JW1220

Controller for Adaptive 100/120Hz Current Ripple Removing Circuit

Parameters Subject to Change Without Notice

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FEATURES

- Controller for adaptive 100/120Hz current ripple remover
- Built-in zener diode for input voltage clamping
- VG output voltage high to 10V
- Programmable amplitude of LED current ripple
- Programmable maximum cathode voltage of LED
- Programmable maximum LED current
- Short protection
- Over temperature protection
- SOT23-6L Package

APPLICATIONS

- LED lighting

DESCRIPTION

JW1220 is a controller for driving external NMOSFET to remove the 100/120Hz LED current ripple on AC/DC power by a capacitor between VC and GND.

The adaptive technology of JW1220 ensures minimum power dissipation on NMOSFET while removing LED current ripple.

JW1220 clamps the input voltage on VIN pin by 30V. Only one resistor is needed when the output voltage of AC/DC power is higher than 30V.

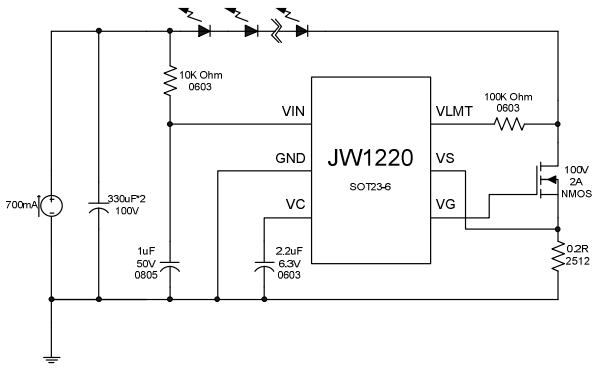
JW1220 allows user to setup maximum LED current by the sensing resistor between the source of NMOSFET and ground, which keeps NMOSFET damaged when LED short connected or hot-plug.

By sensing the drain voltage of NMOSFET via a resistor between the drain and VLMT pin, JW1220 allows user to setup the maximum cathode voltage of LED string, which could help limit the power dissipation on chip.

It's considered that LED is shorted when the cathode voltage of LED is higher than short connecting threshold and remains over 0.5 second. JW1220 shuts down NMOSFET when LED is shorted.

JW1220 provides over thermal protection. When OTP is trigged, the current removing function is blocked, and then the temperature decreases.

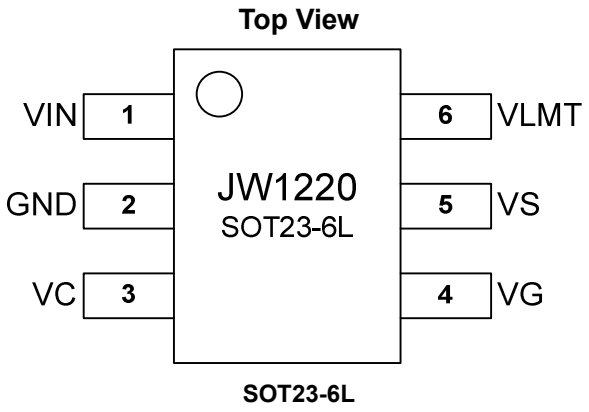
TYPICAL APPLICATION



ORDER INFORMATION

PART MARKING	PACKAGE DESCRIPTION	Top Marking	Package Form
JW1220	SOT23-6L	JW1220	Tape and reel packaging: 3000 pieces/tape

PIN CONFIGURATION



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ABSOLUTE MAXIMUM RATING

VIN clamp voltage. 30V
VG 20V
VS, VC, VLMT . . . . . -0.3V ~ 6V
Junction Temperature[2) 3)]. 150ºC
Lead Temperature . . . . . 260 ºC
Storage Temperature. . . . . —65 ºC ~ +150 ºC

RECOMMENDED OPERATING CONDITIONS

Maximum Junction Temperature (T_J). 150ºC

THERMAL RESISTANCE θ_{JA} θ_{Jc}

SOT23-6L . . . . . 50 . . . 10℃/W

Note:

1) Exceeding these ratings may damage the device.
2) The JW1220 guarantees robust performance from -40°C to 150°C junction temperature. The junction temperature range specification is assured by design, characterization and correlation with statistical process controls.
3) The JW1220 includes thermal protection that is intended to protect the device in overload conditions. Thermal protection is active when junction temperature exceeds the maximum operating junction temperature. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.
4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARATERISTICS

VIN = 12V, TA = 25ºC, unless otherwise stated.

Item	Symbol	Condition	Min.	Typ.	Max.	Units
VIN clamp voltage	V_{IN_CLP}		33	35	37	V
VIN operation current	I_{IN}	5V<VIN<33V	0.24	0.3	0.38	mA
VIN startup voltage threshold	V_{THULVO}		4.6	4.7	4.8	V
VIN startup voltage hysteresis	$V_{HYSUVLO}$			0.75		V
Maximum VG output voltage	V_{VG}		9.5	10	10.5	V
VC startup current	I_{VCST}	VC short to GND when startup	0.7	0.8	0.9	mA
VLMT reference voltage	V_{VLMTR}		1.95	2	2.05	V
NMOSFET drain voltage limit	V_{D_CLP}	Drain voltage of NMOSFET when voltage limit is trigged. R_{LIMIT}=100K.	3.4	4	4.6	V
SHORT protection threshold	V_{TH_SHORT}	Drain voltage of NMOSFET when SHORT is trigged. R_{LIMIT}=100K.	5	6	7.5	V
SHORT protection delay	TSP			0.5		s
VS voltage limit	V_{VS}		0.18	0.2	0.22	V

PIN DESCRIPTION

SOT23-6L Pin No.	Name	Description
1	VIN	Power Supply
2	GND	Ground
3	VC	LED Current Ripple Programming
4	VG	NMOSFET GATE driving voltage output
5	VS	LED current sensing input
6	VLMT	LED Voltage Limit and SHORT protection Programming

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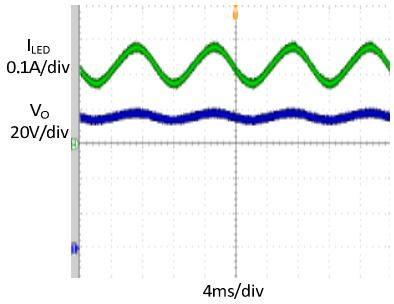
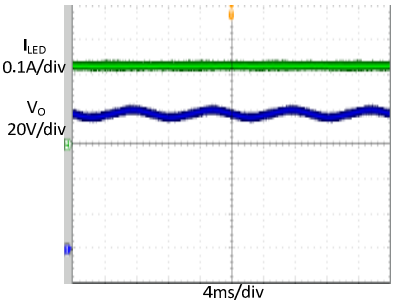
TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN}= 90~264V_{AC}, V_{OUT}=75V, I_{OUT}=240mA, COUT= 100μF/100V*2, TA = +25°C, unless otherwise noted

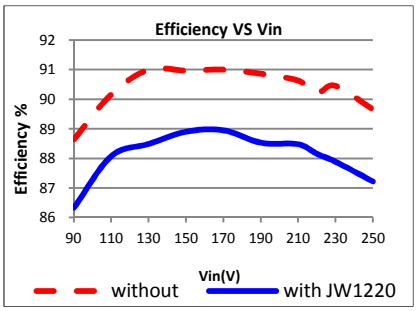
Pre-driver Output Steady State



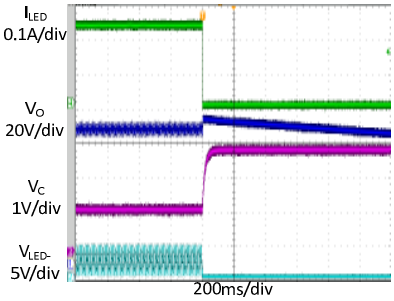
+JW1220 Output Steady State



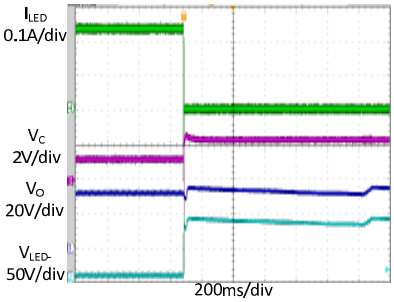
Efficiency comparison(with and without JW1220)



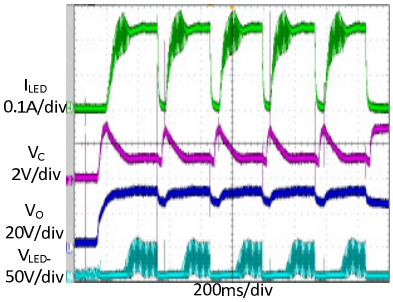
Open Circuit protection Test



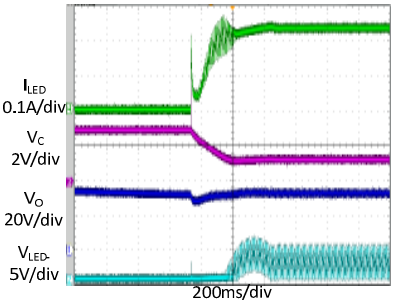
Short Circuit Protection Test



Continuous power on/off test



LED Hot plug



FUNCTIONAL DESCRIPTION

JW1220 is a controller for driving external NMOSFET to remove the 100/120Hz LED current ripple on AC/DC power.

Theory of Operation

The LED string and JW1220 are both supplied by an AC/DC current source. The drain of external NMOSFET is connected to the cathode of LED string. A sensing resistor R_{SENSE} is connected between the source of NMOSFET and GND. The gate is connected to the VG of JW1220.

JW1220 drives NMOSFET to transfer the LED current ripple to voltage ripple on NMOSFET, and ensures the constant voltage across LED string and the current flow through LED string.

The scalable adaptive function of JW1220 can regulate the cathode voltage of LED string to minimum to improve the efficiency of the system.

Current Ripple Removing

The capacitor C_C between VC and GND is a integration capacitor. JW1220 transform the voltage on C_C to a reference voltage. The current regulator regulates the voltage on R_{SENSE} equal to the reference voltage.

The relationship between the voltage on C_C and R_S is shown as following:

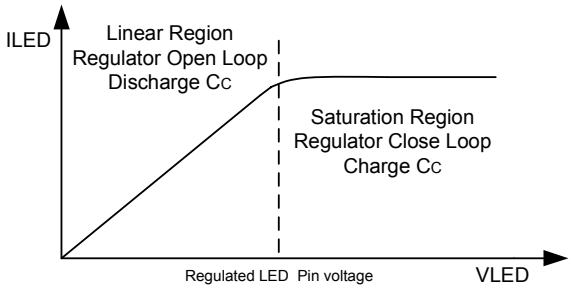
$$V_{RS} = I_{LED} * R_{SENSE} = V_{VC} / 10$$

C_C should be large enough in order to remove the current ripple of the LED string. However, too large capacitor may slow down the dynamic response.

Adaptive Regulation

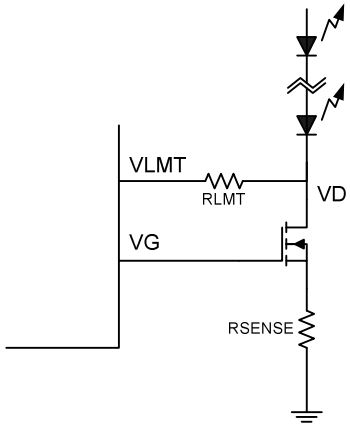
JW1220 control the voltage on C_C by monitoring the operation state of external NMOSFET. The efficiency of system is relatively low when NMOSFET is working in the saturation region. JW1220 detects it and charges C_C to raise the V_{VC} and I_{LED}, then the output voltage of power supply is reduced, and the voltage drop on NMOSFET decreases.

Conversely, when NMOSFET is working in the linear region, LED current regulation loop is open. JW1220 detects it and discharges C_C to reduce the V_{VC} and I_{LED}, then the output voltage of power supply is raised, and the LED current regulation loop is close.



Drain Voltage of NMOSFET Limit

The voltage ripple on the drain of NMOSFET maybe very large when the current ripple is removed, which would bring large power dissipation on chip. The resistor between the drain of NOMSFET and VLMT pin can setup the limit value of drain voltage of NMOSFET.



The limit threshold is calculated as below:

$$V_{limit} = 2V + R_{LMT} * 20uA$$

LED Current Limit

The voltage of VS pin is limited to 0.2V internally. So the current limitation is $0.2V/R_S$.

Current limit can protect the chip when LED is short connected or HOT-PLUG.

The function of current limit is higher priority than drain voltage limit. It means that the voltage on drain of NMOSFET is not limited when LED current exceed current limit threshold.

LED Short Protection

JW1220 detect SHORT by R_{LMT}. When the drain voltage of NMOSFET exceeds the SHORT PROTECTION THRESHOLD and the state holds for more than 0.5 second, JW1220 considers the LED string is SHORT connected, and shut down the external MOSFET. The shut down state is latched until system restart.
The SHORT PROTECTION THRESHOLD is calculated as:

$$V_{THSCP} = 2V + R_{LMT} * 40uA$$

Over Thermal Protection

JW1220 monitors operation temperature. When the temperature is higher than 135℃, the current ripple removing function is blocked, which could help NMOFSET cooling.

Over thermal protection will not be reset until the system restart.

PCB Design Guideline

1. The bypass capacitor of VIN should be placed as close as possible to the VIN pin and GND pin of IC.
2. JW1220 should be placed far away from the power devices such as MOSFET and SBD.
3. The area of LED current loop should be as small as possible.

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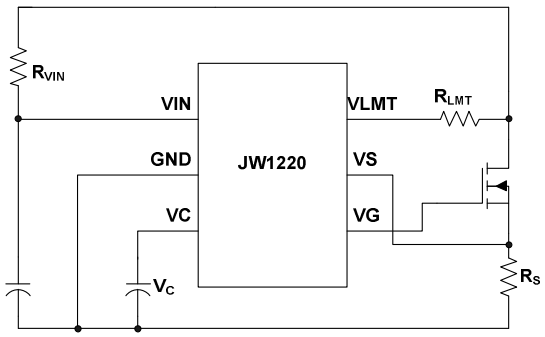
APPLICATION NOTE

JW1220 design guide:



1. Because of the 30V zener integrated and the 4.6V V_{IN} start threshold, the value of R_{VIN} may satisfy the following conditions:

$$R_{VIN} < \frac{V_F - 4.6V}{0.5mA}$$

V_F: the voltage of LED

2. The maximum voltage of VS pin is 2V in order to limit the maximum output current especially in the short circuit condition. The value of R_S can be calculated as below:

$$R_S < \frac{0.2V}{I_{LED}}$$

I_{LED}: the output current of the pre-driver

3. When the voltage of LED- reaches V_{SCP} which is set by the R_{LMT}, JW1220 pulls down the VIN then turns off the MOSFET. In order to ensure nothing will be damaged in the short circuit condition, the value of R_{LMT} must satisfy the following conditions:

$$V_{OVP} - V_F < V_{SCP} < V_F$$

$$V_{SCP} < V_{INSTART} = R_{VIN} * 0.5mA + 4.6V$$

$$V_{SCP} = 2V + 40uA * R_{LMT}$$

V_{OVP}: the output voltage when the pre-driver is open.

V_{SCP}: the threshold of JW1220 short circuit protection.

$V_{INSTART}$: the output voltage of the pre-driver when the VIN of JW1220 is 4.6V.

4. The value of the capacitor between VC and GND can determine the final amplitude of the current ripple. It should be large enough in order to remove the current ripple of the LED string. However, too large capacitor may slow down the dynamic response. In normal condition, 1uF or 2.2uF is relatively reasonable.
5. To ensure JW1220 work properly, the R_{DSON} of MOSFET must be less than R_S. The MOSFET will endure a large power shorting the output on the moment, so the appropriate package and R_{DSON} of the MOSFET is necessary.
6. When short the LED, there is an overshoot on the drain of the MOSFET. The breakdown voltage of the MOSFET must be higher than V_{OVP}. A diode connected to LED+&LED- can reduce the overshoot when short.

REFERENCE DESIGN

Reference：

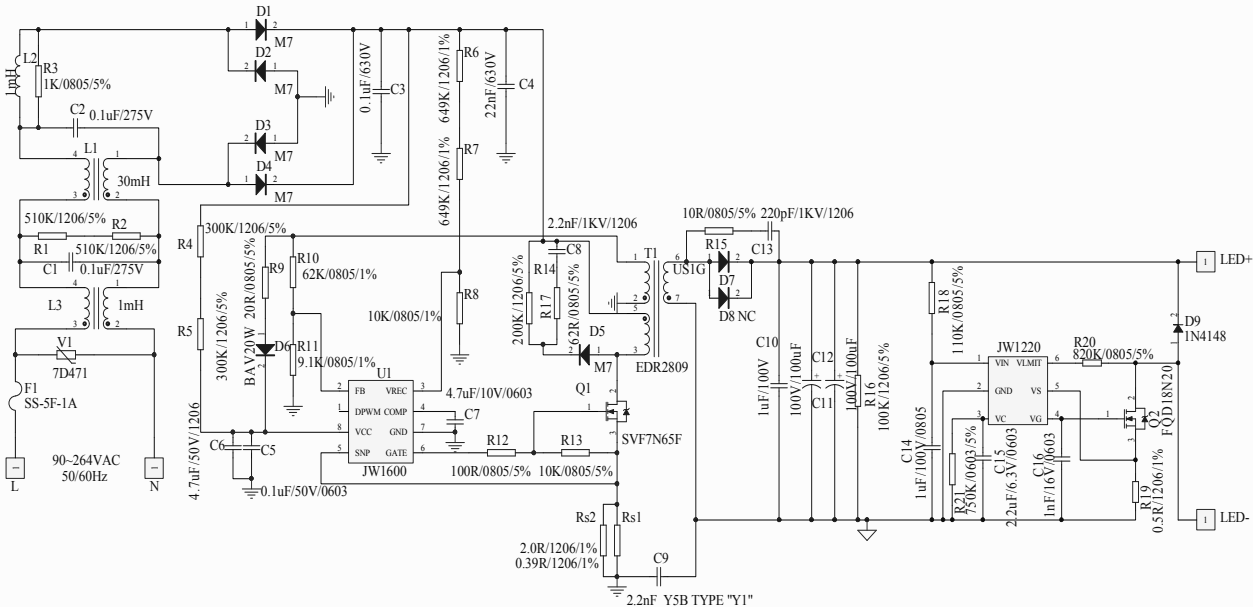
V_{IN}: 90~260VAC

V_{OUT}: 75V

I_{OUT}: 240mA

PF: >0.9

Current ripple:<5%



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PACKAGE OUTLINE

SOT23-6L UNIT: mm