

Non-Synchronous PWM Boost Controller for LED Driver



General Description

The FP7208 and FP7208B are boost topology switching regulator for LED driver. They provide built-in gate driver pin for driving external N-MOSFET. The non-inverting input of error amplifier connects to a 0.1V default reference voltage. They have programmable soft start time set by external capacitors, and over voltage protection set by external resistors. FP7208B has programmable frequency set by external resistor. The LED current can be adjusted by applying an external signal to the EN pin. The EN pin accepts either a DC voltage or a PWM signal. The PWM signal filter components are contained within the chip.

The FP7208B is available in the small footprint DFN-10L package to fit in space-saving PCB layout for application fields.

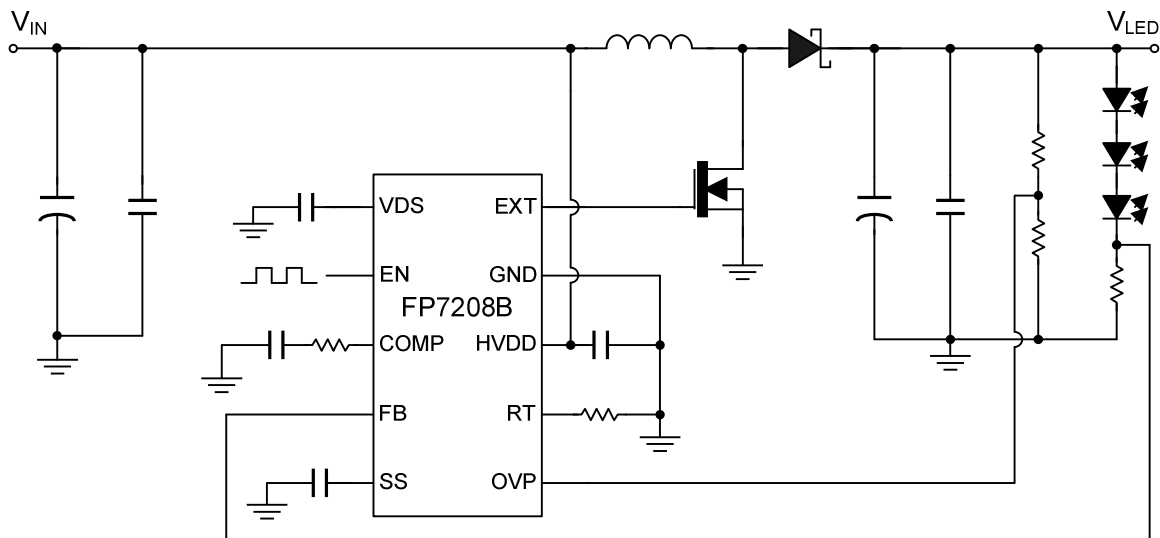
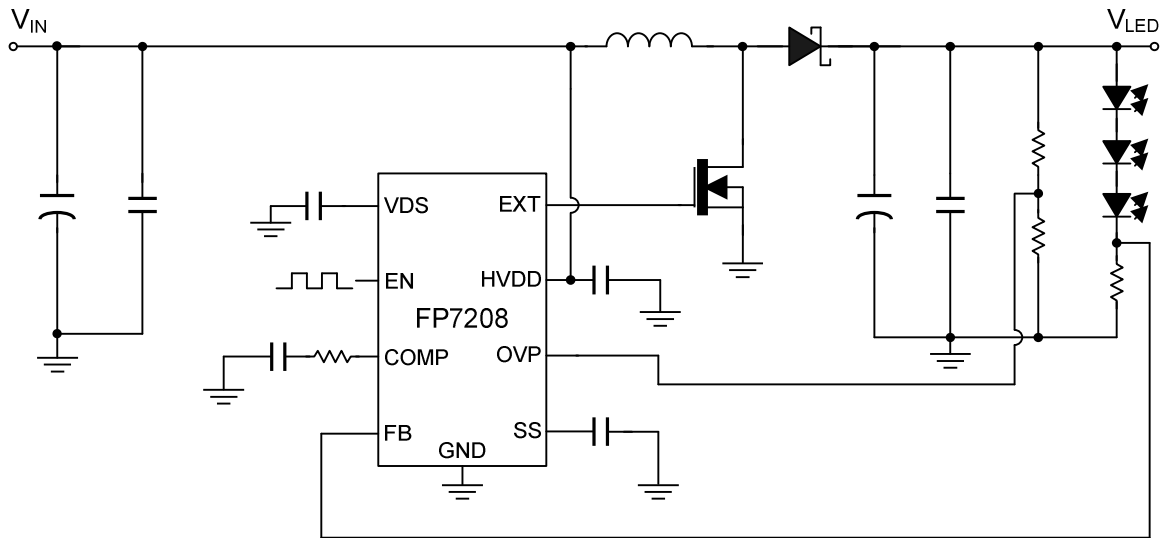
Features

- Wide Supply Voltage Operating Range: 2.5V to 24V
- Precision Feedback Reference Voltage: 0.1V ($\pm 2\%$)
- Analog and Digital Dimming Control
- Shutdown Current: $< 6\mu\text{A}$
- Internal Fixed PWM Frequency: 200KHz / FP7208
- Programmable PWM Frequency: 100KHz~1000KHz / FP7208B
- Programmable Soft Start Function (SS)
- Programmable Over Voltage Protection (OVP)
- Over Temperature Protection (OTP)
- Package: SOP-8L(EP) / FP7208, DFN-10L / FP7208B

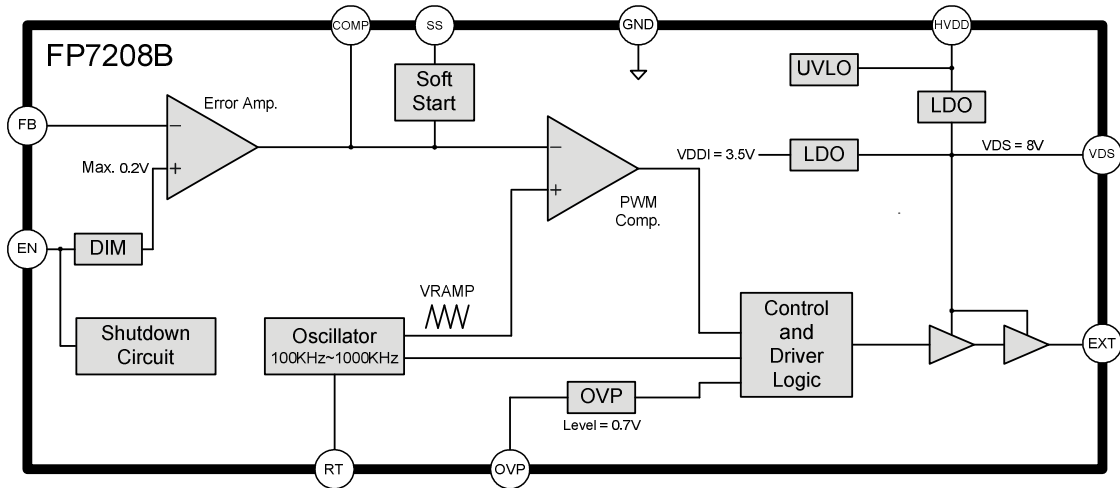
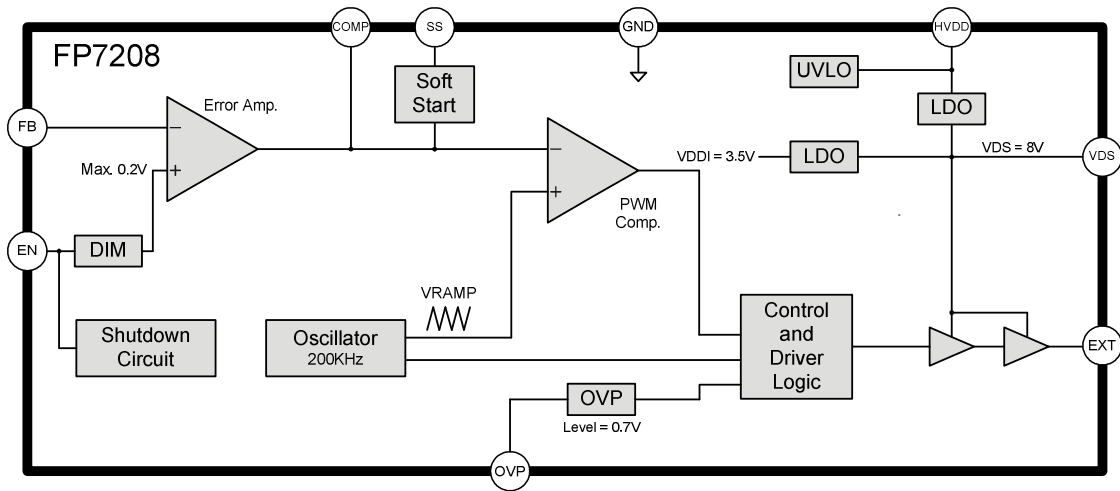
Applications

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

Typical Application Circuit



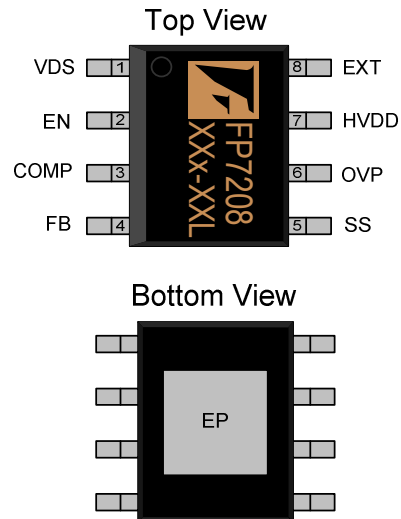
Function Block Diagram



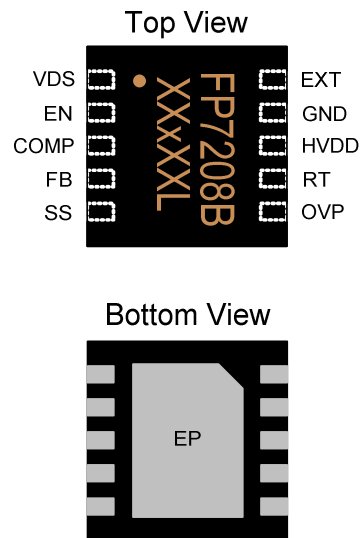
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Pin Descriptions

SOP-8L (EP)



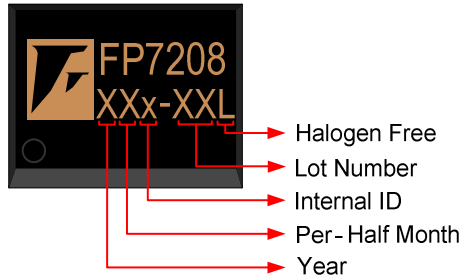
Name	No.	I / O	Description
VDS	1	P	Power Supply for Internal Control Circuits and Gate Drivers
EN	2	I	Enable and Dimming Control
COMP	3	O	Compensation
FB	4	I	Error Amplifier Inverting Input
SS	5	I	Soft Start Programming
OVP	6	I	Over Voltage Protection
HVDD	7	P	IC Power Supply
EXT	8	O	Gate Driver Output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



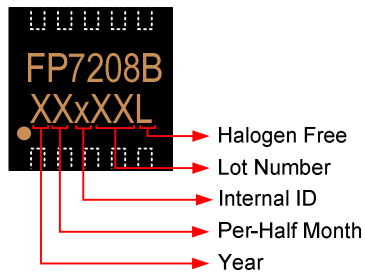
Name	No.	I / O	Description
VDS	1	P	Power Supply for Internal Control Circuits and Gate Drivers
EN	2	I	Enable and Dimming Control
COMP	3	O	Compensation
FB	4	I	Error Amplifier Inverting Input
SS	5	I	Soft Start Programming
OVP	6	I	Over Voltage Protection
RT	7	I	Frequency Programming
HVDD	8	P	IC Power Supply
GND	9	P	IC Ground
EXT	10	O	Gate Driver Output
EP	11	P	Exposed PAD – Connect to Ground

Marking Information

SOP-8L(EP)



DFN-10L



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

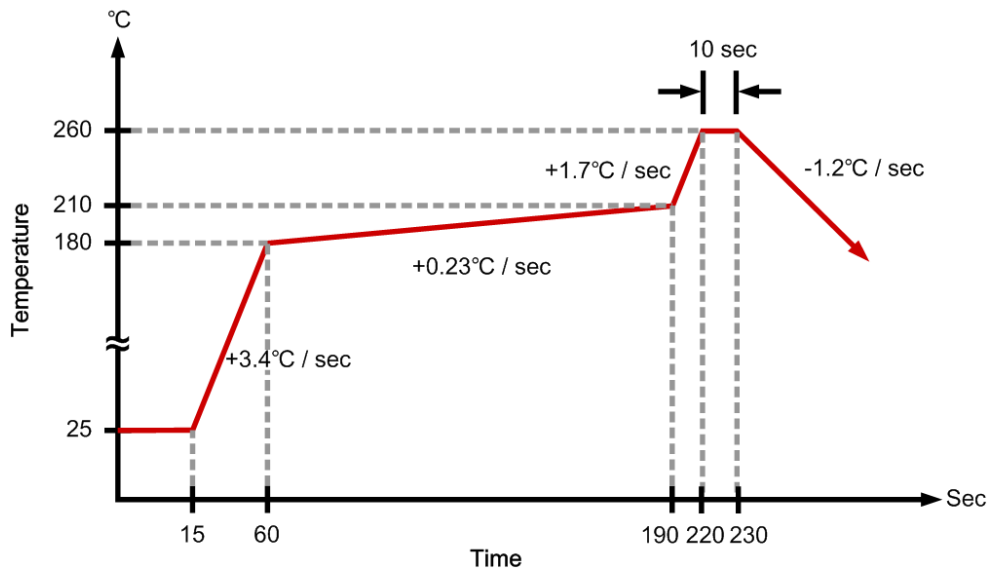
Ordering Information

Part Number	Operating Temperature	Package	MOQ	Description
FP7208XR-G1	-25°C ~ 85°C	SOP-8L(EP)	2500EA	Tape & Reel
FP7208BdR-G1	-25°C ~ 85°C	DFN-10L	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)	θ_{JA}	SOP-8L (EP)			+60	°C / W
		DFN-10L			+60	°C / W
Thermal Resistance (Junction to Case)	θ_{JC}	SOP-8L (EP)			+10	°C / W
		DFN-10L			+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		2.5		24	V
Operating Temperature Range	T _A	Ambient Temperature	-25		+85	°C

DC Electrical Characteristics (HVDD=12V, T_A=25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
System Supply Input						
Input Supply Range	HV _{DD}		2.5		24	V
Under Voltage Lockout	V _{UVLO}			2.2		V
UVLO Hysteresis				0.1		V
Average Current	I _{CC}	FB=0.05V, Switching		5		mA
Quiescent Current	I _{CC}	FB=0.15V, No Switching		245		μA
Shutdown Current	I _{CC}	V _{EN} =GND			6	μA
Input Supply Voltage	V _{DS}	HV _{DD} =12V, I _{DS} =0A		8		V
Oscillator						
Operation Frequency	f _{OSC}	FP7208		200		KHz
		RT=NC, FP7208B		200		KHz
		RT=50KΩ, FP7208B		500		KHz
Maximum Duty Ratio	%	FB=0.05V		90		%
Soft Start						
Soft-Start bias Current	I _{SS}	V _{SS} =0V		1.5		μA
Reference Voltage						
Feedback Voltage	V _{FB}	EN=Floating		0.1		V
		EN=2.25V		0.2		V
Enable Control						
Enable Voltage	V _{EN}		0.25			V
Shutdown Voltage	V _{EN}				0.15	V
External Transistor Connection current						
EXT Pull-UP Resistance	R _{EXTH}	V _{DS} =8V		1		Ω
EXT Pull-Down Resistance	R _{EXTL}	V _{DS} =8V		1		Ω
Over Voltage Protection						
OVP Threshold	V _{OVP}			0.7		V
Thermal Shutdown						
Thermal Shutdown Threshold	T _{TS}			+150		°C

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Function Description

Operation

The FP7208 and FP7208B are voltage mode boost controllers for LED driver. They operate with pulse width modulation (PWM), and change to PSM mode when outputs are light load. The internal resistive divider provides default 0.1V reference for the error amplifier. The maximum reference voltage is only 0.2V, 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.

Oscillator

The oscillator frequency can be set from 100KHz to 1000KHz by connecting a resistance between RT to ground. Acceptable resistance values range from 300KΩ to 20KΩ. The frequency is 200KHz when the resistance is unconnected. The relationship between the timing resistance RT and frequency is shown in Figure 1. The oscillator frequency can be calculated using formula below.

$$RT(K\Omega) = \frac{25000}{f_{OSC}(KHz)}$$

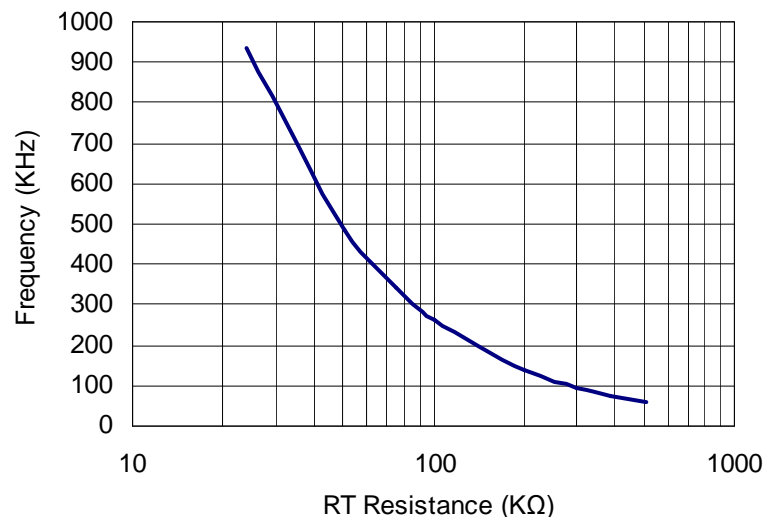


Figure 1. Frequency vs. RT Resistance

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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 6uA (max). The EN pin rising threshold is 0.25V. The EN pin voltage is 1.25V when it is floating for automatic startup application.

DC Dimming Control

The DC voltage is connected to EN pin to adjust the feedback voltage (V_{FB}) then LED current is also changed. The DC voltage is valid from 0.25V to 2.25V. The feedback voltage and LED current keep constant when the DC voltage is higher than 2.25V. The LED current (I_{LED}) can be calculated using formula below.

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

PWM Dimming Control

The PWM signal is connected to EN pin to adjust the feedback voltage (V_{FB}) then LED current is also changed. The EN pin is built-in components of filter to regulate PWM signal become a DC voltage. The DC voltage is valid from 0.25V to 2.25V. The feedback voltage and LED current keep constant when the DC voltage is higher than 2.25V. The PWM signal is recommended above 10KHz. The LED current (I_{LED}) can be calculated using formula below.

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

Over Voltage Protection

The gate driver signal is turned off when the voltage of OVP pin exceeds 0.7V. The voltage (V_{OVP}) can be calculated using formula below.

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

Thermal Shutdown Protection

The IC will shut down automatically when the internal junction temperature exceeds +150°C. The device can restart until the junction temperature drops below +120°C approximately.

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Application Information

Inductor Selection

Inductance value is decided based on different condition. 4.7μH to 22μH 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.

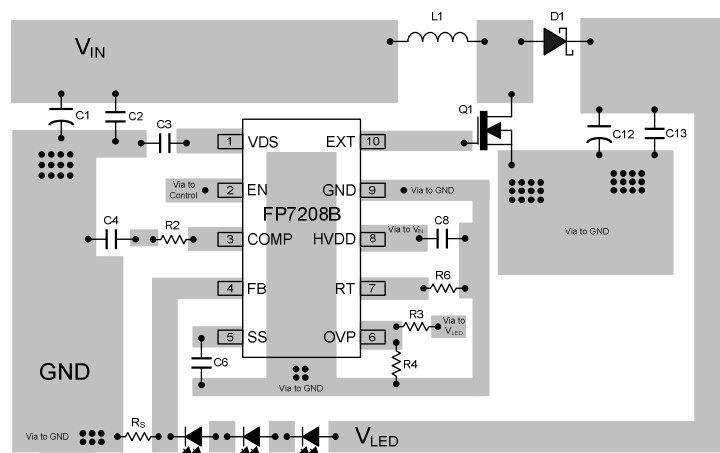
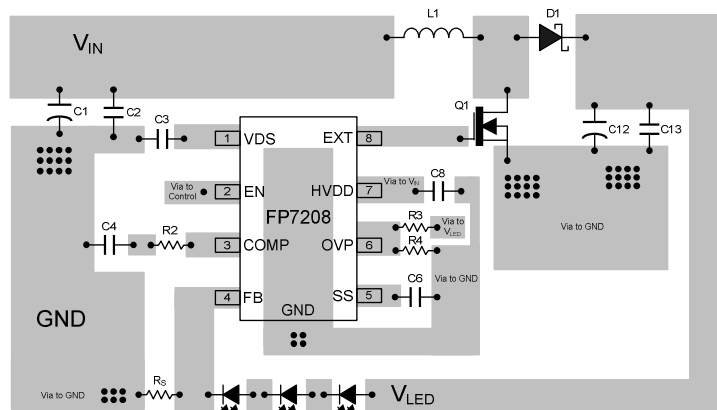
LED Current Programming

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

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

Layout Considerations

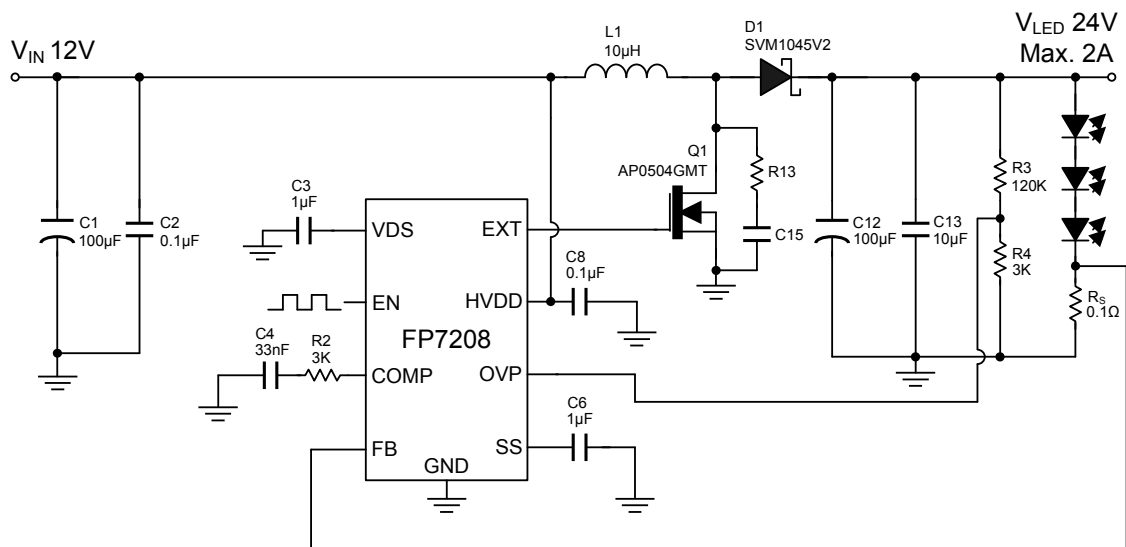
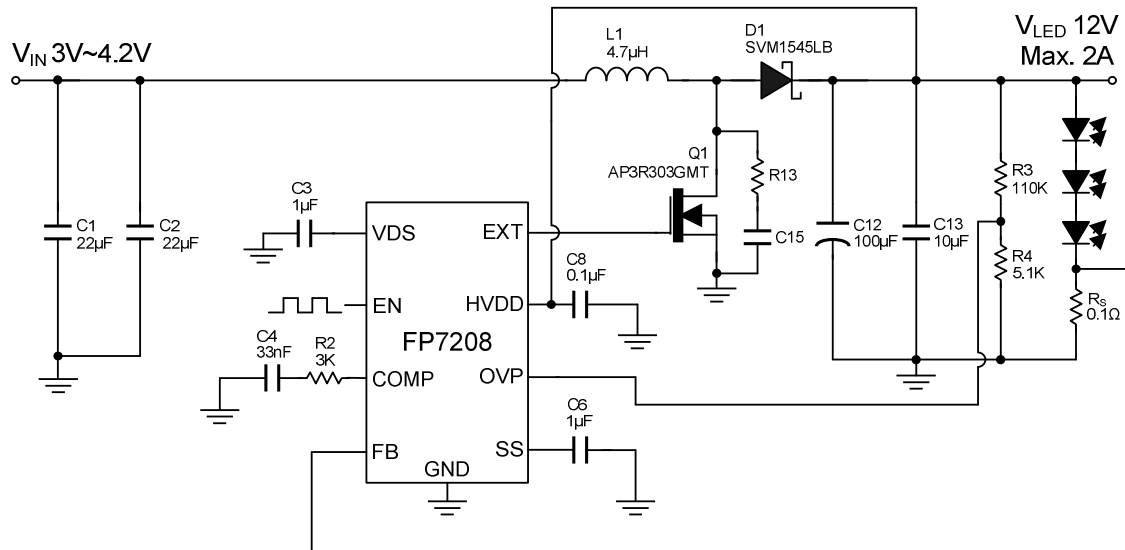
1. The power traces, consisting of the GND trace, the MOS drain trace and the V_{IN} trace should be kept short, direct and wide.
2. Layout switching node MOS drain, inductor and schottky diode connection traces wide and short to reduce EMI.
3. Place C8 nearby HVDD pin as closely as possible to maintain 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 Q1, 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 Q1.



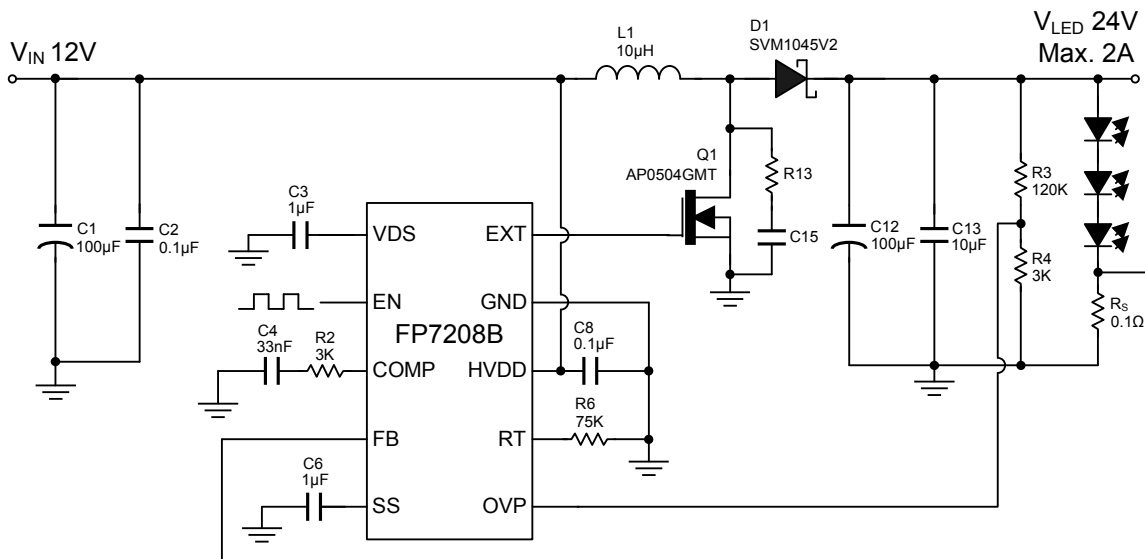
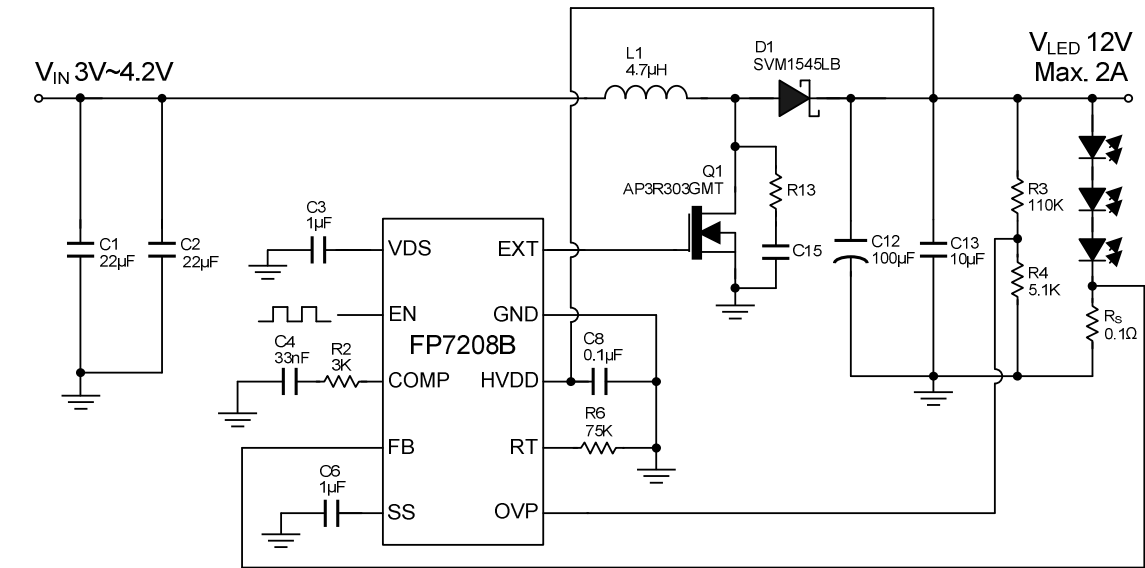
Suggested Layout

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Application Information



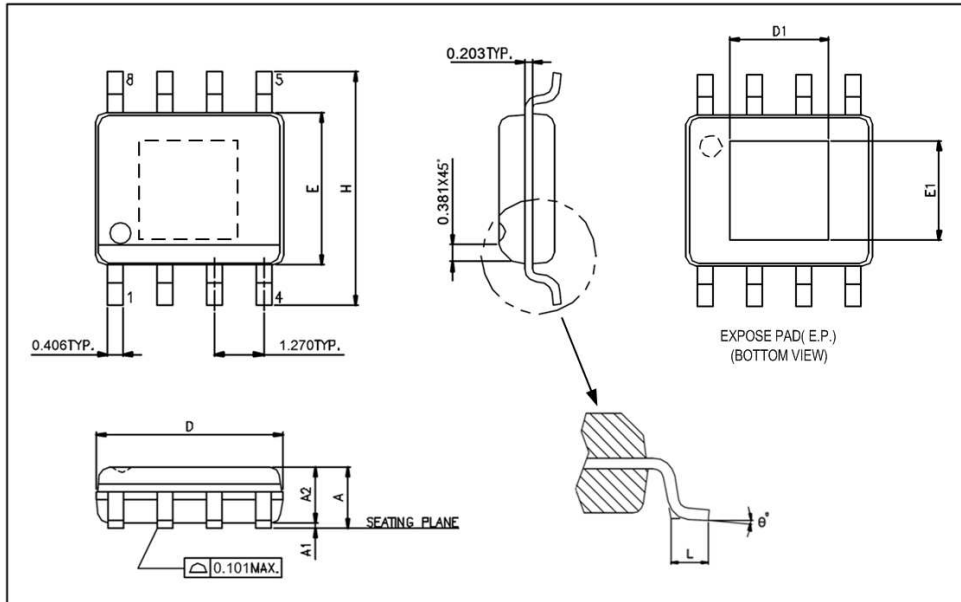
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Note:

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

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
θ°	0°	8°

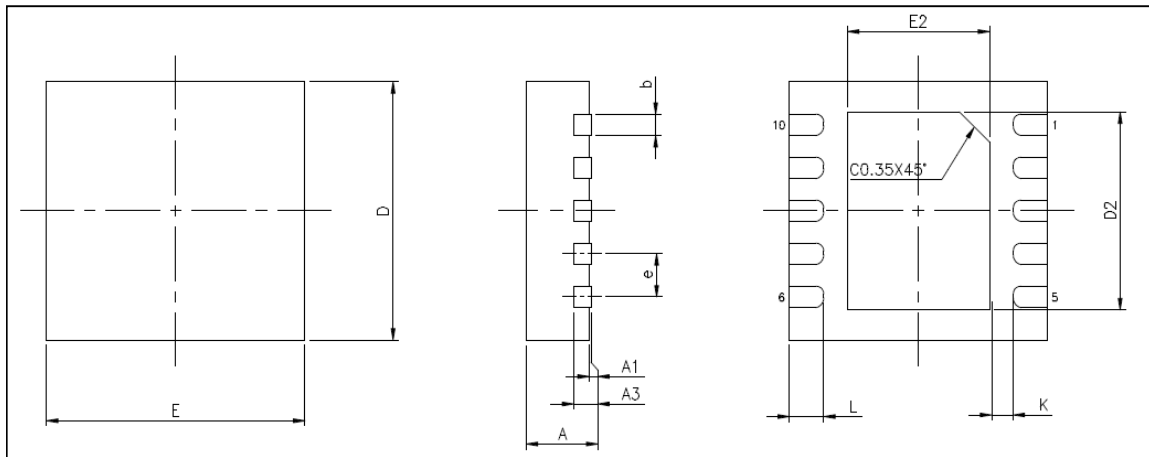
Exposed PAD Dimensions:

Symbols	Min. (mm)	Max. (mm)
E1	1.94	2.29
D1	1.94	2.29

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.

DFN-10L



Symbols	Min. (mm)	Max. (mm)
A	0.700	0.800
A1	0.000	0.050
A3	0.20REF	
b	0.180	0.300
D	3.00	
E	3.00	
D2	2.200	2.700
E2	1.400	1.750
e	0.500	
L	0.300	0.500
K	0.200	-

Unit: mm