

## Non-Synchronous PWM Boost Controller for LED Driver



### General Description

The FP7208 is boost topology switching regulator for LED driver. It provides built-in gate driver pin for driving external N-MOSFET. The non-inverting input of error amplifier connects to a 0.2V reference voltage. It has programmable soft start time set by external capacitor, and over voltage protection set by external resistor. The LED current can be adjusted by an external signal connecting to the EN pin. EN pin accepts either a DC voltage or a PWM signal. The PWM signal filter components are contained within the chip.

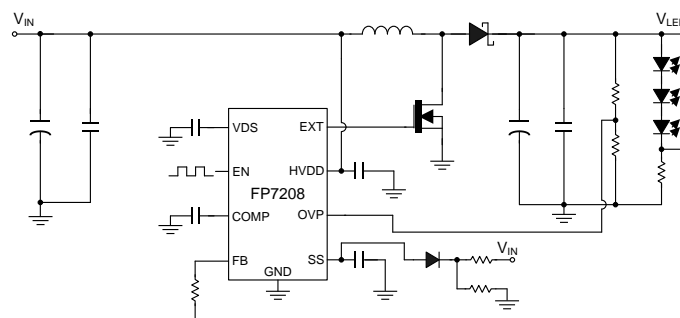
### Features

- Start-up Voltage: 2.5V
- Wide Supply Voltage Operating Range: 4.5V to 24V
- Precision Feedback Reference Voltage: 0.2V (Max.)
- Analog and Digital Dimming Control
- Shutdown Current: 6 $\mu$ A (Max.)
- Internal Fixed Switching Frequency: 300KHz
- Programmable Soft Start Function (SS)
- Programmable Over Voltage Protection (OVP)
- Over Temperature Protection (OTP)
- Package: SOP-8L(EP)

### Applications

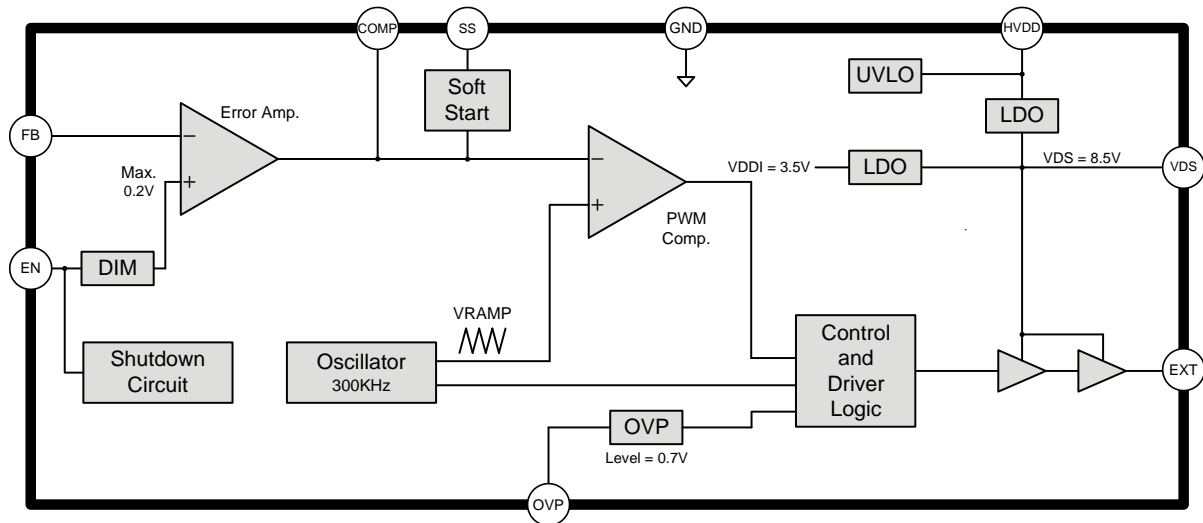
- LED Module
- Display Backlight
- Car Lighting
- Portable LED Lighting

### Typical Application Circuit



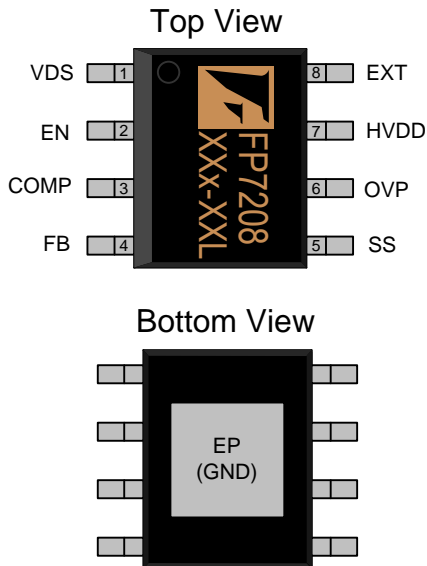
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## Function Block Diagram



## Pin Descriptions

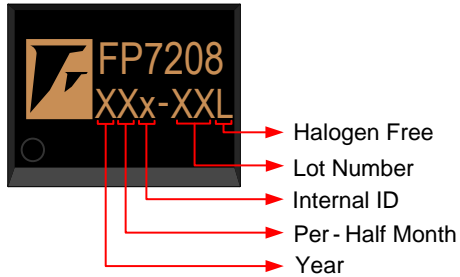
### SOP-8L (EP)



Name	No.	I / O	Description
VDS	1	P	Power Supply for Internal Control Circuits and Gate Drivers
EN	2	I	Enable and Dimming Control
COMP	3	O	Compensation
FB	4	I	Error Amplifier Inverting Input
SS	5	I	Soft Start Programming
OVP	6	I	Over Voltage Protection
HVDD	7	P	IC Power Supply
EXT	8	O	Gate Driver Output
GND	9	P	IC Ground (Exposed PAD) – Must Connect to Ground

## Marking Information

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

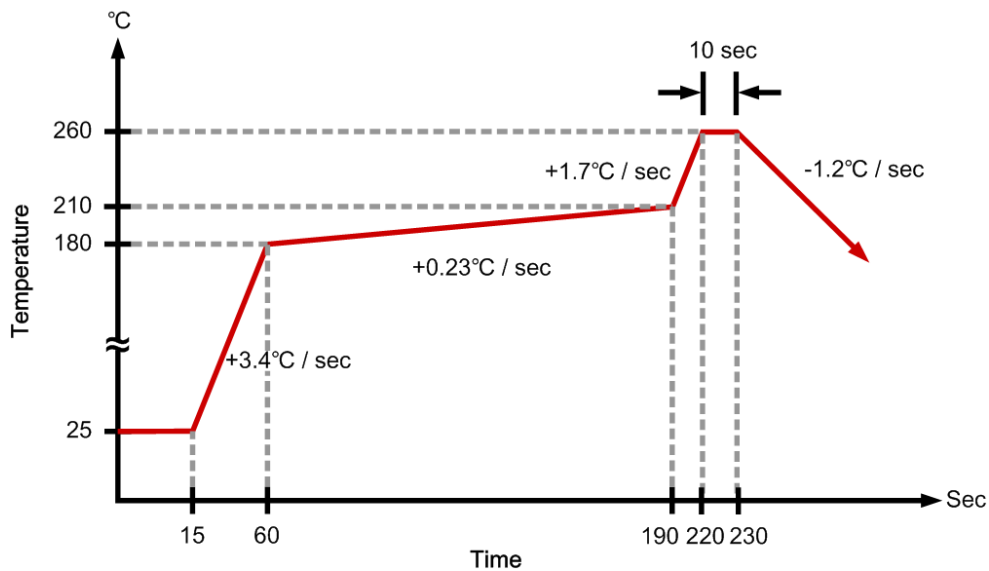
## Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP7208XR-G1	-25°C ~ 85°C	SOP-8L(EP)	2500EA	Tape & Reel

## Absolute Maximum Ratings

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	HVDD	-	0	-	25	V
VDS,EXT Voltage	-	-	0	-	16	V
Others Pin Voltage	-	-	0	-	6	V
Thermal Resistance (Junction to Ambient)	$\theta_{JA}$	SOP-8L (EP)	-	-	+60	°C / W
Thermal Resistance (Junction to Case)	$\theta_{JC}$	SOP-8L (EP)	-	-	+10	°C / W
Junction Temperature	$T_J$	-	-	-	+150	°C
Operating Temperature	$T_{OP}$	-	-25	-	+85	°C
Storage Temperature	$T_{ST}$	-	-65	-	+150	°C
Lead Temperature	-	(soldering, 10 sec)	-	-	+260	°C

## IR Re-flow Soldering Curve



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## Recommended Operating Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage	HVDD	-	4.5	-	24	V
Operating Temperature Range	T <sub>A</sub>	Ambient Temperature	-25	-	+85	°C

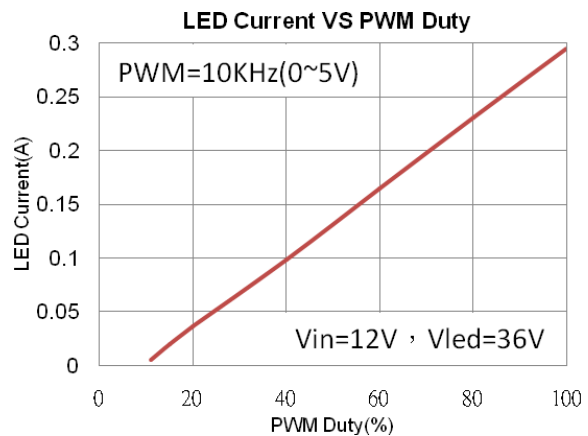
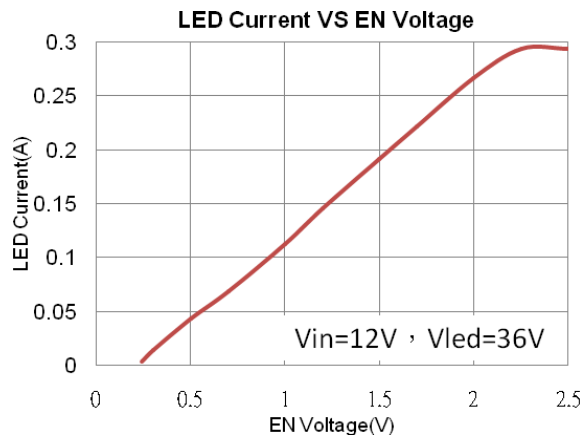
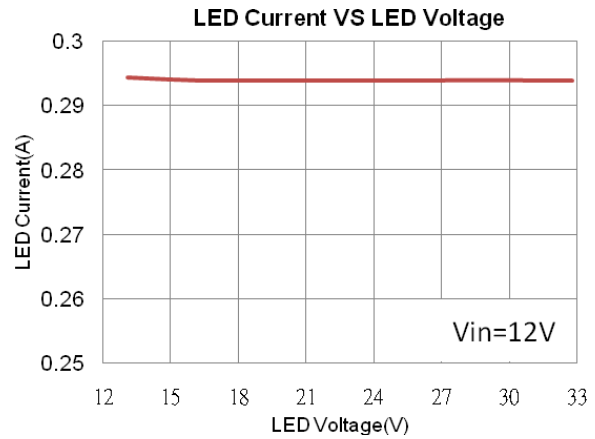
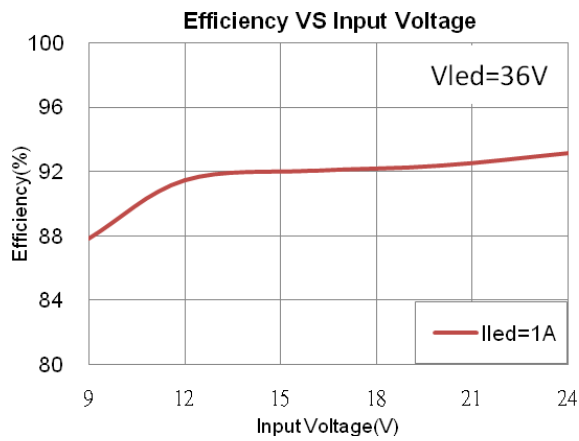
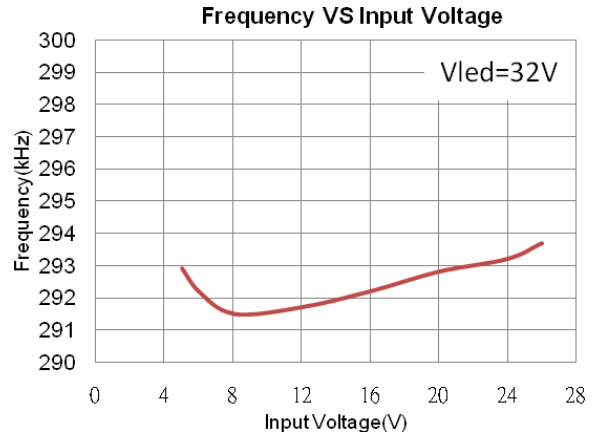
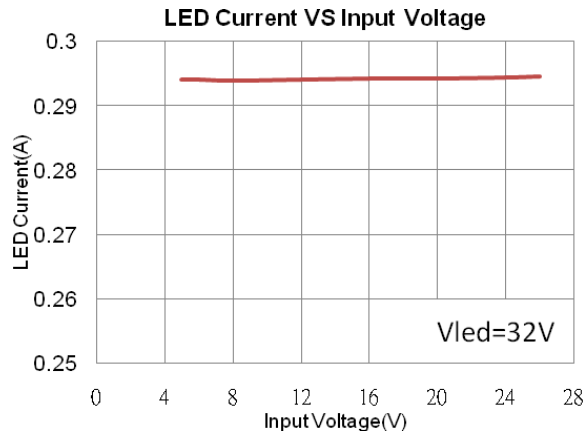
## DC Electrical Characteristics (HVDD=12V, T<sub>A</sub>=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>System Supply Input</b>						
Start-up Voltage	HV <sub>DD</sub>	-	2.5			V
Input Supply Range	HV <sub>DD</sub>	-	4.5	-	24	V
Under Voltage Lockout	V <sub>UVLO</sub>	-	-	2.2	-	V
UVLO Hysteresis	-	-	-	0.1	-	V
Average Current	I <sub>CC</sub>	FB=0V, Switching	-	5	-	mA
Quiescent Current	I <sub>CC</sub>	FB=0.55V, No Switching	-	245	-	μA
Shutdown Current	I <sub>CC</sub>	V <sub>EN</sub> =GND	-	-	6	μA
Input Supply Voltage	V <sub>DS</sub>	HV <sub>DD</sub> =12V, I <sub>DS</sub> =0A	-	8.5	-	V
<b>Oscillator</b>						
Operation Frequency	f <sub>OSC</sub>	FB=0V	250	300	350	KHz
Maximum Duty Ratio	%	FB=0V	-	90	-	%
<b>Soft Start</b>						
Soft-Start bias Current	I <sub>SS</sub>	V <sub>SS</sub> =0V	-	1.5	-	μA
<b>Reference Voltage</b>						
Feedback Voltage	V <sub>FB</sub>	Connect EN to V <sub>DS</sub> with a 100kΩ, EN ≈ 3V	0.191	0.200	0.209	V
<b>Enable Control</b>						
Enable Voltage	V <sub>EN</sub>	-	0.20	0.25	0.30	V
Shutdown Voltage	V <sub>EN</sub>	-	-	-	0.07	V
<b>External Transistor Connection current</b>						
EXT Pull-UP Resistance	R <sub>EXTH</sub>	V <sub>DS</sub> =8.5V	-	1	-	Ω
EXT Pull-Down Resistance	R <sub>EXTL</sub>	V <sub>DS</sub> =8.5V	-	1	-	Ω
<b>Over Voltage Protection</b>						
OVP Threshold	V <sub>OVP</sub>	-	0.65	0.70	0.75	V
<b>Thermal Shutdown</b>						
Thermal Shutdown Threshold	T <sub>TS</sub>	-	-	+150	-	°C

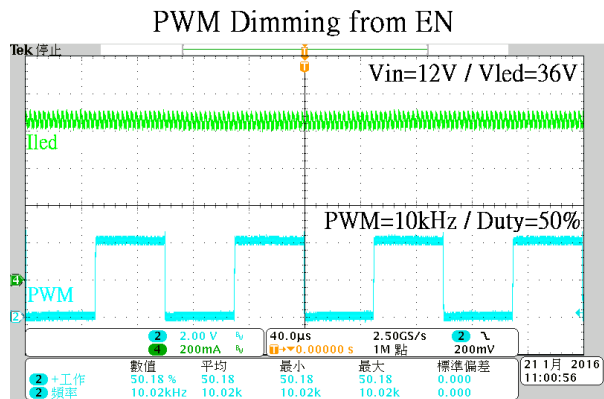
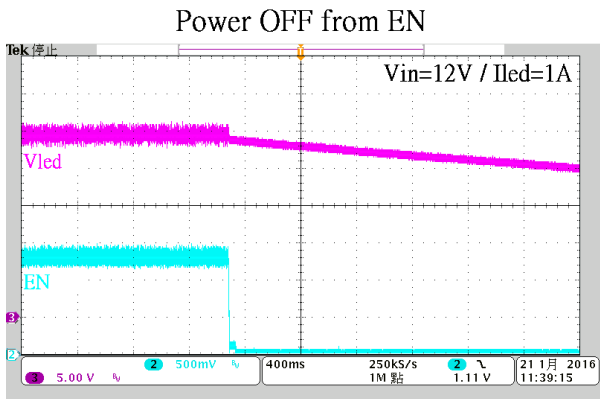
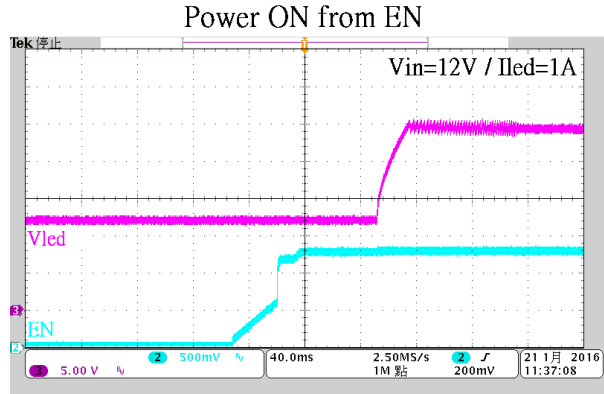
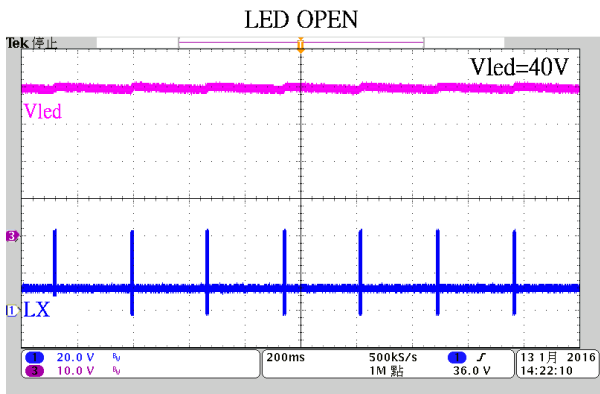
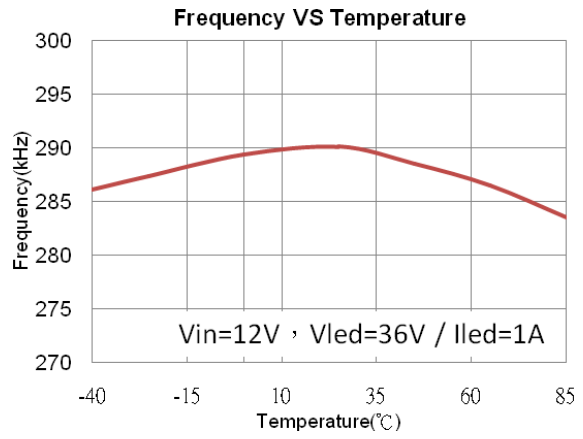
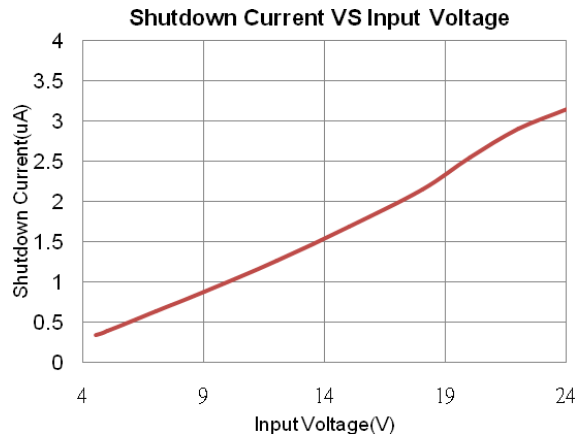
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## Typical Operating Characteristics

( $V_{IN}=12V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified)



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## Function Description

### Operation

The FP7208 is voltage mode boost controller for LED driver. It operates with pulse width modulation (PWM), and changes to PSM mode when output is light load. The internal resistive divider provides 0.2V reference for the error amplifier, which can reduce the power dissipation in the current sense resistor.

### Soft Start Function

Soft start time is programmable to connect capacitor between SS pin to ground. After the IC is enabled, the output of error amplifier is clamped by the internal soft-start function, which causes PWM pulse width increasing slowly and thus reducing input surge current during power on. The soft start bias current is 1.5μA.

### Enable Mode / Shutdown Mode

Drive the EN pin to ground to shutdown the IC. Shutdown mode forces to turn off all internal circuitry, and reduces the HVDD supply current to 6μA (max). EN pin rising threshold is 0.25V.

### DC Dimming Control

The DC voltage is connected to EN pin adjust the voltage to change feedback voltage ( $V_{FB}$ ). EN internal voltage is clamped in 2.25V ( $V_{EN}$ ) when external voltage exceeds 2.25V. The valid EN voltage is from 0.25V to 2.25V. The maximum feedback voltage is 0.2V. The LED current ( $I_{LED}$ ) can be calculated using formula below.

$$V_{FB} = \frac{V_{EN} - 0.25V}{10}, \quad I_{LED} = \frac{V_{FB}}{R_S}$$

### PWM Dimming Control

The PWM signal is connected to EN pin adjust duty cycle to change feedback voltage ( $V_{FB}$ ). EN internal voltage is clamped in 2.25V ( $V_{PWM}$ ) when external PWM voltage exceeds 2.25V, and internal filter regulates PWM signal become a DC voltage. The DC voltage is valid from 0.25V to 2.25V. The PWM signal is recommended above 10KHz. The LED current ( $I_{LED}$ ) can be calculated using formula below.

$$V_{FB} = \frac{V_{PWM} \times \text{Duty} - 0.25V}{10}, \quad I_{LED} = \frac{V_{FB}}{R_S}$$



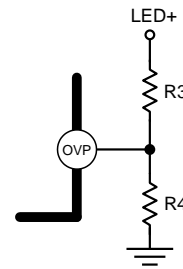
## FB Voltage Setting

How to set FB voltage when LEDs don't need dimming control. The resistor 100KΩ is connected between VDS and EN, which cause EN voltage more than 2.25V. The FB voltage is constant 0.2V.

## Over Voltage Protection

The gate driver signal is turned off when OVP pin voltage exceeds 0.7V. The voltage ( $V_{OVP}$ ) can be calculated using formula below, and circuit is shown as below.

$$V_{OVP} = 0.7V \left( 1 + \frac{R3}{R4} \right)$$



## Application Information

### Inductor Selection

Inductance value is decided based on different condition. 4.7μH to 68uH inductance value is recommended for general application circuit. There are three important inductor specifications, DC resistance, saturation current and core loss. Low DC resistance has better power efficiency.

### Capacitor Selection

The output capacitor is required to maintain the DC voltage during switching. Low ESR capacitors are preferred to reduce the output voltage ripple. Ceramic capacitor of X5R and X7R are recommended, which have low equivalent series resistance (ESR) and wider operation temperature range.

### Diode Selection

Schottky diodes with fast recovery times and low forward voltages are recommended. Ensure the diode average and peak current rating exceed the average output current and peak inductor current. In addition, the diode's reverse breakdown voltage must exceed the output voltage.

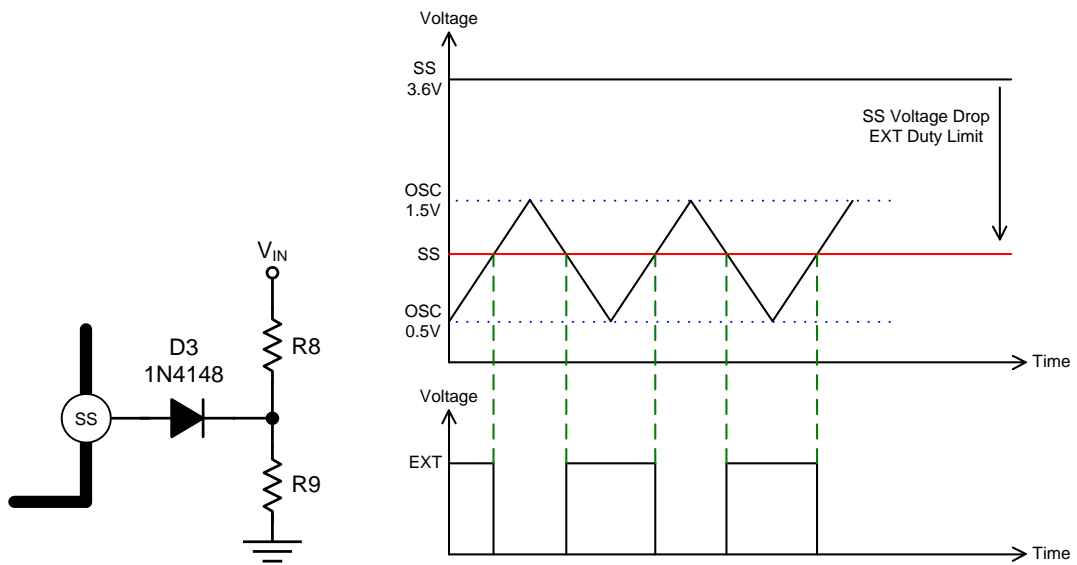
### LED Current Programming

The LED current is set by a resistor from the FB pin to ground. The LED current is:

$$I_{LED} = \frac{V_{FB}}{R_S}$$

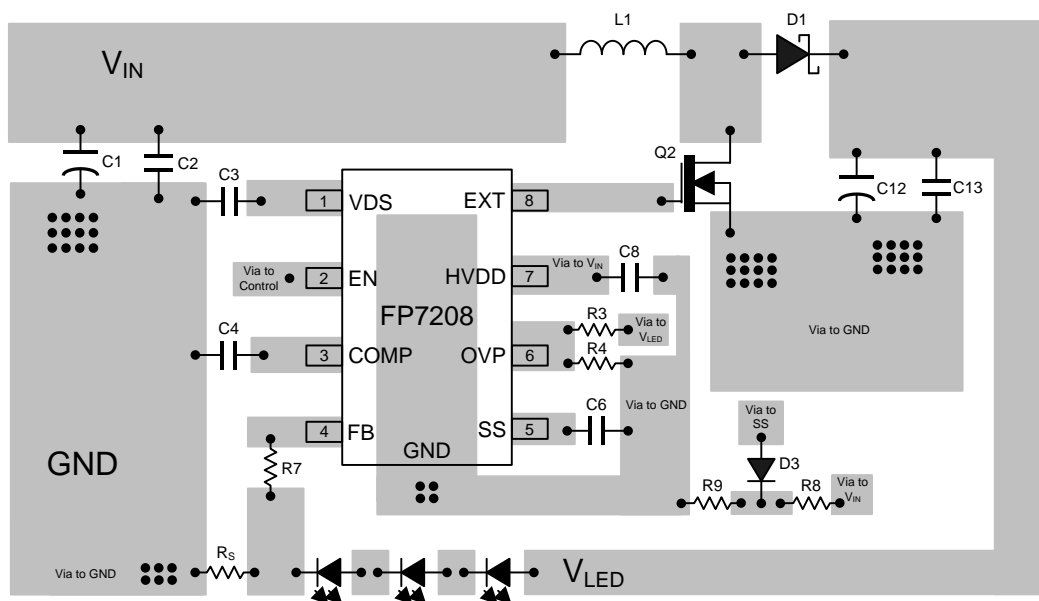
### Input Current Limit Setting

The SS voltage is adjusted using a resistive voltage divider connected from input voltage to D3 cathode, D3 Anode connects to SS pin. The input occur inrush current to cause input voltage drop off then SS voltage also drop less than 1.5V, PWM duty of EXT pin can be limited, which reduces inrush current to protect switching MOSFET. The level of internal oscillator is from 0.5V to 1.5V. D3 is unconnected the SS voltage is 3.6V. The circuit and detailed figure are shown as below.



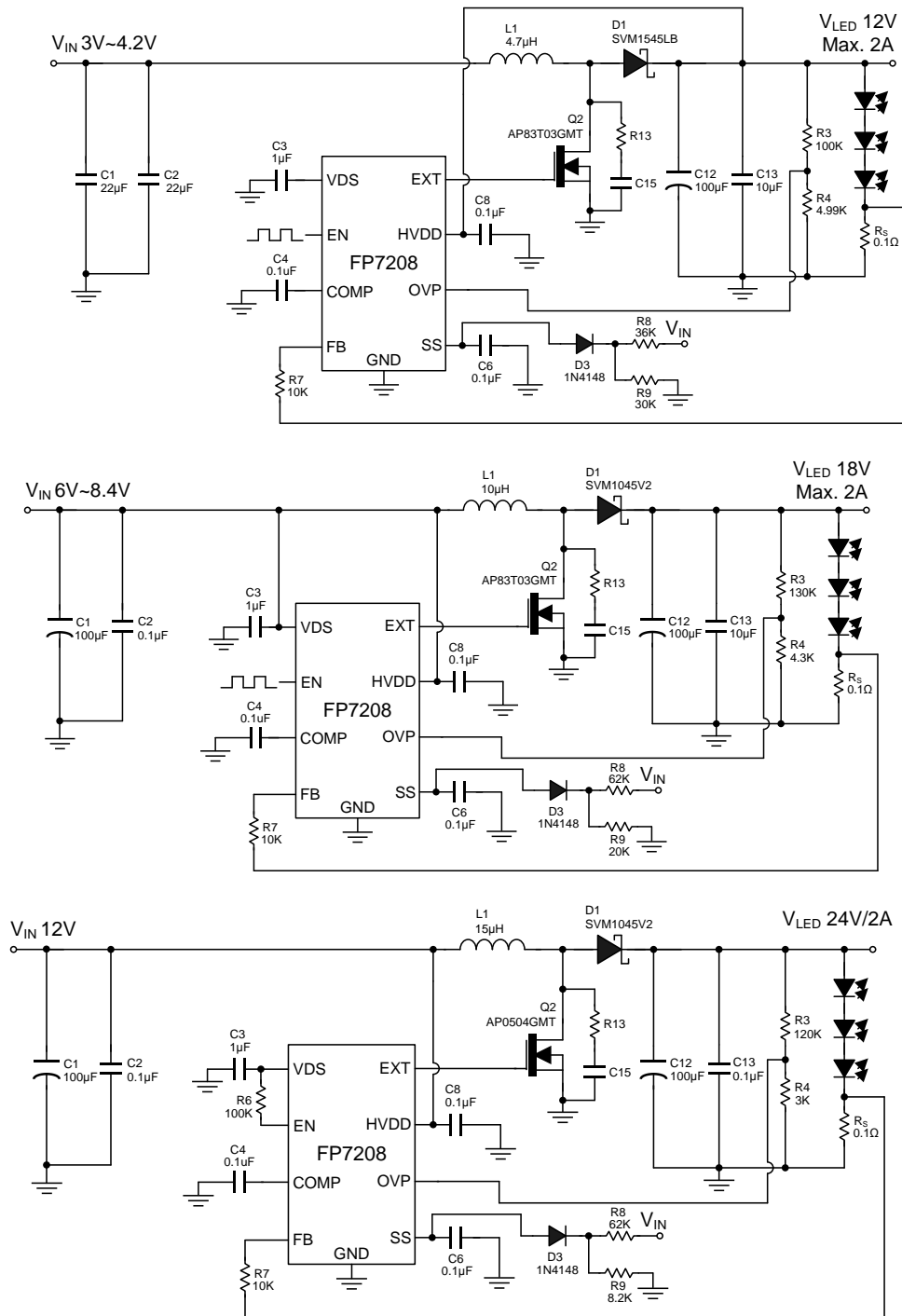
### Layout Considerations

1. The power traces, consisting of the GND trace, the MOS drain trace and the  $V_{IN}$  trace should be kept short, direct and wide.
2. Layout switching node MOS drain, inductor and schottky diode connection traces wide and short to reduce EMI.
3. Place C8 nearby HVDD pin as closely as possible to maintain input voltage steady and filter noise.
4. The sense resistor  $R_s$  must be connected to FB pin directly and as closely as possible.
5. FB is a sensitive node. Please keep it away from switching node, MOS drain.
6. The GND of the Q2, C1, C2, C12 and C13 should be connected close and together directly to a ground plane.
7. The output capacitor C12 and C13 should be connected close and together directly to the ground of Q2.



**Suggested Layout**

## Application Information



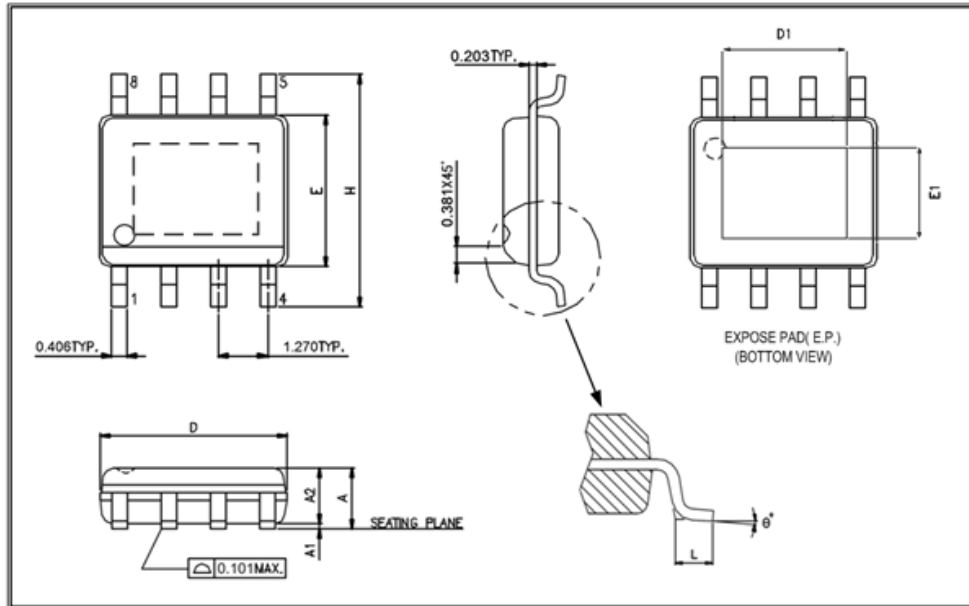
### Note:

1. The X5R and X7R of ceramic capacitors are recommended to choose.
2. R13 and C15 are added for reducing EMI (Electromagnetic Interference).

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## Package Outline

### SOP-8L (EP)



UNIT: mm

Symbols	Min. (mm)	Max. (mm)
A	1.30	1.70
A1	0	0.15
A2	1.25	1.55
D	4.70	5.10
E	3.80	4.00
H	5.80	6.20
L	0.40	1.27

#### Exposed PAD Dimensions:

Symbols	Min. (mm)	Max. (mm)
D1	2.60	3.45
E1	1.90	2.56

#### 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.