

## 28V, 2A Buck Constant Current Switching Regulator for White LED



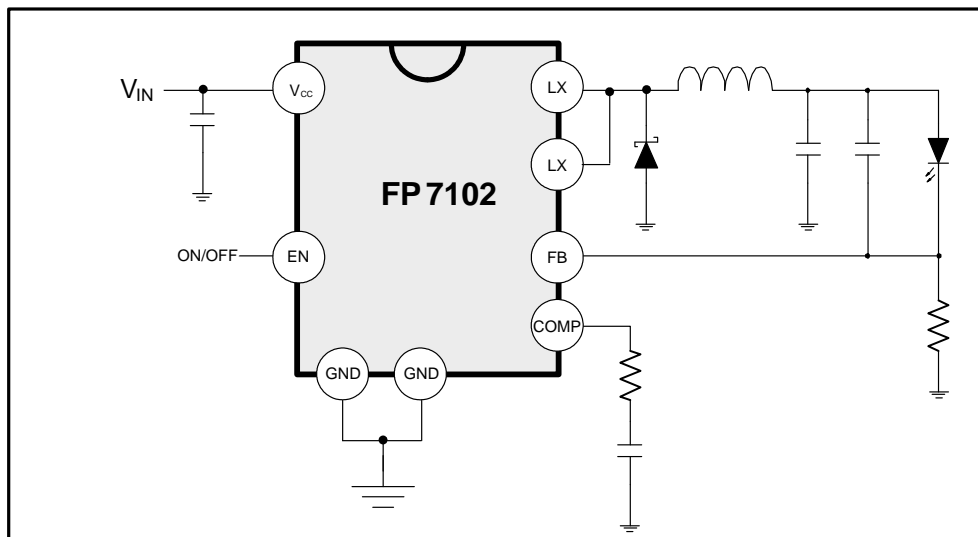
### General Description

The FP7102 is a PWM control buck converter designed to provide a simple, high efficiency solution for driving high power LEDs. With a 0.25V reference voltage feedback control to minimize power dissipation, an external resistor sets the current as needed for driving various types of LEDs. The FP7102 includes a high current P-MOSFET to realize high efficiency and excellent transient characteristics. The PWM control circuit is able to change the duty ratio linearly from 0 up to 100%. Other features include user accessible EN pin for enabling, thermal shutdown, cycle-by-cycle current limit and over current protection.

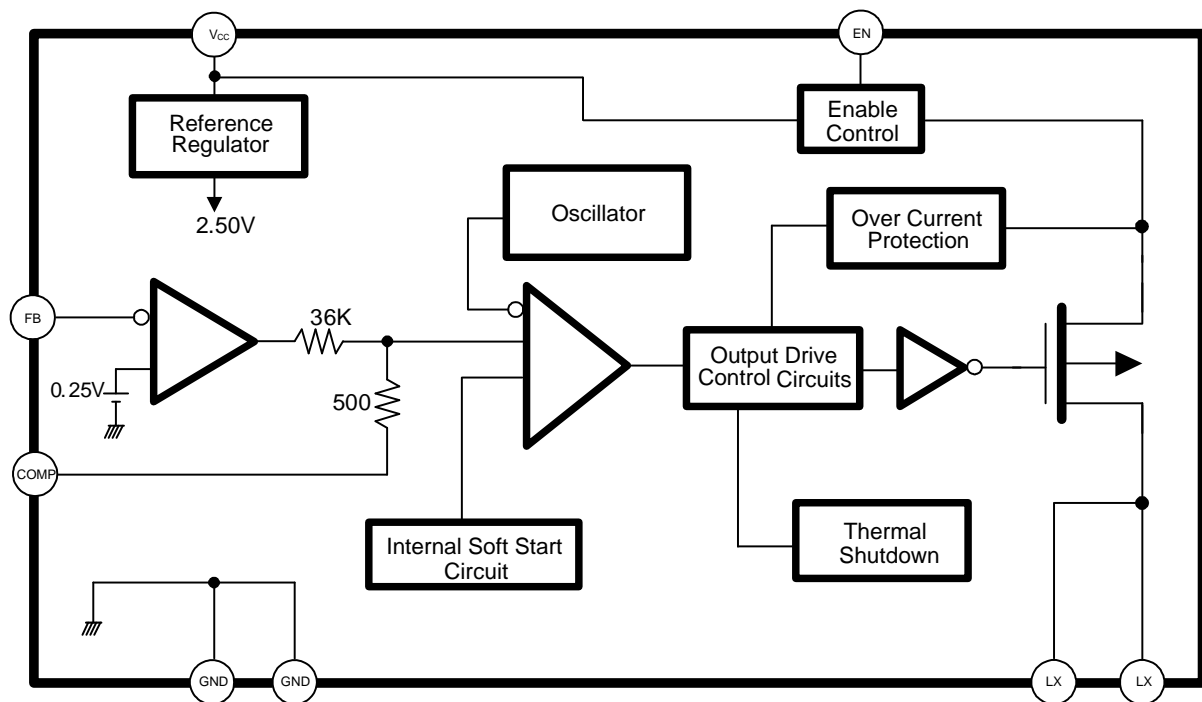
### Features

- Wide Supply Voltage Operating Range: 3.6 to 28V
- Built-in P-MOSFET for 2A Loading Capability
- Precision Feedback Reference Voltage: 0.25V
- Low Current Consumption: 4mA
- Internal Fixed Oscillator Frequency: 320KHz (Typ.)
- Internal Soft-Start Function (SS)
- Over Current Protection
- Package: SOP-8L & SOP-8L(EP)

### Typical Application Circuit



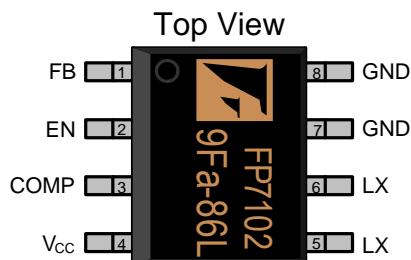
## Function Block Diagram



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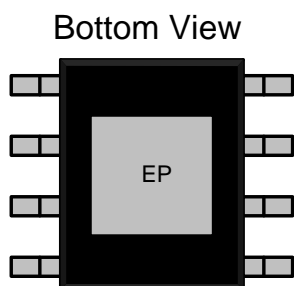
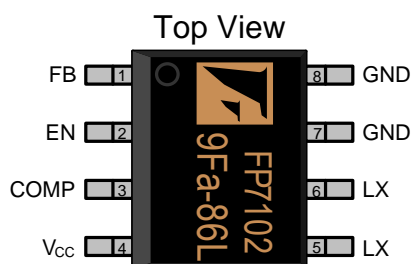
## Pin Descriptions

### SOP- 8L



| Name            | No. | I / O | Description                         |
|-----------------|-----|-------|-------------------------------------|
| FB              | 1   | I     | Error Amplifier Inverting Input     |
| EN              | 2   | I     | Enable Control                      |
| COMP            | 3   | O     | Error Amplifier Compensation Output |
| V <sub>CC</sub> | 4   | P     | IC Power Supply (PMOS Source)       |
| LX              | 5   | P     | PMOS High Current Output            |
| LX              | 6   | P     | PMOS High Current Output            |
| GND             | 7   | O     | IC Ground                           |
| GND             | 8   | O     | IC Ground                           |

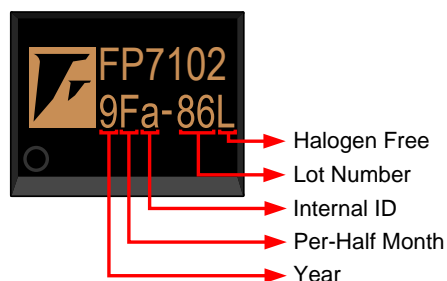
### SOP- 8L (EP)



| Name            | No. | I / O | Description                         |
|-----------------|-----|-------|-------------------------------------|
| FB              | 1   | I     | Error Amplifier Inverting Input     |
| EN              | 2   | I     | Enable Control                      |
| COMP            | 3   | O     | Error Amplifier Compensation Output |
| V <sub>CC</sub> | 4   | P     | IC Power Supply (PMOS Source)       |
| LX              | 5   | P     | PMOS High Current Output            |
| LX              | 6   | P     | PMOS High Current Output            |
| GND             | 7   | O     | IC Ground                           |
| GND             | 8   | O     | IC Ground                           |
| EP              | 9   | P     | Exposed PAD. Must connect to LX     |

## Marking Information

### SOP- 8L & SOP-8L (EP)



**Halogen Free:** Halogen free product indicator

**Lot Number:** Wafer lot number's last two digits

For Example      Lot : 123456 → XXx-56L

**Internal ID:** Internal Identification Code

**Per-Half Month:** Production period indicator in half month time unit

For Example : A → First Half Month of January  
B → Second Half Month of January  
C → First Half Month of February  
D → Second Half Month of February

**Year:** Production year's last digit

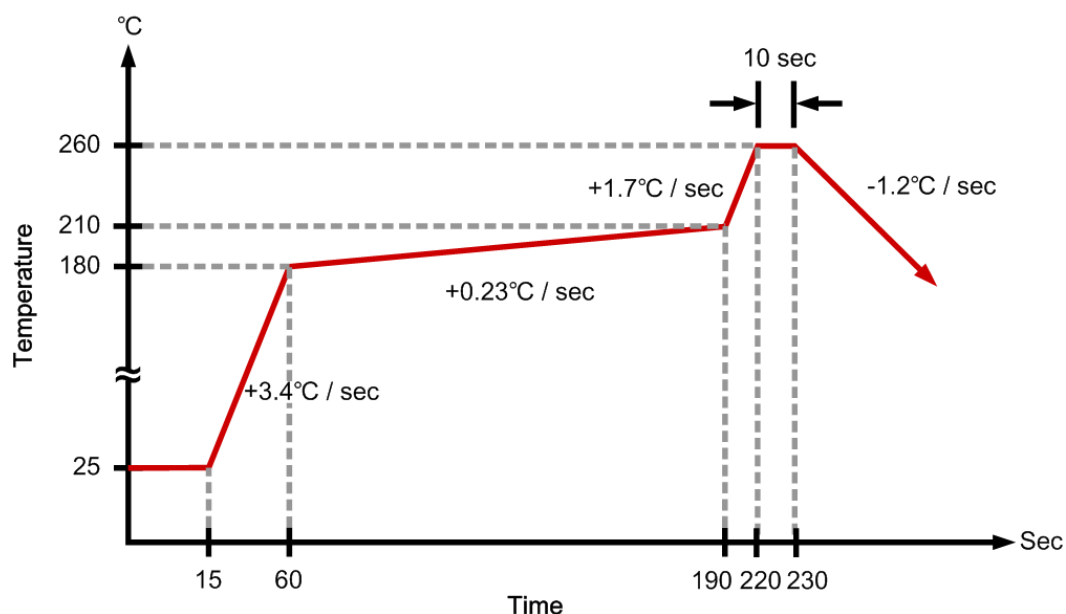
## Ordering Information

| Part Number  | Ambient Operating Temperature | Junction Operating Temperature | Package     | MOQ    | Description |
|--------------|-------------------------------|--------------------------------|-------------|--------|-------------|
| FP7102DR-LF  | -25°C ~ +85°C                 | -25°C ~ +125°C                 | SOP-8L      | 2500EA | Tape & Reel |
| FP7102DR-LF. | -25°C ~ +85°C                 | -25°C ~ +125°C                 | SOP-8L      | 2500EA | Tape & Reel |
| FP7102XR-LF  | -25°C ~ +85°C                 | -25°C ~ +125°C                 | SOP-8L (EP) | 2500EA | Tape & Reel |
| FP7102XR-LF. | -25°C ~ +85°C                 | -25°C ~ +125°C                 | SOP-8L (EP) | 2500EA | Tape & Reel |

## Absolute Maximum Ratings

| Parameter                              | Symbol        | Conditions                                | Min. | Typ. | Max. | Unit                        |
|--|---------------|---|------|------|------|-----------------------------|
| Power Supply Voltage                   | $V_{IN}$      |   |      |      | 28   | V                           |
| Output Source Current                  |               |   |      |      | 2    | A                           |
| Error Amplifier Inverting Input        |               |   | -0.3 |      | +1.2 | V                           |
| Allowable Power Dissipation            | $P_D$         | SOP-8L, $T_A \leq +25^\circ\text{C}$      |      |      | 650  | mW                          |
|  |               | SOP-8L (EP), $T_A \leq +25^\circ\text{C}$ |      |      | 1500 | mW                          |
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | SOP-8L                                    |      |      | +110 | $^\circ\text{C} / \text{W}$ |
|  |               | SOP-8L (EP)                               |      |      | +60  | $^\circ\text{C} / \text{W}$ |
| Thermal Resistance Junction to Case    | $\theta_{JC}$ | SOP-8L                                    |      |      | +55  | $^\circ\text{C} / \text{W}$ |
|  |               | SOP-8L (EP)                               |      |      | +10  | $^\circ\text{C} / \text{W}$ |
| ESD Susceptibility                     |               | HBM (Human Body Mode)                     |      | 2    |      | KV                          |
|  |               | MM (Machine Mode)                         |      | 200  |      | V                           |
| Storage Temperature                    |               |   | -55  |      | +150 | $^\circ\text{C}$            |
| Lead Temperature (soldering, 10 sec)   |               |   |      |      | +260 | $^\circ\text{C}$            |

## IR Re-flow Soldering Curve



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## Recommended Operating Conditions

| Parameter                      | Symbol   | Conditions | Min. | Typ. | Max. | Unit |
|--------------------------------|----------|------------|------|------|------|------|
| Supply Voltage                 | $V_{IN}$ |            | 3.6  |      | 28   | V    |
| Ambient Operating Temperature  |          |            | -25  |      | +85  | °C   |
| Junction Operating Temperature |          |            | -25  |      | +125 | °C   |

## DC Electrical Characteristics ( $V_{CC}=6V$ , $T_A=25^{\circ}C$ , unless otherwise noted)

| Parameter                              | Symbol                               | Conditions                                 | Min.  | Typ. | Max.  | Unit  |
|--|--------------------------------------|--|-------|------|-------|-------|
| Reference                              |                                      |  |       |      |       |       |
| Output Voltage                         | V <sub>REF</sub> *1                  | FP7102DR-LF                                | 0.246 |      | 0.252 | V     |
|  |                                      | FP7102DR-LF.                               | 0.240 |      | 0.246 | V     |
|  |                                      | FP7102XR-LF                                | 0.246 |      | 0.252 | V     |
|  |                                      | FP7102XR-LF.                               | 0.240 |      | 0.246 | V     |
| Input Regulation                       | △V <sub>REF</sub>                    | V <sub>CC</sub> = 3.6 V to 25 V            |       | 2    | 12.5  | mV    |
| Output Voltage Change with Temperature | △V <sub>REF</sub> / V <sub>REF</sub> | T <sub>A</sub> = -25°C to 25°C             |       | 1    | 2     | %     |
|  |                                      | T <sub>A</sub> = 25°C to 85°C              |       | 1    | 2     |       |
| Oscillator Section                     |                                      |  |       |      |       |       |
| Oscillation Frequency                  | f                                    |  |       | 320  |       | KHz   |
| Frequency Change with Voltage          | Δf / ΔV                              | V <sub>CC</sub> =3.6V to 25V               |       | 5    |       | %     |
| Frequency Change with Temperature      | Δf / ΔT                              | T <sub>A</sub> = -25°C to +85°C            |       | 5    |       | %     |
| Error Amplifier Section                |                                      |  |       |      |       |       |
| Input Bias Current                     | I <sub>B</sub>                       |  | -1.0  | -0.2 | 1.0   | μA    |
| Voltage Gain                           | A <sub>v</sub>                       |  |       | 100  |       | V / V |
| Frequency Bandwidth                    | BW                                   | A <sub>v</sub> =0 dB                       |       | 6    |       | MHz   |
| Output Voltage Swing Positive          | V <sub>POS</sub>                     |  | 1.7   | 2    |       | V     |
| Output Voltage Swing Negative          | V <sub>NEG</sub>                     |  |       | 0.1  | 0.2   | V     |
| Output Source Current                  | I <sub>SOURCE</sub>                  | V <sub>comp</sub> =200mV                   | -15   | -30  |       | μA    |
| Output Sink Current                    | I <sub>SINK</sub>                    | V <sub>comp</sub> =200mV                   | 15    | 30   |       | μA    |
| Idle Period Adjustment Section         |                                      |  |       |      |       |       |
| Maximum Duty Cycle                     | T <sub>DUTY</sub>                    | V <sub>FB</sub> =0.2V                      |       | 100  |       | %     |
| Output Section                         |                                      |  |       |      |       |       |
| PMOS D-S Voltage                       | V <sub>DSS</sub>                     | V <sub>COMP</sub> =0.1V                    |       | -20  |       | V     |
| PMOS Source Current                    | I <sub>D</sub>                       |  |       | -2   |       | A     |
| PMOS On Resistance                     | R <sub>DS (ON)</sub>                 | V <sub>CC</sub> =5.0V, V <sub>FB</sub> =0V |       | 70   | 150   | mΩ    |
|  |                                      | V <sub>CC</sub> =10V, V <sub>FB</sub> =0V  |       | 42   | 90    |       |
| Output Leakage Current                 | I <sub>L</sub>                       |  |       | 5    |       | μA    |
| Thermal Shutdown Section               |                                      |  |       |      |       |       |
| Thermal shutdown Temperature           |                                      |  |       | 150  |       | °C    |
| Over Current Protection Section        |                                      |  |       |      |       |       |
| PMOS OCP Current                       | I <sub>OCP</sub>                     |  |       | 3    |       | A     |

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| Parameter                    | Symbol         | Conditions  | Min. | Typ. | Max. | Unit    |
|------------------------------|----------------|-------------|------|------|------|---------|
| <b>Total Device Section</b>  |                |             |      |      |      |         |
| EN Input Current             | $I_{EN}$       | EN pin Open |      |      | 20   | $\mu A$ |
| Upper Threshold Voltage (EN) | $V_{UPPER}$    |             |      | 1.12 |      | V       |
| Lower Threshold Voltage (EN) | $V_{LOW}$      |             |      | 0.87 |      | V       |
| Hysteresis                   | $V_{HYS}$      |             | 210  | 250  |      | mV      |
| Average Supply Current       | $I_{AVE}$      |             |      | 4    | 6    | mA      |
| $V_{CC}$ Shutdown            | $I_{SHUTDOWN}$ |             |      | 15   |      | $\mu A$ |

**\*1 : Test error is not included, such as test machine, test board, contact resistance and so on. The total error results in drift of  $V_{FB}$  about  $\pm 3mV$ .**

## Detailed Description

### Voltage Reference

A built-in 2.5V reference regulator supplies FP7102 internal circuits. Also, this 2.5V reference voltage is divided down by an internal resistive divider to provide a 0.25V precision reference voltage to the error amplifier non-inverting terminal.

### Setting the LED Current

FP7102 is a constant current buck regulator. The LEDs are connected between  $V_{OUT}$  and FB pin as shown in the **Typical Application Circuit** section. The FB pin is 0.25V in regulation. Therefore, the LEDs current  $I_F$  is set by  $V_{FB}$  and the resistor  $R_2$  connected between FB and ground by the following equation:

$$I_F = \frac{V_{FB}}{R_2}$$

$I_F$  should not exceed the 2A current capability of FP7102 and therefore  $R_2$  minimum value must be approximately  $0.13\Omega$ .

### Output Voltage

The output voltage is primarily determined by the number of LEDs(n) connected between  $V_{OUT}$  and FB pin. Therefore,  $V_{OUT}$  can be written as:

$$V_{OUT} = ((n \times V_F) + V_{FB})$$

Where  $V_F$  is the forward voltage of one LED at the set LED current level (see LED manufacturer datasheet for forward characteristics curve)

### Oscillator

The fixed PWM frequency is generated by an internal oscillator. Its typical values are 320KHz.

### Thermal Protection

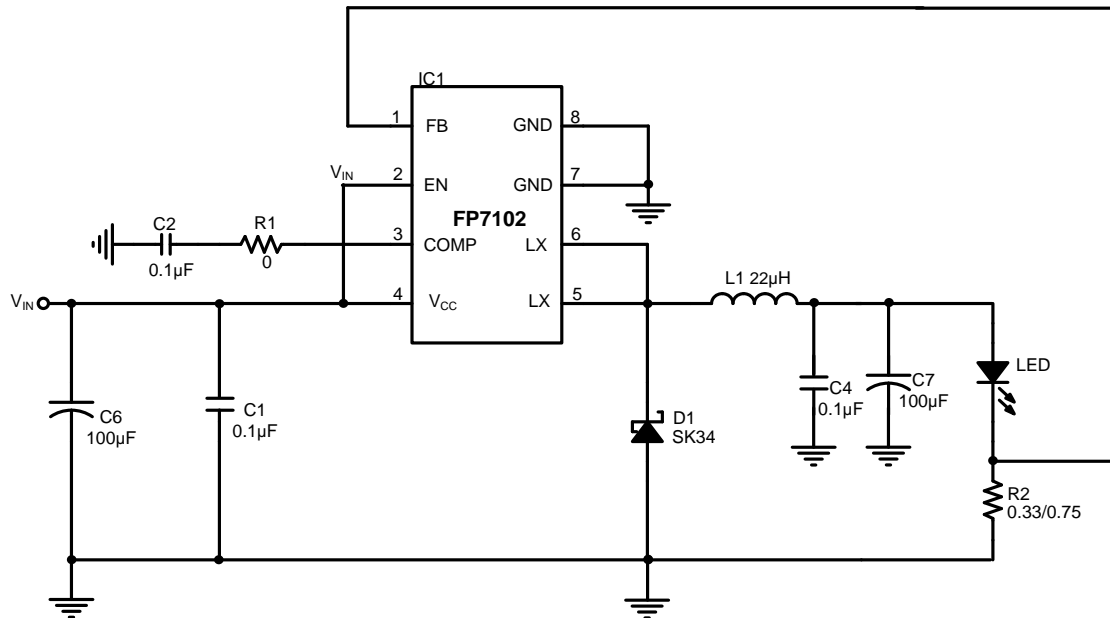
The thermal protection is triggered when junction temperature is higher than  $150^\circ\text{C}$  that may occurs by an abnormal heavy current loading. When this happens, the FP7102 turns output off. Once the junction temperature is cooled down to lower than  $130^\circ\text{C}$ , FP7102 starts again and turns the power switch on.



**Over Current Protection**

The FP7102 uses cycle-by-cycle current limit to protect the internal power switch. During each switching cycle, a current limit comparator detects if the power switch current exceeds the internal setting current. If it does, over current protection function decrease the oscillator frequency to prevent thermal issue.

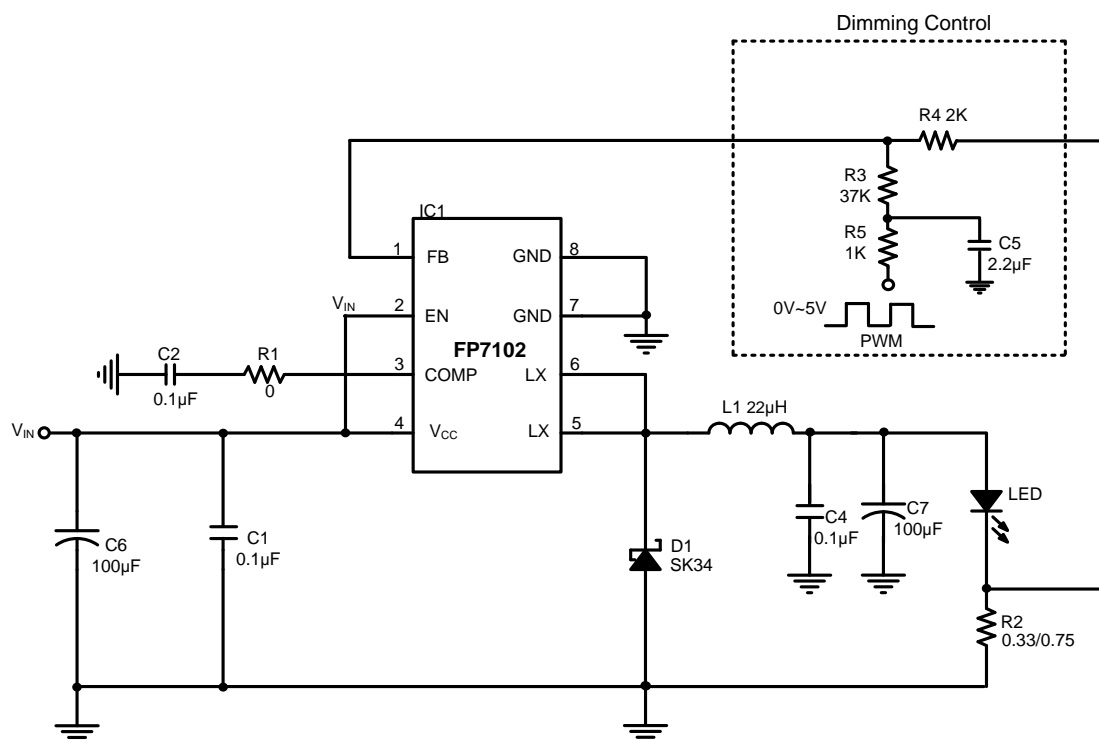
## Typical Application



**FP7102 1W / 3W LED for DC Input Circuit**

## Dimming Control Circuit

Changing the duty cycle of PWM signal can get different LED current. The PWM signal is recommended above 10kHz. The application circuit is shown in the following.



The LED current can be calculated by the following equation:

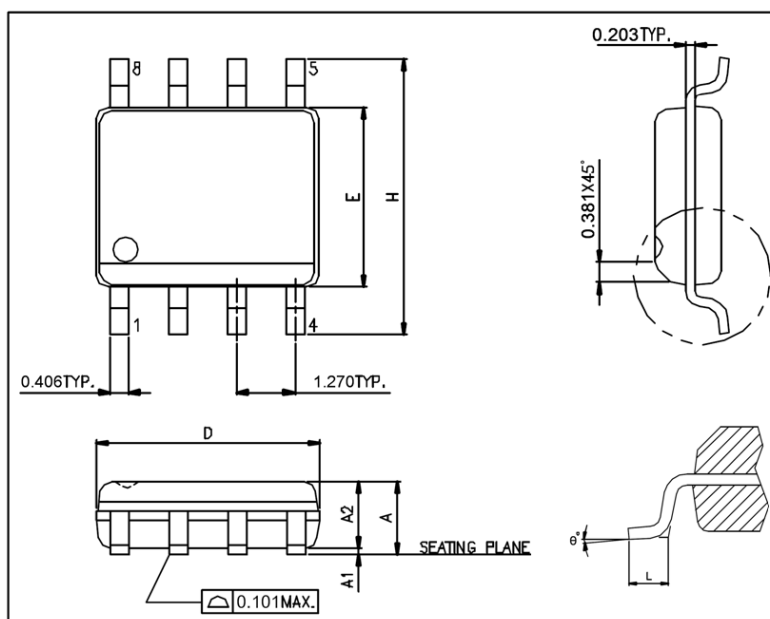
$$I_{LED} = \frac{V_{FB} - \frac{R4 \times (V_{PWM} \times \text{Duty} - V_{FB})}{R3 + R5}}{R2}$$

## Notice:

1. Tapping reel aluminum foil bags after unpacking must be stored at ≤10% RH environment.
2. Tapping reel aluminum foil bags after unpacking must sure surface-mount is completed within 168 hours.

## Package Outline

### SOP-8L

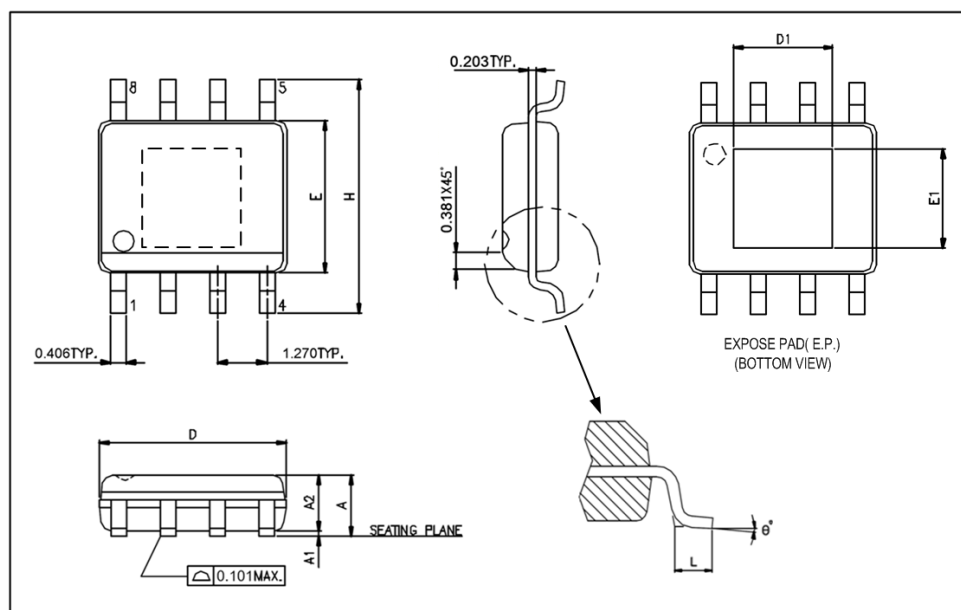


UNIT: mm

| Symbols | Min. (mm) | Max. (mm) |
|---------|-----------|-----------|
| A       | 1.346     | 1.752     |
| A1      | 0.101     | 0.254     |
| A2      |           | 1.498     |
| D       | 4.800     | 4.978     |
| E       | 3.810     | 3.987     |
| H       | 5.791     | 6.197     |
| L       | 0.406     | 1.270     |
| θ°      | 0°        | 8°        |

### Note:

1. Package dimensions are in compliance with JEDEC outline: MS-012 AC.
2. Dimension "D" does not include molding flash, protrusions or gate burrs.
3. Dimension "E" does not include inter-lead flash or protrusions.

**SOP-8L (EP)**

**UNIT: mm**

| Symbols        | Min. (mm) | Max. (mm) |
|----------------|-----------|-----------|
| A              | 1.346     | 1.752     |
| A1             | 0.050     | 0.152     |
| A2             |           | 1.498     |
| D              | 4.800     | 4.978     |
| E              | 3.810     | 3.987     |
| H              | 5.791     | 6.197     |
| L              | 0.406     | 1.270     |
| $\theta^\circ$ | 0°        | 8°        |

**Exposed PAD Dimensions:**

| Symbols | Min. (mm) | Max. (mm) |
|---------|-----------|-----------|
| E1      |           | 2.184 REF |
| D1      |           | 2.971 REF |

**Note:**

1. Package dimensions are in compliance with JEDEC outline: MO-178 AA.
2. Dimension "D" does not include molding flash, protrusions or gate burrs.
3. Dimension "E" does not include inter-lead flash or protrusions