

## LED Driver with Average-Mode Constant Current Control



### General Description

The FP7183 is an average current mode control LED driver IC operating in a constant off-time mode. FP7183 does not produce a peak-to-average error, and therefore greatly improves accuracy, line and load regulation of the LED current without any need for loop compensation or high-side current sensing. The output LED current accuracy is  $\pm 2\%$ .

The FP7183 can be powered from an 8.0 - 100V supply. A PWM dimming input is provided that accepts an external control TTL compatible signal. The output current can be programmed by an internal 250mV reference, or controlled externally through a 0.2 – 1.5V dimming input.

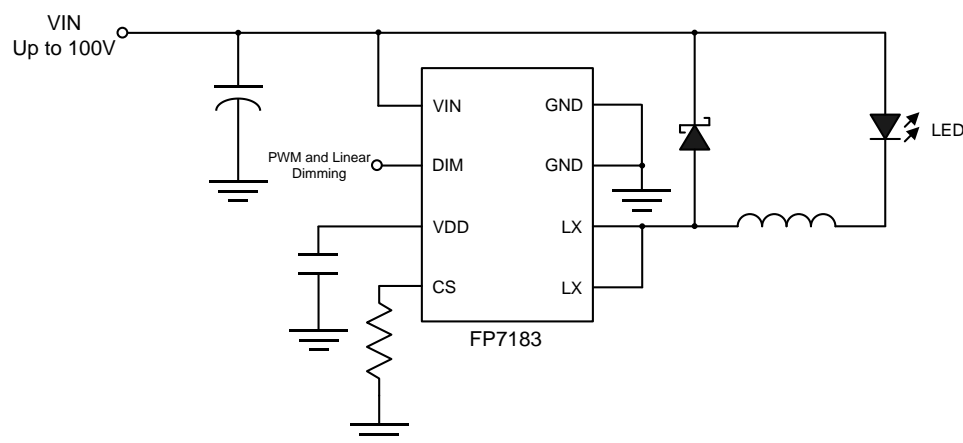
### Features

- Fast average current control
- Internal 8 to 100V linear regulator
- Linear and PWM dimming capability
- Output short circuit protection with skip mode
- Requires few external components for operation
- Internal 100V N-MOSFET

### Applications

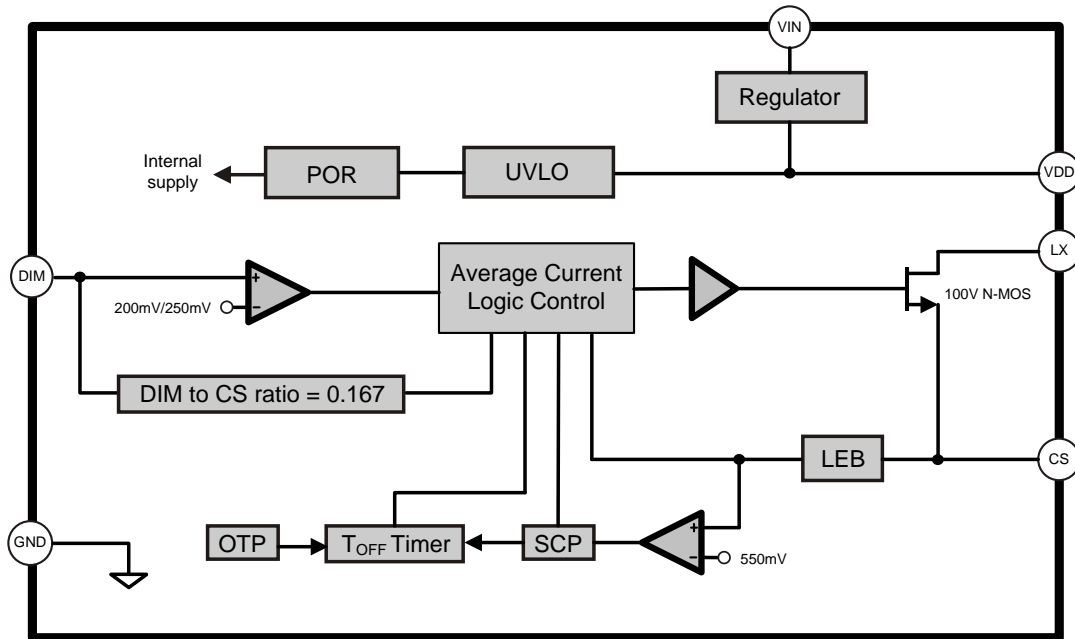
- DC/DC LED driver applications
- Back lighting of flat panel displays
- General purpose constant current source
- Signage and decorative LED lighting
- Chargers

### Typical Application Circuit



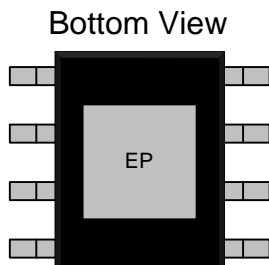
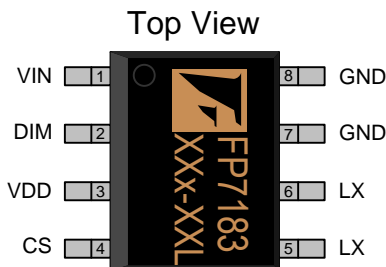
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## Function Block Diagram



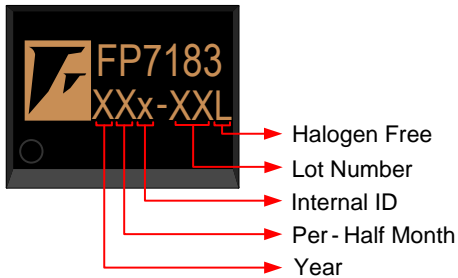
## Pin Descriptions

### SOP-8L(EP)



| Name | No. | I / O | Description   |
|------|-----|-------|---|
| VIN  | 1   | I     | This pin is the input of an 8 - 100V linear regulator.  |
| DIM  | 2   | I     | This pin is the linear and PWM dimming input of the IC.   |
| VDD  | 3   | I     | This is the power supply pin for all internal circuits.   |
| CS   | 4   | I     | This pin is the current sense pin used to sense the FET current by means of an external sense resistor. |
| LX   | 5   | O     | Power switch  |
| LX   | 6   | O     | Power switch  |
| GND  | 7   | P     | Ground return for all internal circuitry.   |
| GND  | 8   | P     | Ground return for all internal circuitry.   |
| EP   | 9   | O     | Exposed PAD. Must connect to LX.  |

## Marking Information



**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

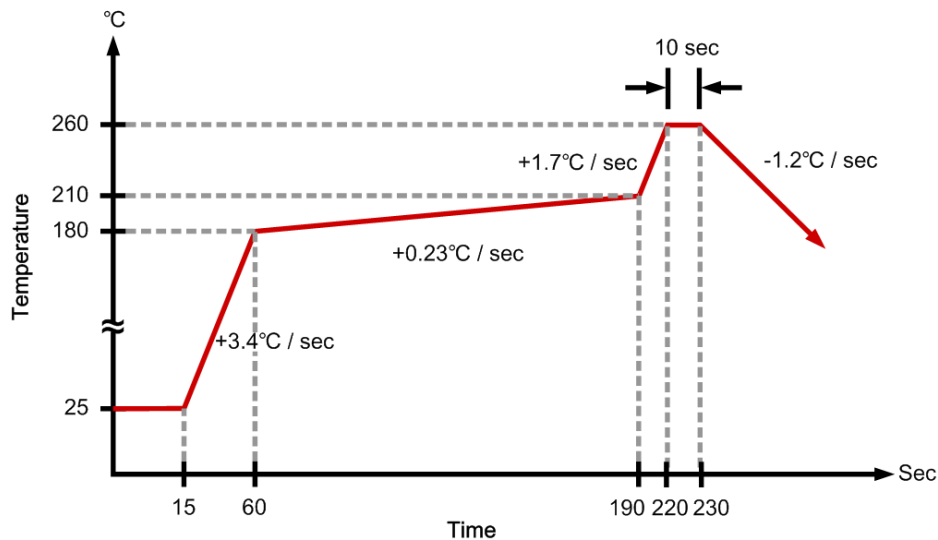
## Ordering Information

| Part Number | Operating Temperature | Package    | MOQ     | Description |
|-------------|-----------------------|------------|---------|-------------|
| FP7183XR-G1 | -25°C ~ +85°C         | SOP-8L(EP) | 2500 EA | Tape & Reel |

## Absolute Maximum Ratings

| Parameter                               | Symbol        | Conditions                        | Min. | Typ. | Max.          | Unit           |
|---|---------------|-----------------------------------|------|------|---------------|----------------|
| Power Supply Voltage                    | $V_{IN}$      | $V_{IN}$ to GND                   |      |      | 100           | V              |
|   | $V_{DD}$      | $V_{DD}$ to GND                   |      |      | 8.5           | V              |
| CS, DIM, GATE,                          |               |                                   | -0.3 |      | $V_{DD}-0.3V$ | V              |
| Internal MOS $V_{DS}$ Breakdown Voltage | $V_{DS}$      |                                   | 100  |      |               | V              |
| Allowable Power Dissipation             | $P_D$         | SOP-8L(EP) $T_A \leq +25^\circ C$ |      |      | 630           | mW             |
| Junction to Ambient Thermal Resistance  | $\theta_{JA}$ |                                   |      | 128  |               | $^\circ C / W$ |
| Operating Temperature                   |               |                                   | -25  |      | +85           | $^\circ C$     |
| Storage Temperature                     | $T_S$         | SOP-8L(EP)                        | -40  |      | +150          | $^\circ C$     |
| SOP-8L(EP) Lead Temperature             |               | (soldering, 10 sec)               |      |      | +260          | $^\circ C$     |

## IR Re-flow Soldering Curve



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## Recommended Operating Conditions

| Parameter             | Symbol   | Conditions | Min. | Typ. | Max. | Unit |
|-----------------------|----------|------------|------|------|------|------|
| Supply Voltage        | $V_{IN}$ |            | 8.5  |      | 100  | V    |
| Operating Temperature |          |            | -25  |      | 85   | °C   |

## DC Electrical Characteristics ( $V_{IN}=11V, T_A = 25^\circ C$ , unless otherwise noted)

| Parameter                                | Symbol                   | Conditions   | Min.  | Typ.  | Max.  | Unit |
|--|--------------------------|--|-------|-------|-------|------|
| <b>Internal Regulator</b>                |                          |  |       |       |       |      |
| Internally regulated voltage             | $V_{DD}$                 | $V_{IN} = 8V, I_{DD(ext)} = 0, 500pF$ at GATE; DIM = VDD         | 7.25  | 7.5   | 7.75  | V    |
| Line regulation of VDD                   | $\Delta V_{DD,line}$     | $V_{IN} = 8 - 100V, I_{DD(ext)} = 0, 500pF$ at GATE; DIM = VDD   | 0     | -     | 1.0   | V    |
| Load regulation of $V_{DD}$              | $\Delta V_{DD,load}$     | $I_{DD(ext)} = 0 - 0.6mA, 500pF$ at GATE; DIM = VDD              | 0     |       | 100   | mV   |
| $V_{DD}$ undervoltage lockout threshold  | UVLO                     | $V_{DD}$ rising  |       | 6.5   |       | V    |
| $V_{DD}$ undervoltage lockout hysteresis | $\Delta UVLO$            | $V_{DD}$ falling   |       | 500   |       | mV   |
| <b>PWM Dimming</b>                       |                          |  |       |       |       |      |
| Pin DIM input low voltage                | $V_{EN(lo)}$             | $V_{IN} = 8 - 100V$  |       |       | 0.1   | V    |
| Pin DIM input high voltage               | $V_{EN(hi)}$             | $V_{IN} = 8 - 100V$  | 1.6   |       |       | V    |
| <b>Average Current Sense Logic</b>       |                          |  |       |       |       |      |
| Current sense reference voltage          | $V_{CS}$                 |  | 0.245 | 0.25  | 0.255 | mV   |
| DIM-to-CS voltage ratio                  | $A_{V(DIM)}$             |  | 0.164 | 0.167 | 0.17  |      |
| DIM-to-CS voltage offset                 | $A_{V(DIM)}$<br>(OFFSET) | Offset = $V_{CS} - A_{V(DIM)} \cdot V_{DIM}$<br>$V_{DIM} = 1.2V$ | 0     |       | 10    | mV   |
| CS threshold temp regulation #           |                          |  |       |       | 5     | mV   |
| DIM input voltage, shutdown              | $V_{DIM(OFF)}$           |  |       | 200   |       | mV   |
| DIM input voltage, enable                | $\Delta V_{DIM(OFF)}$    |  |       | 250   |       | mV   |
| Current sense blanking interval          | $T_{BLANK}$              |  | 250   |       | 350   | ns   |
| Minimum on-time                          | $T_{ON(min)}$            | $CS = V_{CS} + 30mV$   |       |       | 1000  | ns   |
| <b>Short Circuit Protection</b>          |                          |  |       |       |       |      |
| Hiccup threshold voltage                 | $V_{CS}$                 |  | 495   | 550   | 605   | mV   |
| Current limit delay CS – GATE #          | $T_{DELAY}$              | $CS = V_{CS} + 30mV$   |       |       | 150   | ns   |
| Short circuit hiccup time                | $T_{HICCUP}$             |  | 450   | 550   | 650   | us   |
| Minimum on-time (short circuit)          | $T_{ON(min)}$            | $CS = V_{DD}$  |       |       | 600   | ns   |

### Notes:

# Guaranteed by design

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| Parameter                                      | Symbol                | Conditions  | Min. | Typ. | Max. | Unit |
|--|-----------------------|---|------|------|------|------|
| <b>T<sub>OFF</sub> Timer</b>                   |                       |   |      |      |      |      |
| Minimum off time                               | T <sub>OFF(MIM)</sub> |   |      | 0.6  |      | us   |
| Maximum off time                               | T <sub>OFF(MAX)</sub> |   |      | 50   |      | us   |
| Maximum on time                                | T <sub>ON(MAX)</sub>  |   |      | 60   |      | us   |
| <b>Internal MOSFET</b>                         |                       |   |      |      |      |      |
| Drain-Source Breakdown Voltage                 | BV <sub>DSS</sub>     | V <sub>GS</sub> =0V, I <sub>D</sub> =250uA                      | 100  |      |      | V    |
| Drain-Source Leakage Current                   | I <sub>DSS</sub>      | V <sub>DS</sub> =80V, V <sub>GS</sub> =0V, T <sub>J</sub> =25°C |      |      | 1    | uA   |
| Static Drain-Source On-Resistance <sup>2</sup> | R <sub>DS(ON)</sub>   | I <sub>D</sub> =1A  |      |      | 320  | mΩ   |

Notes:

$$T_{OFF} = \frac{0.6 \times L \times I_{LED(AVG)}}{V_{LED(MAX)}}$$

## Function Description

### Input Voltage Regulator

The FP7183 can be powered directly from its VIN pin and can work from 8.5 - 100VDC at its VIN pin. When a voltage is applied at the VIN pin, the FP7183 maintains a constant 7.5V at the VDD pin. This voltage is used to power the IC and any external resistor dividers needed to control the IC. The VDD pin must be bypassed by a low ESR capacitor to provide a low impedance path for the high frequency current of the output GATE driver.

The FP7183 can also be operated by supplying a voltage at the VDD pin greater than the internally regulated voltage. This will turn off the internal linear regulator of the IC and the FP7183 will operate directly off the voltage supplied at the VDD pin. Please note that this external voltage at the VDD pin should not exceed 8.5V.

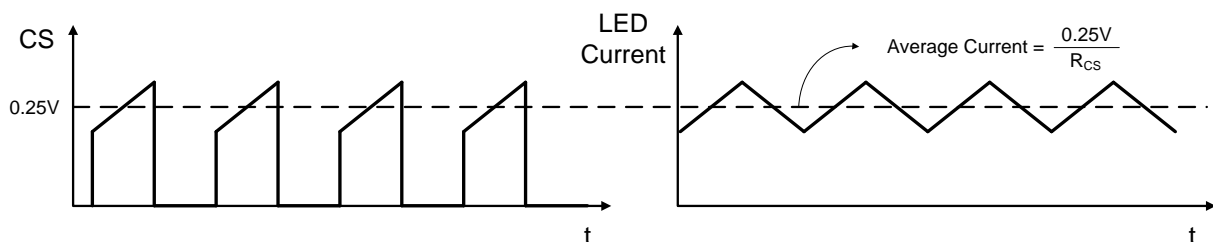
### Average Current Control

The LED current is detected using a sense resistor at the CS pin. The feedback operates in a fast open-loop mode. No compensation is required. When the voltage at the DIM input  $V_{DIM} \geq 1.5V$ , output current is programmed simply as:

$$I_{LED} (A) = \frac{0.25V}{R_{CS} (\Omega)}$$

Otherwise:

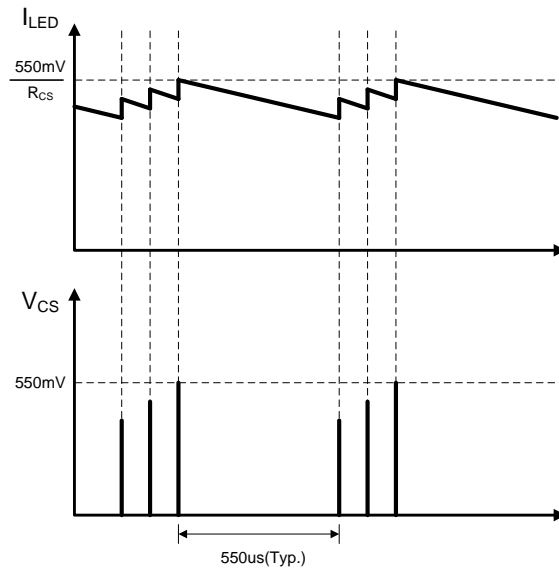
$$I_{LED} (A) = \frac{V_{DIM} (V) \times 0.167}{R_{CS} (\Omega)}$$



The above equations are only valid for continuous conduction of the output inductor. It is a good practice to design the inductor such that the switching ripple current in it is 25% of its average peak-to-peak, full load, DC current.

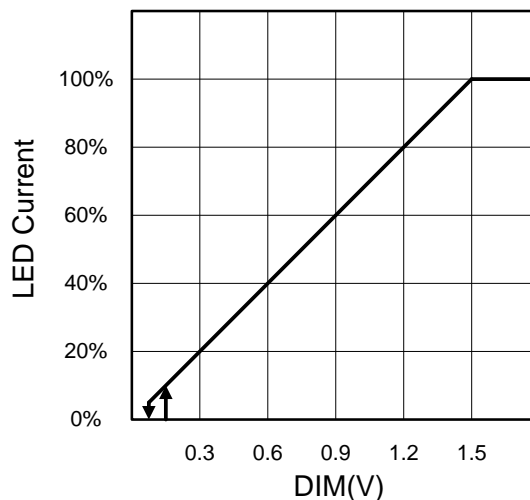
### Output Short Circuit Protection

The short circuit protection comparator trips when the voltage at CS exceeds 0.55V. When this occurs, the GATE off-time  $T_{HICCUP} = 550\mu s$  is generated to prevent stair-casing of the inductor current and potentially its saturation due to insufficient output voltage.



### Linear Dimming

When the voltage at DIM falls below 1.5V, the internal 250mV reference to the constant-current feedback becomes overridden by  $V_{DIM} \cdot 0.167$ . As long as the current in the inductor remains continuous, the LED current is given by the equation above. However, when  $V_{DIM}$  falls below 200mV, the GATE output becomes disabled. The GATE signal recovers, when  $V_{DIM}$  exceeds 250mV. This is required in some applications to be able to shut the LED lamp off with the same signal input that controls the brightness.

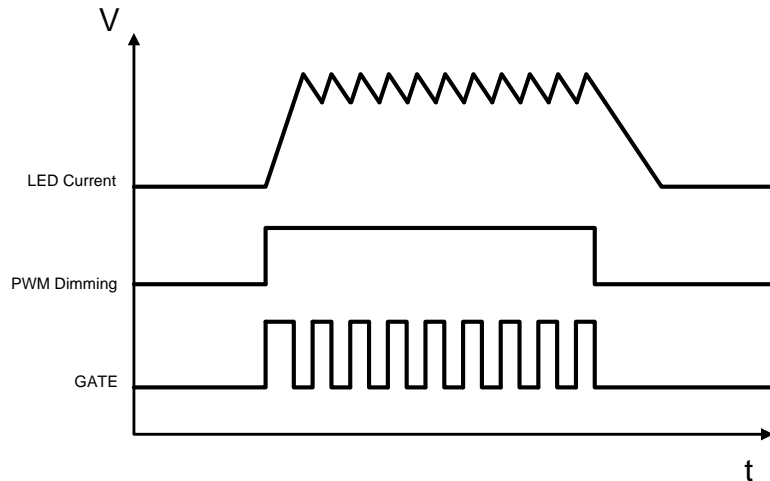


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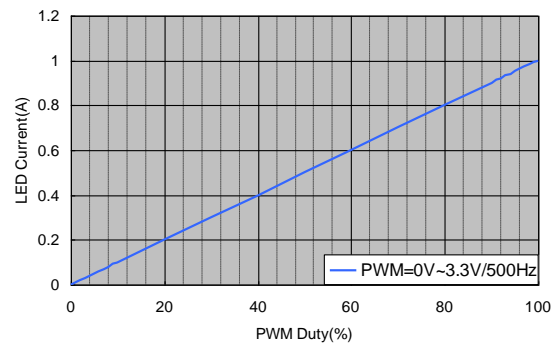
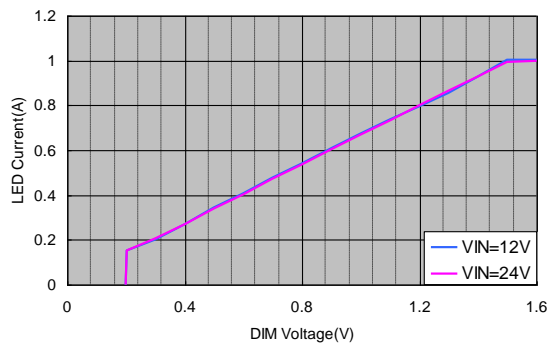
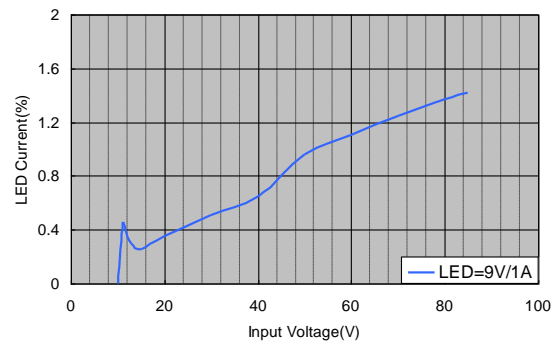
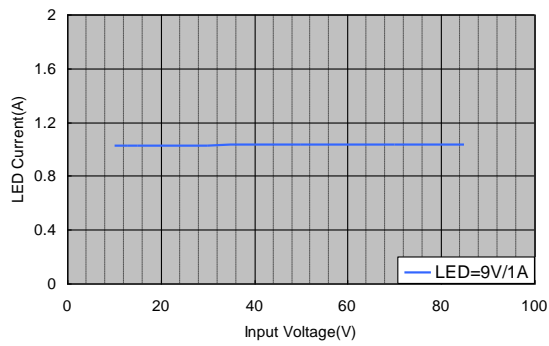
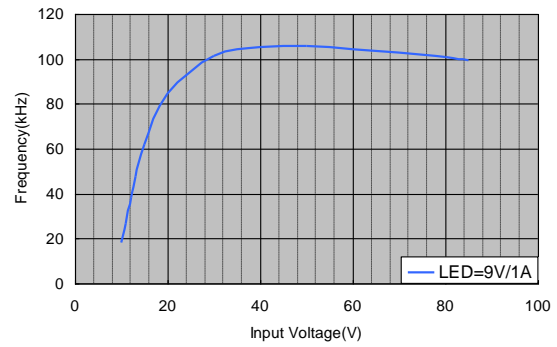
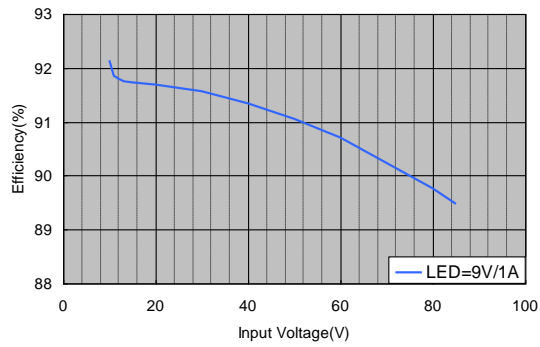
### PWM Dimming

Due to the fast open-loop response of the average-current control loop of the FP7183, its PWM dimming performance nearly matches that of the FP7171.



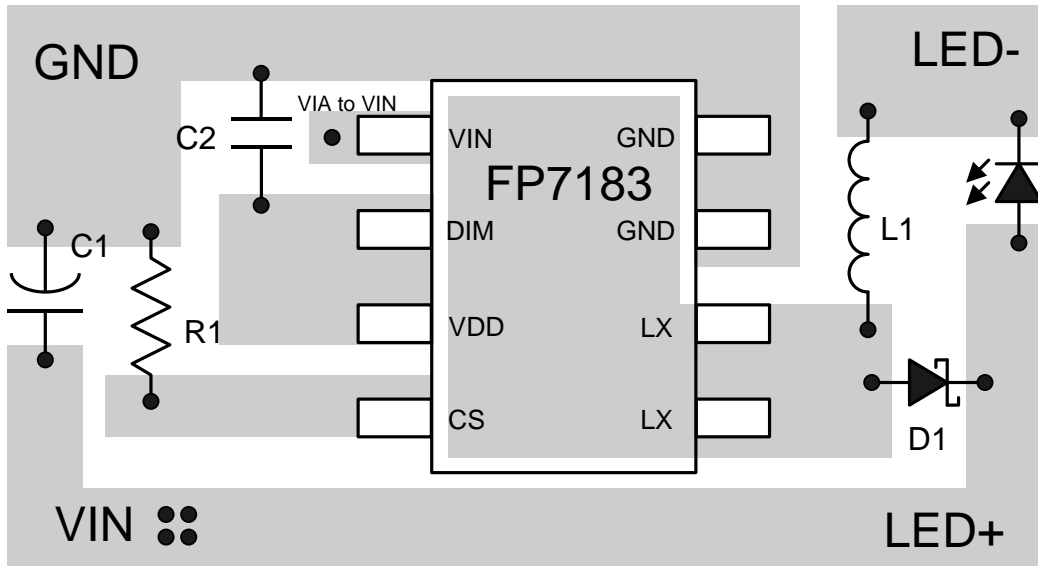
The rising and falling edges are limited by the current slew rate in the inductor. The first switching cycle is terminated upon reaching the 250mV ( $V_{DIM} \cdot 0.167$ ) level at CS. The circuit is further reaching its steady-state within 1 switching cycles regardless of the switching frequency.

※  $V_{IN}=12V$ , LED=9V,  $T_A = 25^{\circ}C$ , unless otherwise noted



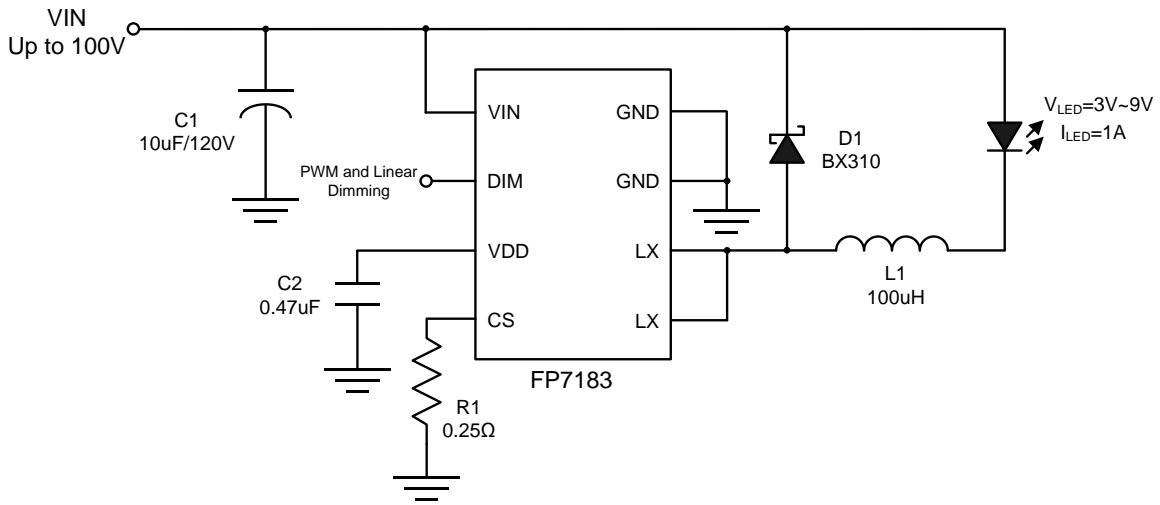
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**Suggested Layout**



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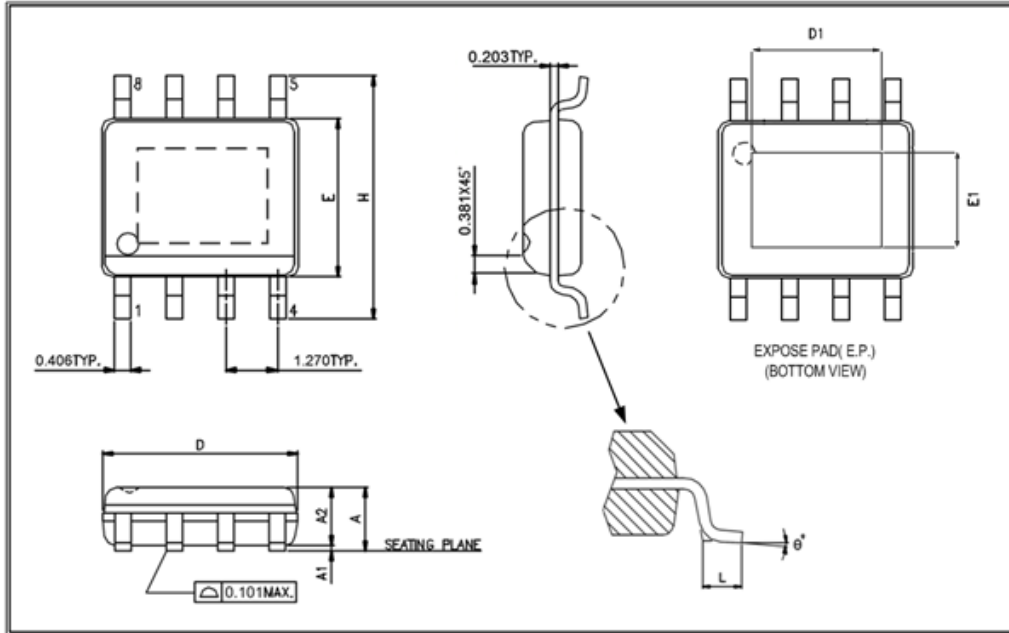
### Typical Application Circuit



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## Package Outline

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      | 2.05      | 2.41      |
| D1      | 2.81      | 3.30      |

### Note:

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

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