TRUE CONSTANT CURRENT BUCK LED DRIVER

Features

- Built-in 600V power MOSFET
- Small package SOP-8, output current can be adjusted to 260mA
- Valley Switching with true constant current control, high efficiency and Low EMI
- PF up to 0.9 (Application Dependant)
- Primary inductance variation compensation
- Wide output voltage range
- Short circuit protection
- Over temperature protection
- Over voltage protection
- Few external components
- Operation temperature：-40 ~ 100℃

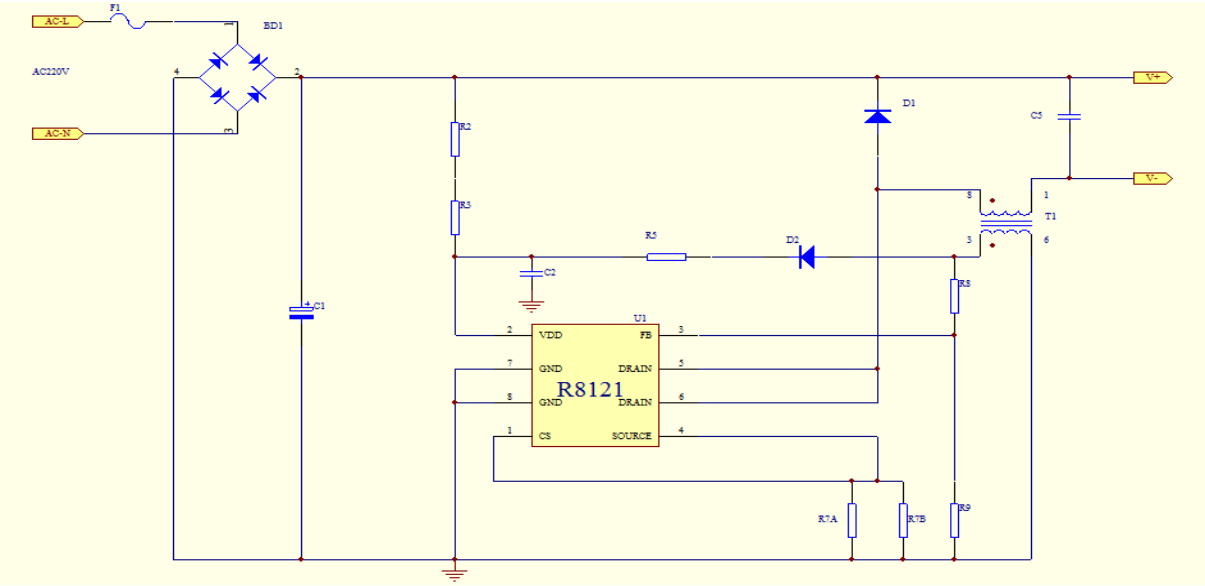
General Description

R8121 is specially designed for LED buck driver，R8121 is working under valley switching mode with constant current control，high efficiency and low EMI，PF can be adjusted to 0.9 with external valley fill circuit without 100Hz ripple；Output current is independent of primary inductance variation with very wide output voltage range.600V power MOSFET is built in R8121,output current can be higher to 260mA with tiny SOP-8 package and few external components.

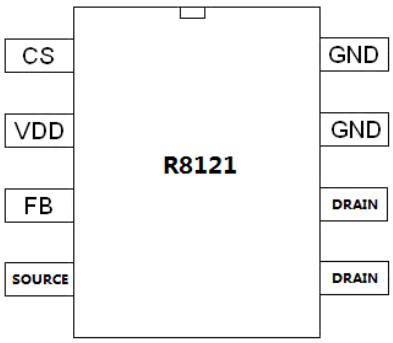
R8121 integrated bunch of protection features including over voltage protection (OVP), short circuit protection (SCP), cycle by cycle current limit and over temperature protection.

R8121 require very low startup current and operation current, the system with R8121 can be operated with full range of line voltage and 8-450V DC input voltage.

Typical Application



Pin Configuration



SOP8

Pin Description

Pin No.	Pin Name	I/O	Function Description
1	CS	I	Current sense input
2	VDD	POW	Power terminal
3	FB	I	Feedback signal input
4	SOURCE	O	Source terminal of MOSFET
5,6	DRAIN		Drain terminal of MOSFET
7,8	GND	POW	Ground terminal

Absolute Ratings

Parameter Name	Symbol	Maximum Ratings	Unit
Supply Voltage	VDD	-0.3~8.0	V
Voltage of input terminal	VI	-0.3~ VDD+0.3	V
Voltage of output terminal	VO	-0.3~ VDD+0.3	V
DRAIN voltage	VDRAIN	-0.3~600	

Power dissipation (at 25 ℃)	CF（SOP8）	PD	630	mW
Thermal Resistance (at 25 ℃)	CF（SOP8）	ΘJA	150	℃/W
ESD protection (Human Body Model)		ESD	2000	V
Storage Temperature		TSTG	-55~150	℃
Junction Temperature			150	℃
Soldering Temperature (soldering, 10 seconds)			300	℃

Note: Absolute maximum ratings are the parameter values or ranges which can cause permanent damage if exceeded. For maximum safe operating conditions, refer to Electrical Characteristics Table.

Electrical Characteristics Table(Unless otherwise specified，TA=25℃)

Parameter Name	Symbol	Test Conditions	Min	Typ	Max	Unit
Clamp Voltage	VDD	IVDD =1mA	6.1	6.8	7.5	V
VDD max sink current	IVDD	VDD sink current			10	mA
VDD startup voltage	VUVLO	VDD rise, Hys = 0.3V	5	5.5	6	V
Quiescent current	IST	Startup current		100	150	uA
CS Reference	VCS	TA=-45℃~85℃	410	420	430	mV
Minimum on time	TON(min)		500		800	nS
OVP threshold	VOVP		0.8	1.2	1.6	V
OTP temperature	TSD			140		℃
OTP hysteresis				20		℃
Rdson of HVMOS				4.1	5	Ω
MOS drain-source breakdown voltage	VDS(BV)		600			V

Block Diagram

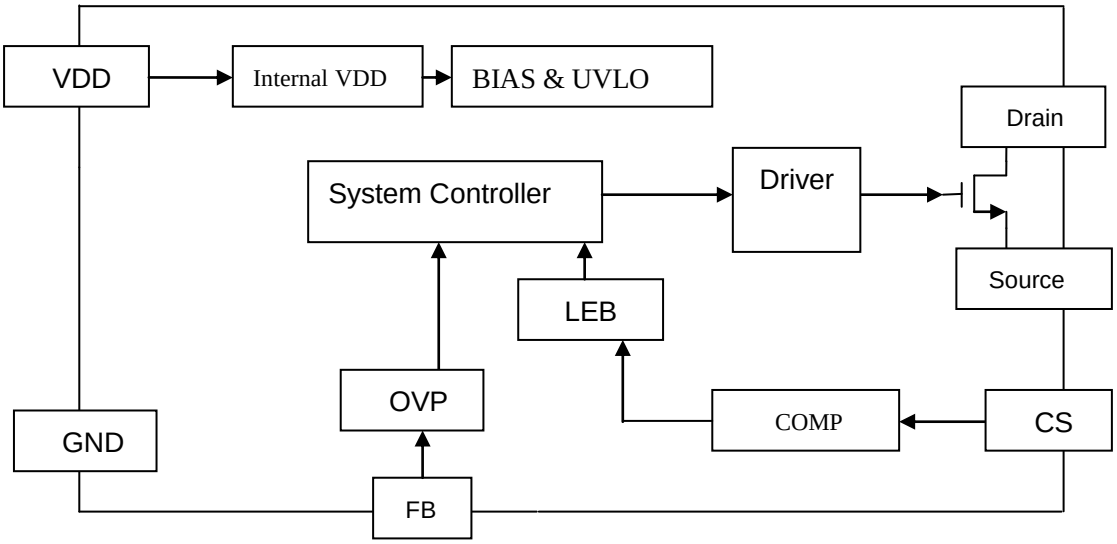


Fig. 1 R8121 Functional Block Diagram

Application Information

R8121 is a LED driver with true constant current control and valley switching mode. The LED current can be adjusted to 260mA with integrated 600V MOSFET and SOP-8 package. R8121 operated in valley-switching mode with few external components and very high efficiency (>90%).

Startup & Power Supply

R8121 startup current is very low, typically 100uA, if the minimum voltage of the system is 85V AC, the startup resistor should be $\frac{85*\sqrt{2}}{150}*10^6 = 801K$.

Primary and auxiliary winding turns ratio should be large enough to provide enough current to VDD of R8121, the following rules should be followed, $\frac{Np}{Na} = \frac{Vout}{9}$, Assume output voltage is 90V, Then $\frac{Np}{Na} = \frac{Vout}{9} = 10$

Current Sense Resistor

Current sense resistor is to sense the current when internal HVMOSFET is turned on. R8121 integrated a cycle by cycle current limit function. If CS internal threshold is reached, the system will turn off the internal HVMOSFET. The system operates at valley switching mode, output current is also controlled with peak current control.

Inductor peak current equation: $Ipk = \frac{420}{Rcs}(mA)$, Rcs is the current sense resistor

Output current equation： $Iout = \frac{Ipk}{2}(mA)$

Primary Inductance Design

After power up, R8121 will turn on the internal HVMOSFET, then the primary inductor current is gradually increased until the current limit is reached.

The internal HVMOSFET conduction time is as follows

$$Ton = \frac{Lp * Ipk}{Vin - Vled}(s)$$

Lp , primary inductance

Vin , rectified main input

$Vled$, forward voltage drop of LED

When the internal HVMOSFET turns off, the inductor current began to decline from the peak, when the inductor current drops to 0, the internal HVMOSFET will be turned on again.

The internal HVMOSFET off time is as follows:

$$Toff = \frac{Lp * Ipk}{Vled}(s)$$

The inductance calculation equation is as follows：

$$Lp = \frac{(Vin - Vled) * Vled}{f * Vin * Ipk}(s)$$

Where f is the operating frequency of the system, when Lp , $Vled$ and Ipk is constant, the operating frequency will follow the rectified main input voltage Vin . When the system operate at minimum Vin ,the frequency of the system can not be as low as audio frequency range; When the system operate at maximum Vin , the frequency of the system can not be higer than 100K, otherwise, the internal HVMOSFET will be very hot due to heavy switching loss.

FB Voltage Detection

R8121 monitors the output voltage by analyze the voltage waveform at FB, when inductor current decrease to zero, the voltage at FB will be proportional to output voltage. When FB monitor voltage is greater than 1.20V (typ), the R8121 will automatically switch to over voltage protection mode, the system will enter into hiccup mode with very low power loss, the output overvoltage value is as follows:

$$Voutovp = 1.2 * \frac{Np}{Na} * \frac{R9 + R8}{R9}(v)$$

R8, R9, please refer to Typical Application Diagram

Assuming VOUTOVP = 90V and R9=10K, R8 can be calculated from the equation above which is 102.5k, we can take 110k resistor.

At hiccup mode, R8121 detect output voltage automatically when the output voltage is lower than VOUTOVP, the system will re-enter the normal operating state.

Output Open/short circuit Protection

R8121 integrated with the output open-circuit protection and short circuit protection as well. R8121 Once detected output open/short ciurcuit, the system will automatically enter hiccup mode until the fault conditions are removed.

Over Temperature Protection

R8121 integrated with the over temperature protection function, the threshold of temperature is 140° C typically. When OTP is triggered, the system will resume to normal mode only when the temperature decrease to 120 ° C.

Input Filter Capacitor

Input filter capacitor should be as large as to ensure that the the rectified voltage value is always higher than the voltage of the LED string. A simple way to check the capacitance is too small or not is, when the input voltage gradually reduce to some point, the output current is not constant any more. At this condition, the input capacitor should be increased.

Power Factor Correction

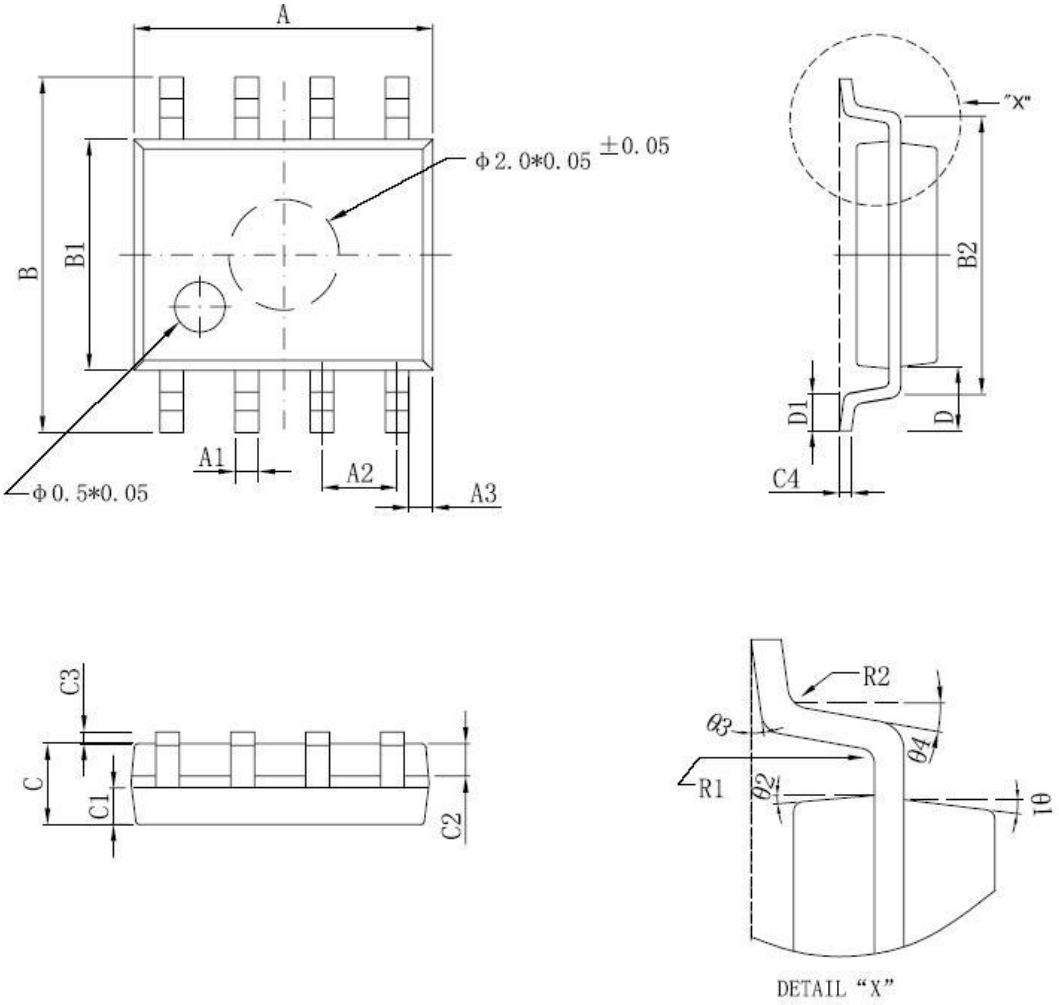
When the system has a power factor correction requirements, a simple passive power factor correction circuit (valley-fill) can be added, the circuit includes three diodes two capacitors may be the system power factor increased to above 0.9.

PCB Design Notice

- C2 should be as close as possible to VDD terminal
- Separate Chip ground and power ground; Separate the auxiliary ground and R9 ground
- Power loop and area should be as small as possible to improve EMI performance.

Package size

SOP8 package outline diagram and size (R8121CF),



尺寸 / 标注	最小（mm）	最大（mm）	尺寸 / 标注	最小（mm）	最大（mm）
A	4,95	5,15	C3	0,05	0,20
A1	0,37	0,47	C4	0.20TYP	
A2	1.27TYP		D	1.05TYP	
A3	0.41TYP		D1	0,40	0.60
B	5,80	6,20	R1	0.07TYP	
B1	3,80	4,00	R2	0.07TYP	
B2	5.0TYP		θ1	17° TYP	
C	1,30	1,50	θ2	13° TYP	
C1	0.55	0,65	θ3	0° ~8°	
C2	0.55	0.65	θ4	12° TYP	

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