## CONTENTS





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## 1. GENERAL DESCRIPTION

The LD1610 is a continuous mode inductive step-down converter, designed for driving single or multiple series connected High Power LEDs with a minimum number of external components. It operates from an input voltage range of 7V to 40V and provides an externally adjustable output current up to 1.0A depending upon input voltage and external components. The LD1610 has internal switching transistor, regulator and output current sensing circuit, which uses an external resistor to set the nominal average output current. The LED dimming can be controlled via pulse width modulation (PWM) through DIM pin. Additionally, to ensure the system reliability, the LD1610 has internal thermal shutdown circuit.

## 2. FEATURES

- 7V ~ 40V input range generates maximum 1.0A output constant current.
- Regulation voltage is 4.5V.
- Over temperature thermal protection
- Over voltage circuit protection
- External dimming control PIN
- High efficiency output design
- Power efficiency up to 95%
- Package : 8-pin Exposed SOP

## 3. APPLICATIONS

- MR16 lighting
- DC/DC LED driver
- Automotive lighting
- Offline LED lamps



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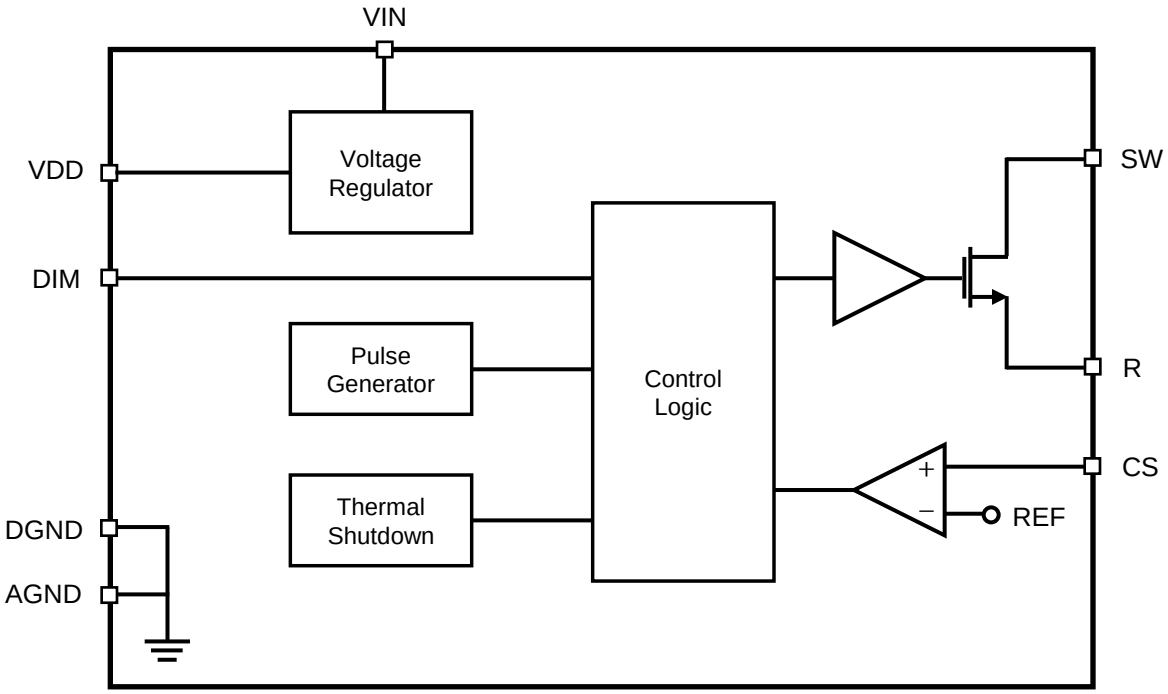
## 4. BLOCK DIAGRAM




## 5. PIN DISCRIPTION

| PIN NAME | DESCRIPTION | PIN No. |
|---|---|---|
| VIN | Input voltage (7V ~ 40V) | 1 |
| VDD | Internal regulator output. Connects decoupling capacitor to this pin with 1.0uF capacitor. | 2 |
| AGND | Analog ground | 3 |
| DIM | Dimming control terminal. Connect to VDD if not used. | 4 |
| DGND | Digital ground | 5 |
| CS | Current sense connection | 6 |
| R | Output current level setting resistor. Connects a resistor from this pin to ground for output current setting. | 7 |
| SW | Switch output terminal | 8 |



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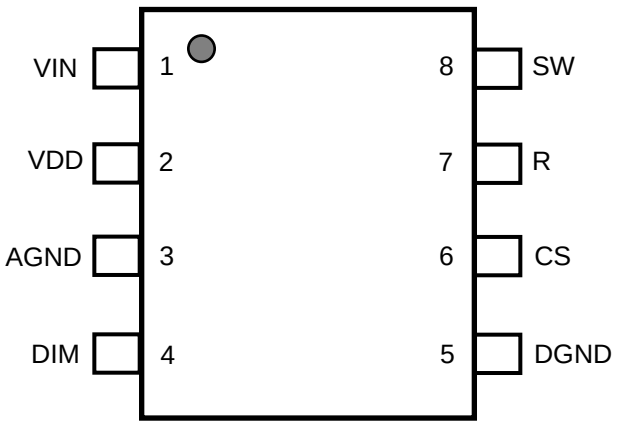
## 6. PIN CONFIGURATION



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## 7. ABSOLUTE MAXIMUM RATINGS

(Unless otherwise stated, GND=0V, $T_A$=25℃)

| PARAMETERS | SYMBOL | RATING | UNIT |
|---|---|---|---|
| VIN Supply Voltage | $V_{IN}$ | 46VDC | V |
| SW Voltage | $V_{SW}$ | 46VDC | V |
| Power Dissipation | $P_D$ | 2.3[1] | W |
| Operating Ambient Temperature | $T_A$ | -40 to 85 | ℃ |
| Operating Junction Temperature | $T_J$ | -40 to 150 | ℃ |

## 8. ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, $V_{IN}$=12V, GND=0V, $T_A$=25℃)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| DC Input Voltage | $V_{IN}$ | DC to $V_{IN}$ | 7 | | 40 | V |
| SW Frequency | $F_{SW}$ | | | | 500[2] | kHz |
| SW On-Resistance | $R_{ON}$ | $I_{LED}$ = 500mA | | | 0.5 | Ω |
| VDD Output Voltage | $V_{DD}$ | | | 4.5 | | V |
| LED Output Current | $I_{LED}$ | | | 350 | 1000 | mA |
| Quiescent Current | | | | | 1.5 | mA |
| Thermal Shutdown | | | | 140 | | ℃ |

Note
[1] :Based on JEDEC-51.
[2] :Frequency depends on input voltage, inductance and output current.



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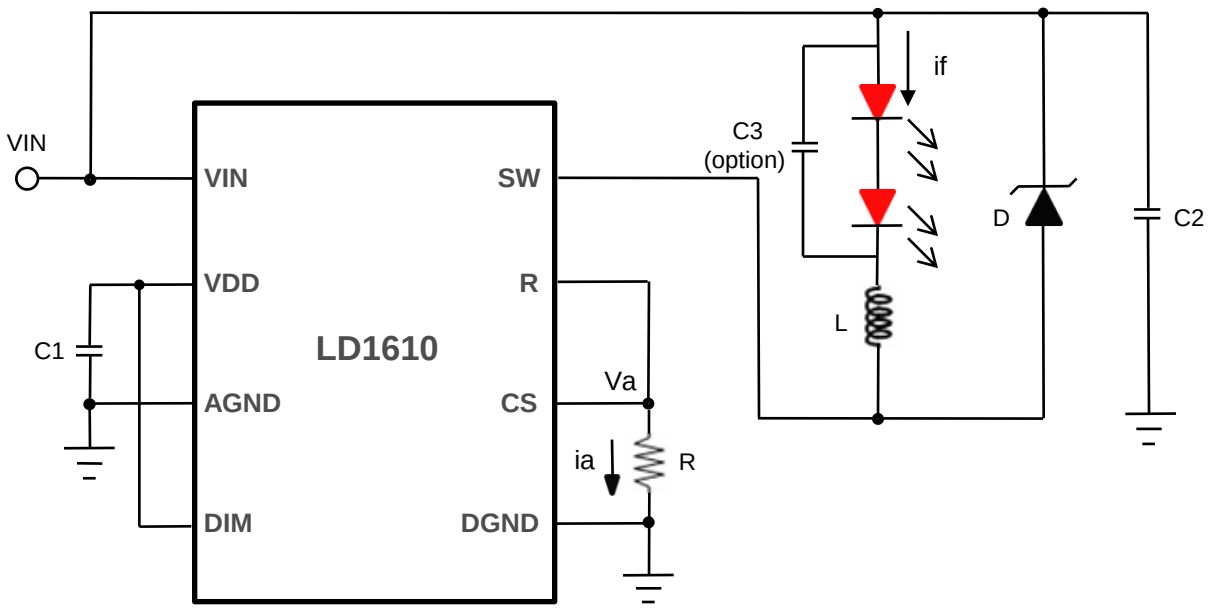
## 9. CIRCUIT DESCRIPTION

During the charging operation, the turning on of the internal power NDMOS stores the input energy in an inductor. When the NDMOS is turned off during the OFF time, the stored energy will deliver to the output through the fly-back diode D, producing the ILED current through the LEDs.
Since LD1610 is designed with a high efficient constant off time controlling technique, the OFF time is fixed at 1.5μs (typical), it is important to make sure the supply voltage is less than 2 times the forward voltage drop across the LEDs.

## 10. APPLICATION INFORMATION

### 10.1 Typical Application Circuit




The LD1610 is a buck mode inductive DC-DC converter, with an internal switch, designed for driving single or multiple LEDs in series up to 1.0A output current. VIN input voltage is 7~40V DC voltage. The constant current operation is Pulse Frequency Modulation (PFM) method.
The off time of switching is fixed at 1.5us. So, the on time of switching depends on DIM pin signal, CS pin voltage and thermal voltage.



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## 10.2 Setting the Output Current with Resistor (R)

If CS pin voltage is below 0.21V then the switch is on. CS pin voltage is over 0.21V then the switch is off. So, typical peak to peak ripple current in the inductor is 15% of LED current (if).

**if = 350mA setting**

ia = if + Δif/2 = 350mA + 350mA x 0.15/2
= 376.25mA
→ Δif ≈ 15%x if
Va = R x ia
→ R = Va / ia = 0.21V / 376.25mA **≈ 558mΩ**

**if = 500mA setting**

ia = if + Δif/2 = 500mA + 500mA x 0.15/2
= 538mA
→ Δif ≈ 15%x if
Va = R x ia
→ R = Va / ia = 0.21V / 538mA **≈ 390mΩ**

**if = 1000mA setting**

ia = if + Δif/2 = 1000mA + 1000mA x 0.15/2
= 1075mA
→ Δif ≈ 15%x if
Va = R x ia
→ R = Va / ia = 0.21V / 1075mA **≈ 195mΩ**

## 10.3 Inductor Selection

Higher values of inductance are recommended at higher supply voltage in order to minimize errors due to switching delays, which results in increased ripple and low efficiency.
High value of inductance also results in a smaller change in output current (if) over the supply voltage range.

L = VLED x toff / Δif

VLED = Vf x N
N = # of LEDs in series
Toff = 1.5us
Δif = 15% x if

If N = 3, if = 350mA, Vf = 3V

**L** = 3V x 3 x 1.5us / ( 0.15 x 350mA ) **≈ 257uH**
In case**,** Δif = 39%x if , **L** = 3V x 3 x 1.5us / ( 0.39 x 350mA ) **≈ 100uH**
In case, Δif = 82%x if , **L** = 3V x 3 x 1.5us / ( 0.8 x 350mA ) **≈ 47uH**



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## 10.4 Layout Considerations

For high frequency and high current switching power supplies, layout is an important design step.
To reduce switching losses, the switch rise and fall times are made as short as possible.
Minimize the length and area of all traces connected to the switch and always use a ground plane under the switching regulator to inter-plane coupling.
The loop including LEDs, the PFM switch and schottky diode contains high current rising and falling and should be kept as short as possible.
The input capacitor needs not only to be close to the VIN pin, but also to the GND pin in order to reduce the supply ripple.



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## 10.5 Components Selection

### Capacitor Selection

The small size of ceramic capacitors makes them ideal for LD1610 applications. X5R and X7R types retain their capacitance over wider voltage and temperature ranges and are recommended over Y5V or Z5U types. A 4.7uF input capacitor(C2) and two 1uF capacitors(C1, C3) are sufficient for the most DC operations. The rated voltage of C2 and C3 is recommended about 1.5 times than VIN, and C1 is 1.5 times than VDD.

Table 1. Recommended Capacitor Manufacturers

| Manufacturer | Site |
|---|---|
| AVX | www.avxcorp.com |
| Kemet | www.kemet.com |
| Murata | www.murata.com |
| Taiyo Yuden | www.t-yuden.com |

### Inductor Selection

Table 2. Recommended Inductor Manufacturers

| Part Number | DCR [Ω] | Current Rating [A] | Inductance [uH] | Manufacturer |
|---|---|---|---|---|
| B1280 Series | 0.01 ~ 0.47 | 0.75 ~ 8.1 | 2.2~330 | sanha |
| SDR0805 Series | 0.11 ~ 1.96 | 0.5 ~ 2.3 | 22 ~ 470 | bourns |
| SDR1006 Series | 0.10 ~ 1.48 | 0.8 ~ 3.5 | 22 ~ 470 | bourns |
| SRU1048 Series | 0.04 ~ 0.49 | 0.52 ~ 2 | 22 ~ 330 | bourns |
| SK75-19074801C | 0.96 | 0.8 | 220 | Sankyo shoji |
| CD104-MC | 0.55 | 0.53 | 220 | Sumida |
| MSS1048-KL | 0.5~1 | 0.43~0.95 | 220~470 | CoilCraft |
| NR10050T211M | 0.45 | 0.8 | 220 | Taiyo yuden |
| 74456222 | 0.78 | 0.9 | 220 | SMD |



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## Diode Selection

The diode D is used in the buck converter to help the inductor release the energy during the NDMOS off-time to supply the ILED to the LED string. The reverse breakdown voltage of the diode should be greater than two times of VIN and the average current through the diode should be 2 x ILED or greater.

Table 3. Recommended Diode Manufacturers

| Part Number | Forward Current [A] | Voltage Drop [V] | Reverse Breakdown Voltage [V] | Manufacturer |
|---|---|---|---|---|
| STPS0540Z | 2.0 | 0.5 at 2.0A | 40 | STMicroelectronics |
| CD214A-B360 | 3.0 | 0.5 at 3.0A | 60 | Bourns |
| CD214A-B180 | 1.0 | 0.79 at 1.0A | 80 | Bourns |
| CD214A-B1100 | 1.0 | 0.79 at 1.0A | 100 | STMicroelectronics |
| STPS2H100 | 2.0 | 0.65 at 1.0A | 100 | STMicroelectronics |
| SR series | 2.0 | 0.5~0.85 at 2.0A | 20 ~ 90 | Won-Top |

## LED Selection

For demonstration and bench testing of LD1610 evaluation boards before shipment, the high-power W42182 LEDs are being used.



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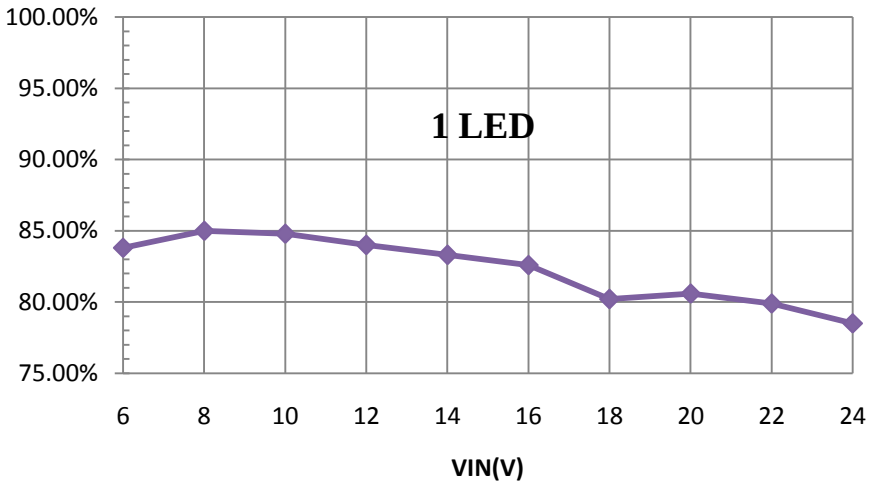
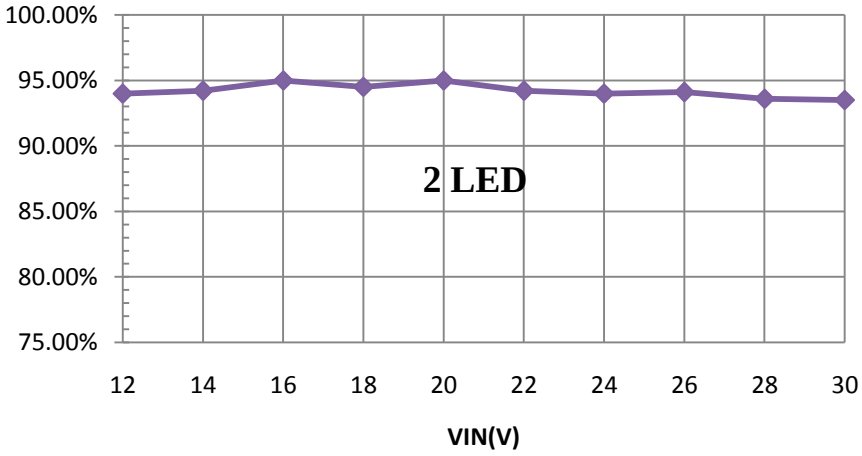
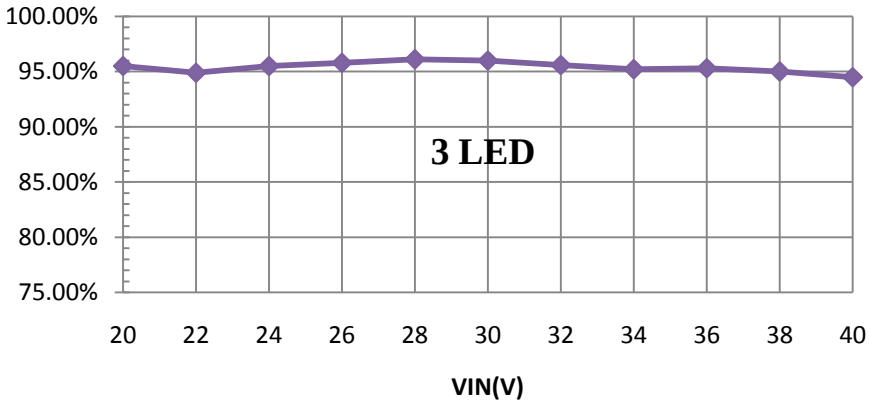
## 10.6 Efficiency vs. Input Voltage

$T_A$ = 25℃, $V_{FORWARD-LED}$ = 3.25V @ 350mA,



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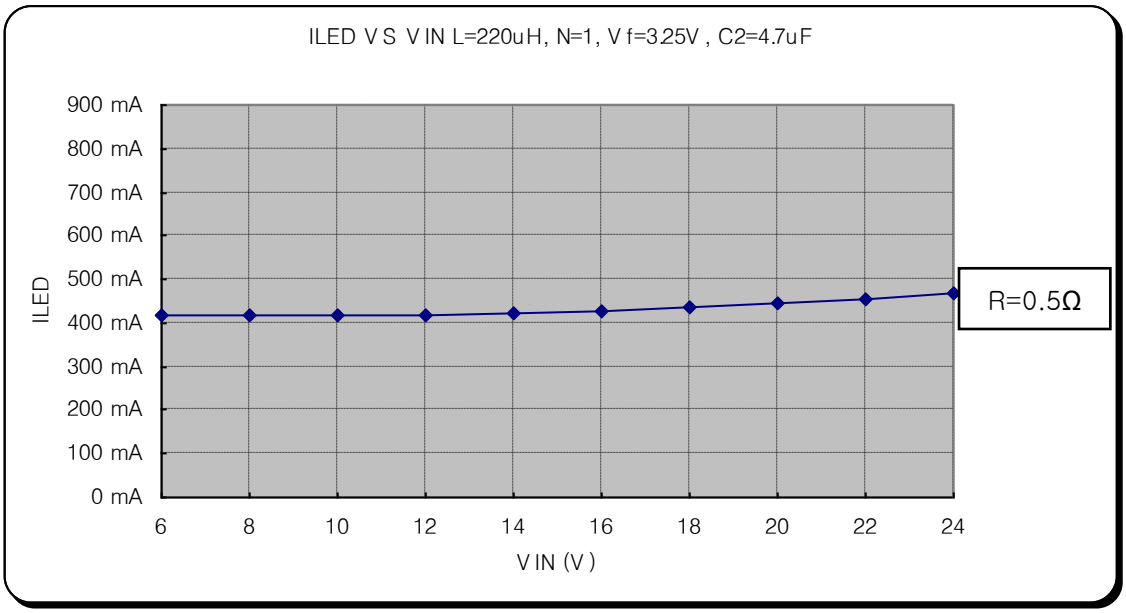
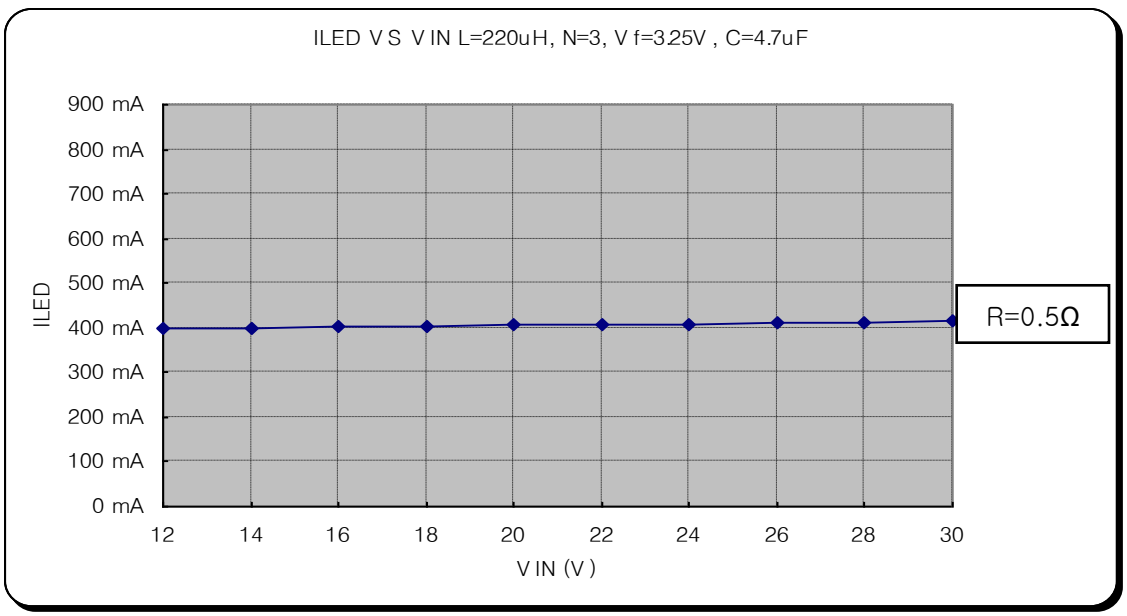
## 10.7 Typical Performance Characteristics

$T_A$ = 25℃, $V_{FORWARD-LED}$ = 3.25V @ 350mA, N = # of LEDs in series, unless otherwise noted



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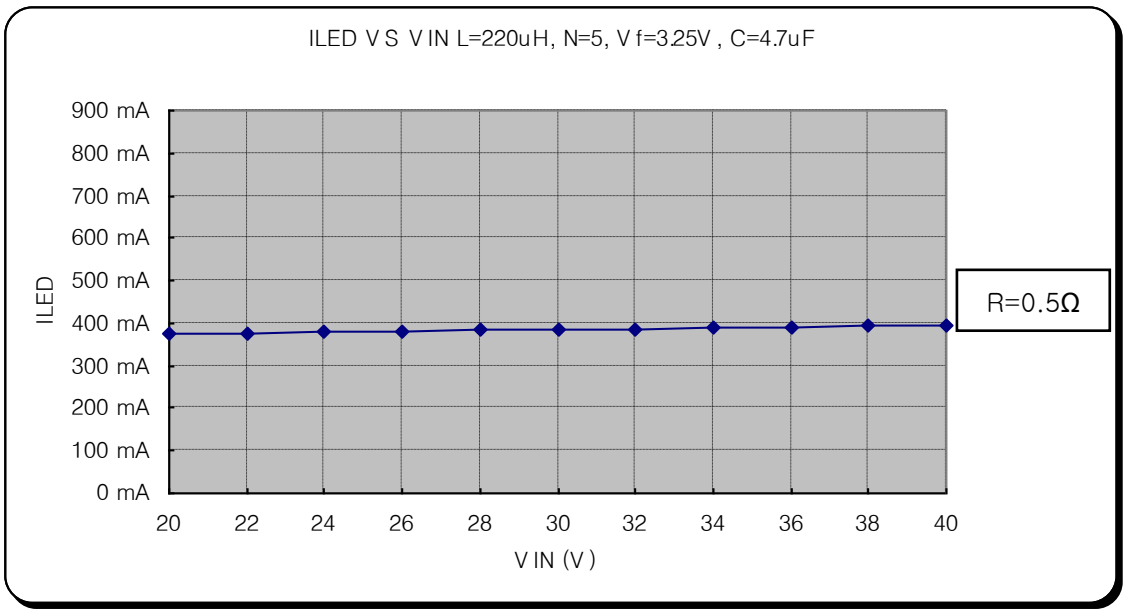




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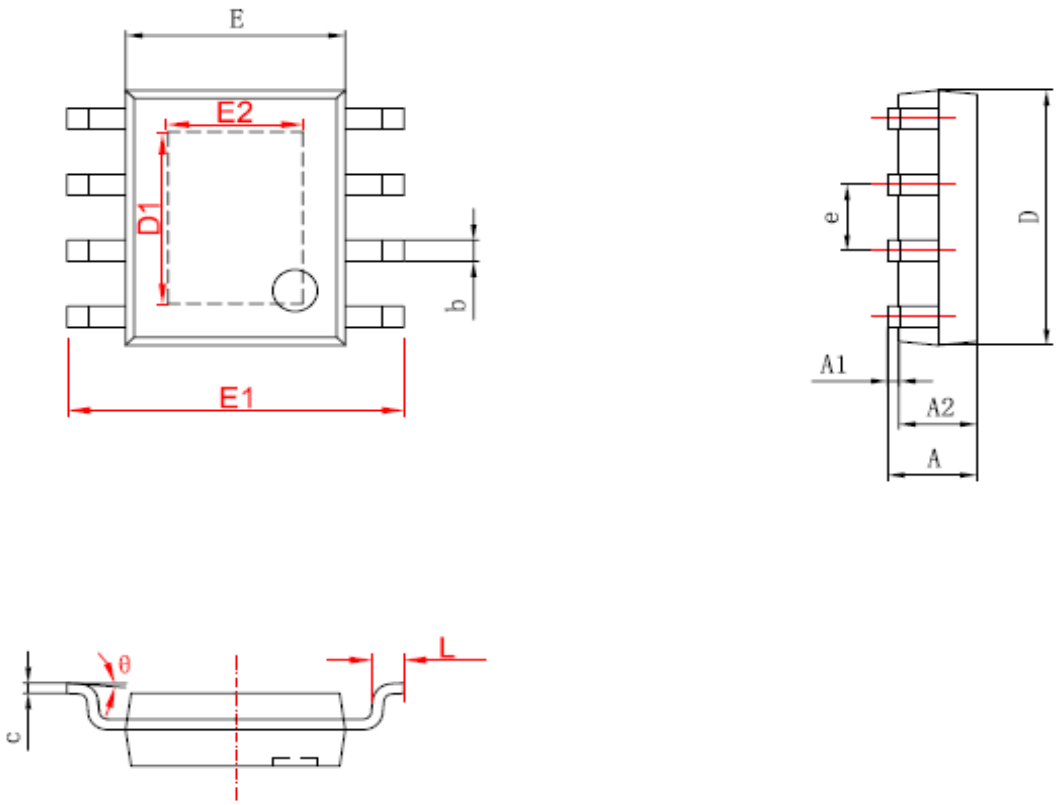
## 11. PACKAGE INFORMATION (ESOP)

SOP8-PP(EXP PAD) PACKAGE OUTLINE DIMENSIONS




| 字符 | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.050 | 0.150 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.006 | 0.010 |
| D | 4.700 | 5.100 | 0.185 | 0.200 |
| D1 | 3.202 | 3.402 | 0.126 | 0.134 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.200 | 0.228 | 0.244 |
| E2 | 2.313 | 2.513 | 0.091 | 0.099 |
| e | 1.270 (BSC) | | 0.050 (BSC) | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

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