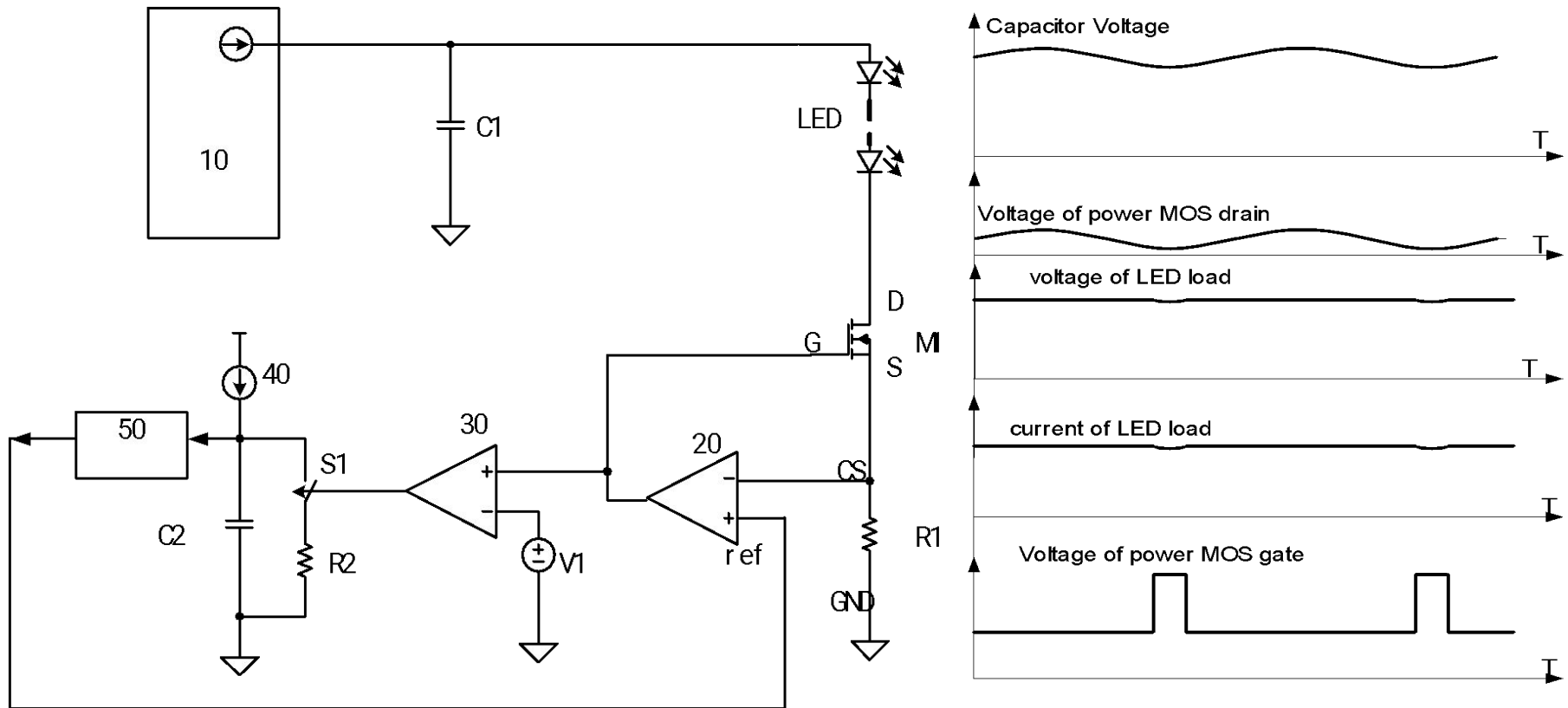




# BP560X System Application Notes

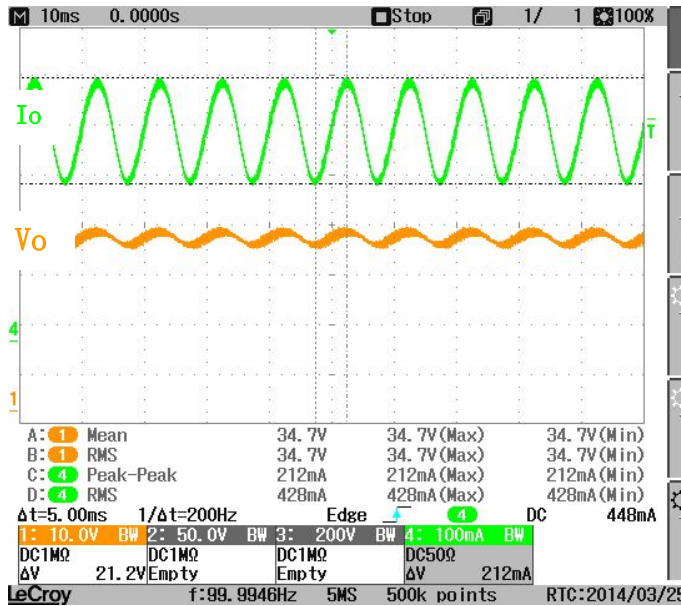
- ◆ Patent
- ◆ Effect
- ◆ Typical Applications / Overview
- ◆ Examples of Design
- ◆ Considerations of Design

## BP560X Patent

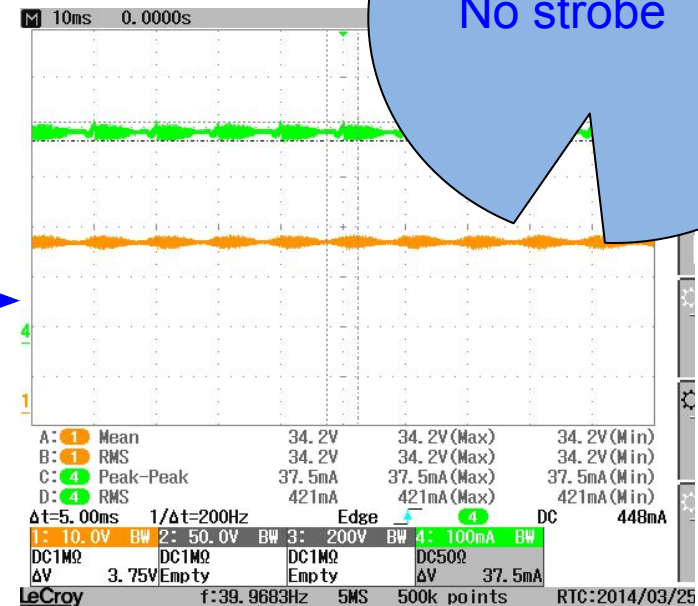


- ◆ Patent application number in China : CN201310218482 ;
- ◆ Patent application number in America : 14-039072

## BP3316D+BP5609 (36V/430mA)



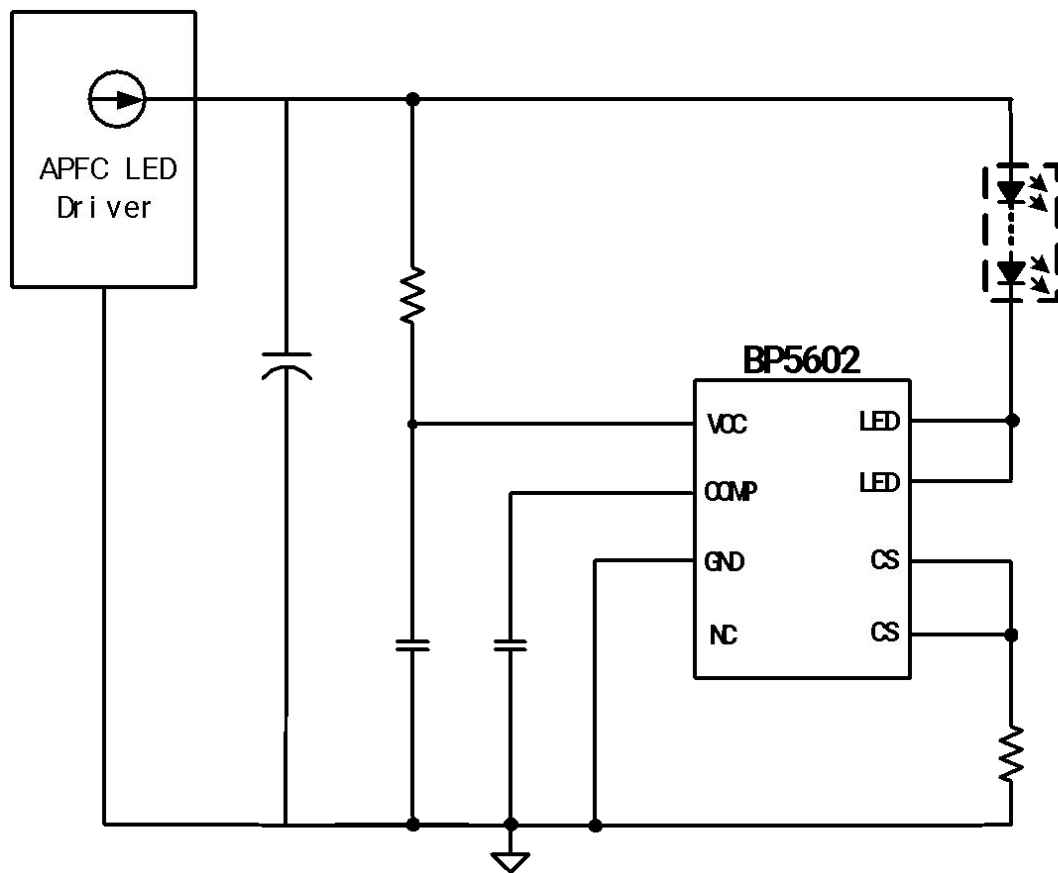
+5609



The Ripple is decreased, No strobe

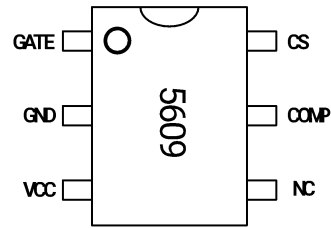
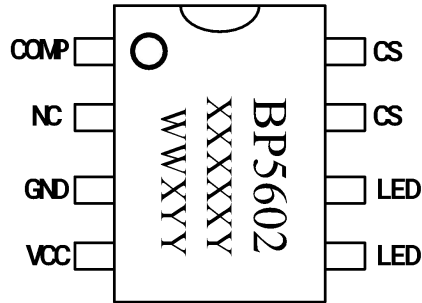
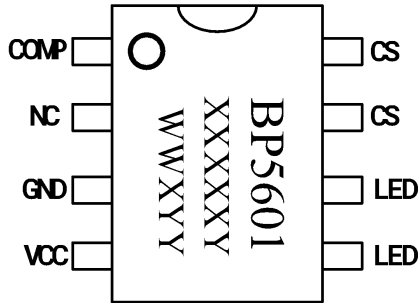
- After the current loop is closed, the current and voltage on the LED are DC ;
- The voltage ripple will be superimposed on the MOSFET

## Overview of the BP5602 high PF and non - strobe solution



- ◆ high efficiency
- ◆ Suitable for a variety of single-stage APFC circuit
- ◆ Peripheral components are simple
- ◆ The magnetic components are not required
- ◆ Wide range of output voltages
- ◆ Wide range of output current
- ◆ Under-voltage protection of Chip power supply
- ◆ Over-temperature protection

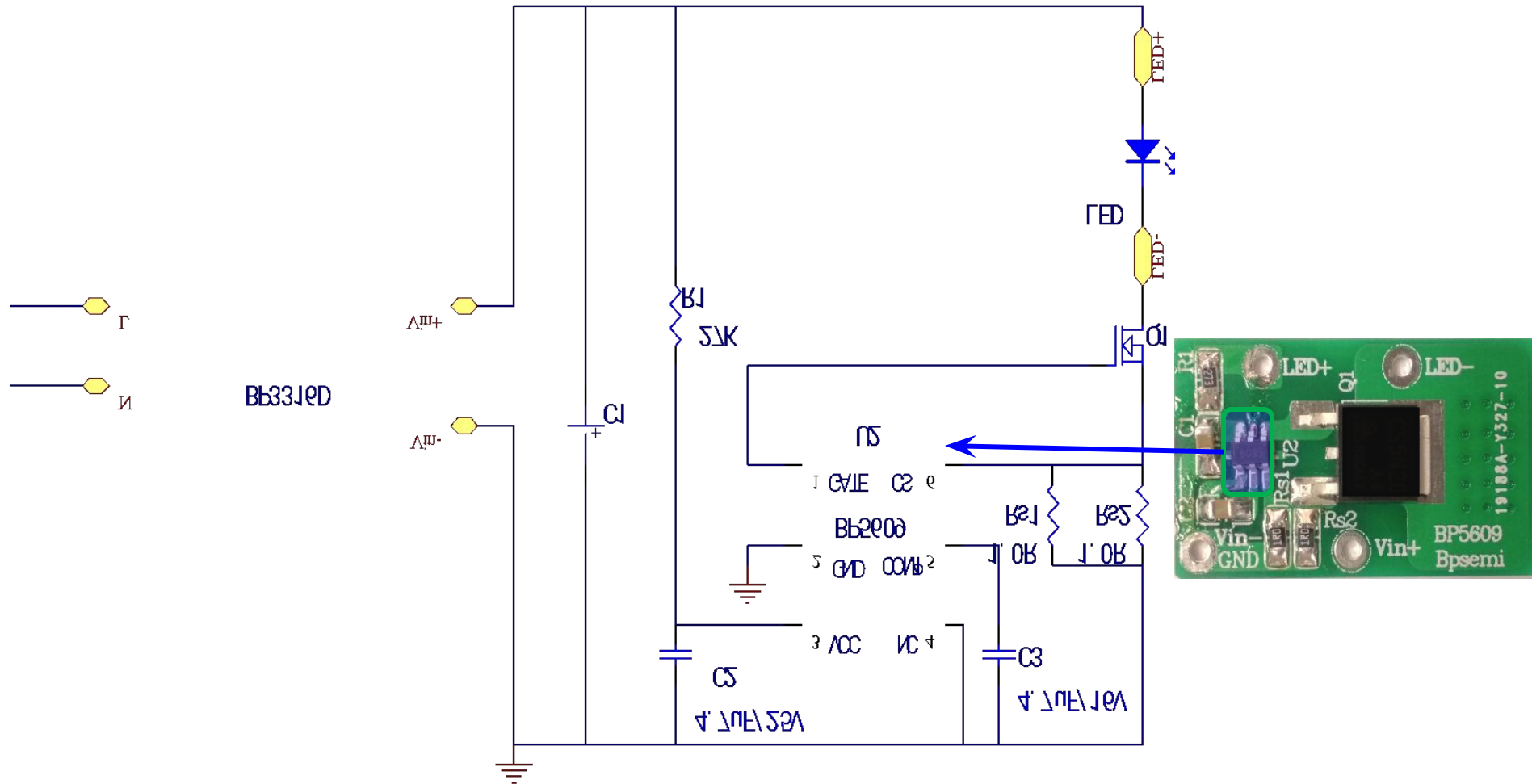
## BP560X Pin-Out & Applications



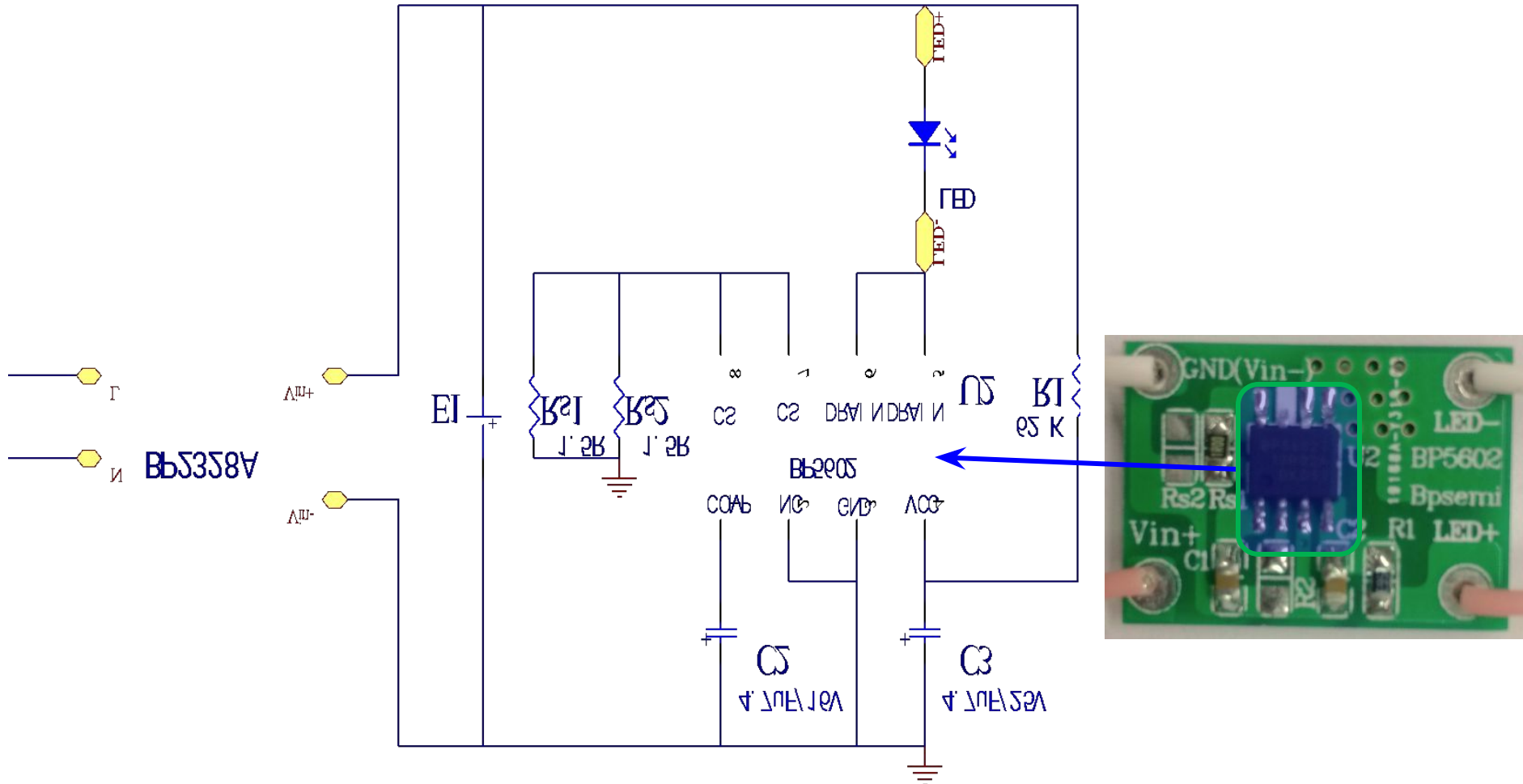
Part No.	MOS	Package	Io(max)
BP5609	External	SOT23-6	Depending on the MOS temperature
BP5601	100V/0.2ohm	SOP-8	220mA
BP5602	200V/0.5ohm	SOP-8	220mA

- The maximum output current, and the output capacitor capacity depend on chip cooling conditions
- The above data test conditions for the output capacitor select 1uF / mA, the chip temperature control in 50 °C or less

## BP5609 Typical Applications ( $V_o=36V; I_o=440mA$ )



## BP5602 Typical Applications ( $V_o=76V; I_o=220mA$ )



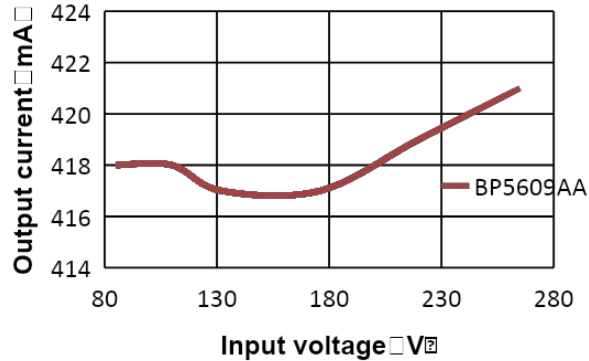


# Examples of Design

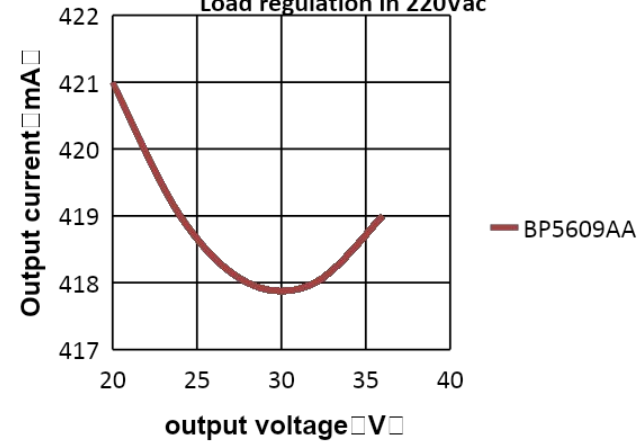


## BP3316D+BP5609 (36V/430mA)

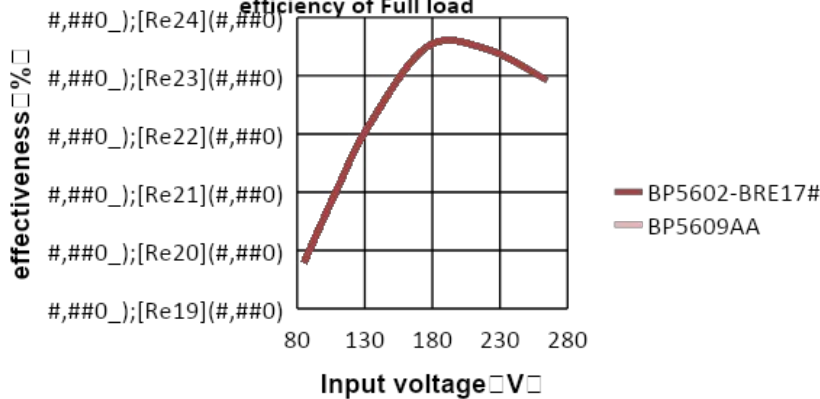
Linear adjustment rate of Full load



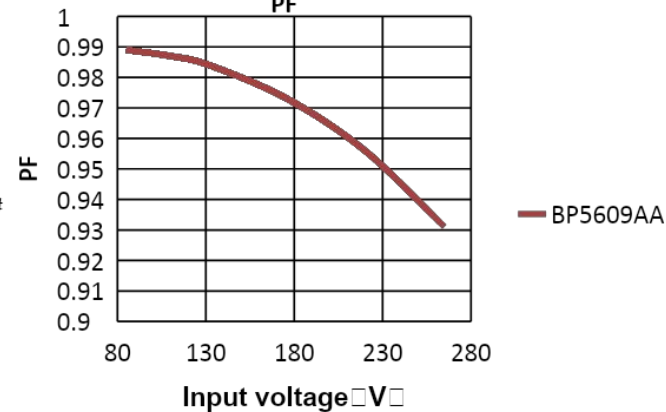
Load regulation in 220Vac



efficiency of Full load



PF



- no-affect to the linear load regulation, and PF / THD; efficiency decreased by about 2 percentage points .

## Selection of pre-output capacitor

- According to the output current, it is recommended to select the pre-output capacitor of  $1\mu\text{F} / \text{mA}$

Capacitance is too large, when from open or normal work to short-circuit it is more likely to burn, and it is not helpful to the system efficiency

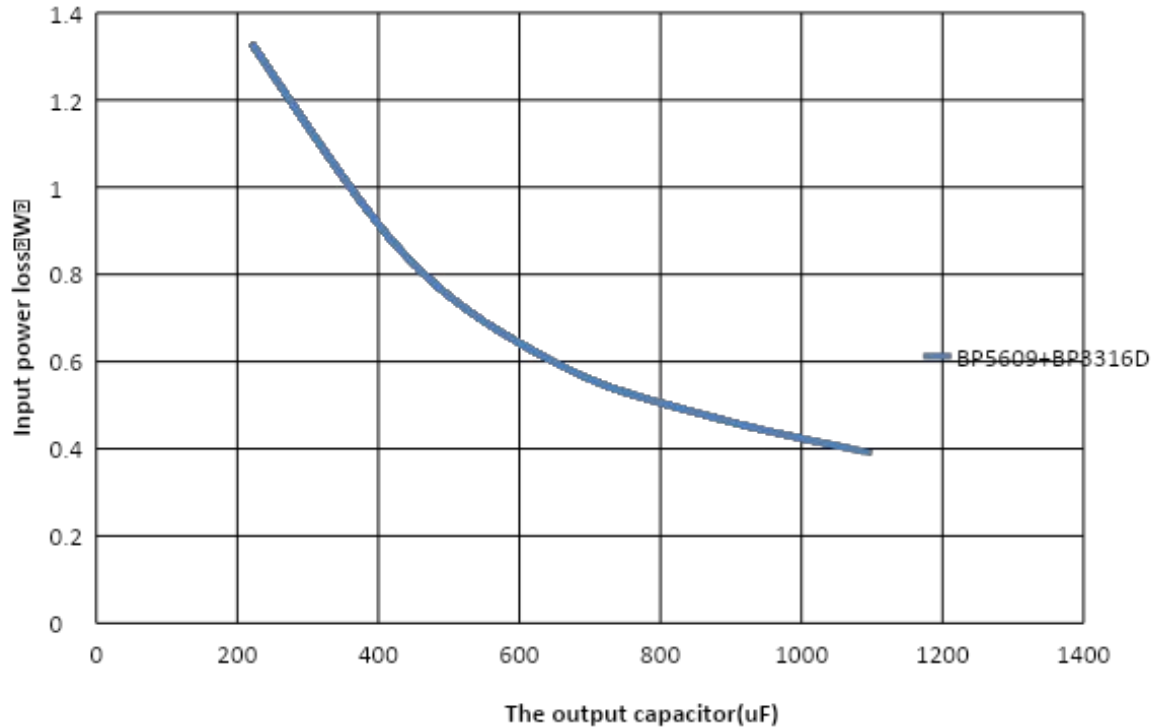
- The pre-output capacitor is larger, the ripple amplitude is lower, the temperature of chip is lower
- The per-input capacitance is larger, the efficiency of the system loss with the BP560X is lower

# Examples of Design



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Power Loss VS Output Cap



- BP3316D + BP5609 36V / 430mA, the output capacitor 440uF, the loss of about 2 to 3% efficiency

# Examples of Design

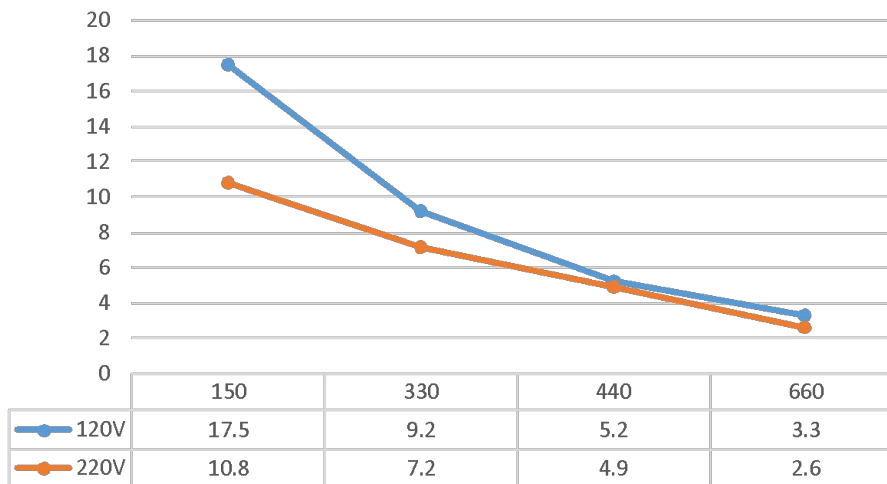


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Output 40V 235mA, the relationship between input electrolysis and output ripple

input electrolysis ( $\mu\text{F}$ )	Output ripple ( $I_{p-p}/I_{\text{mean}}$ )	
	120Vac (%)	220Vac (%)
150	17.5	10.8
330	9.2	7.2
440	5.2	4.9
660	3.3	2.6

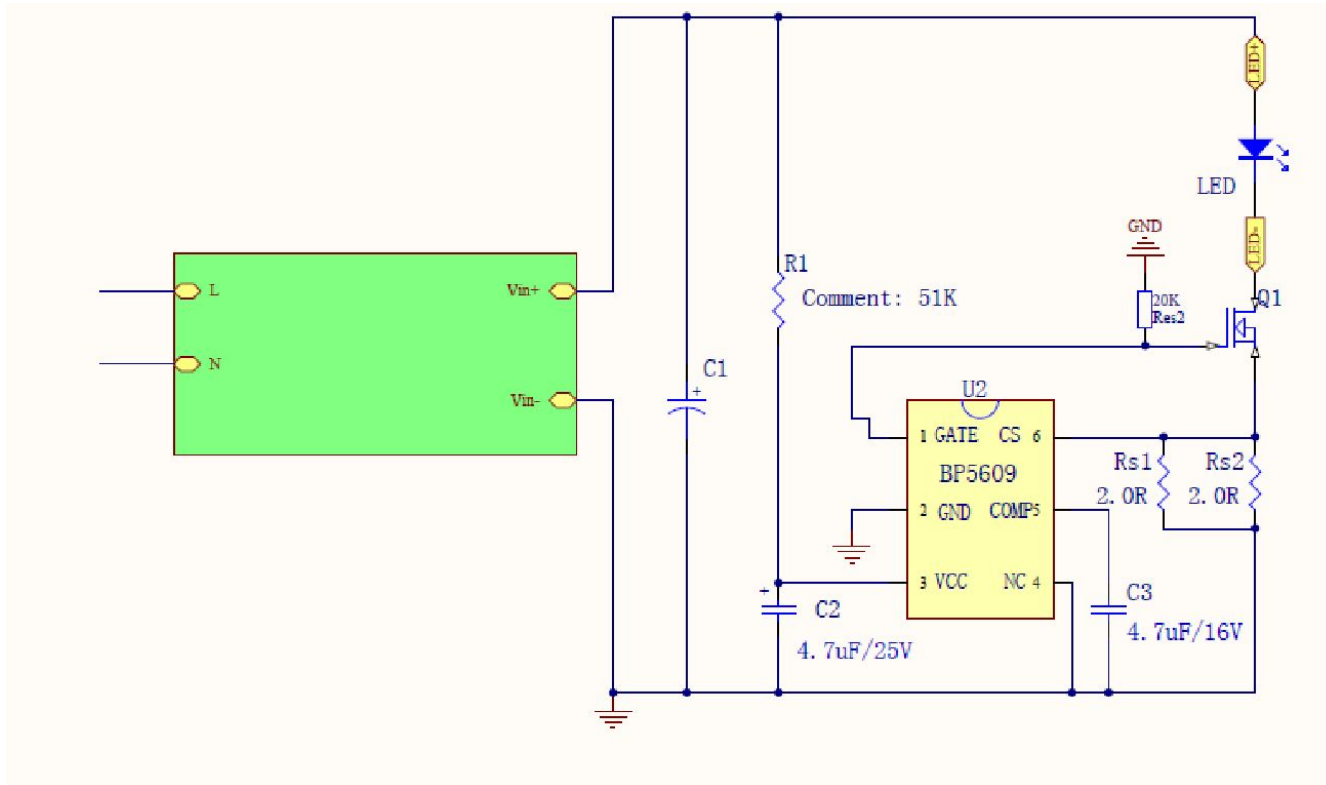
Input electrolysis VS output ripple



Electrolytic capacitors play an important role in the size of the output ripple

## Other way to removal ripple spikes

1、 In the external MOS between G and ground series resistance or capacitance, it had no effect in ripple spikes

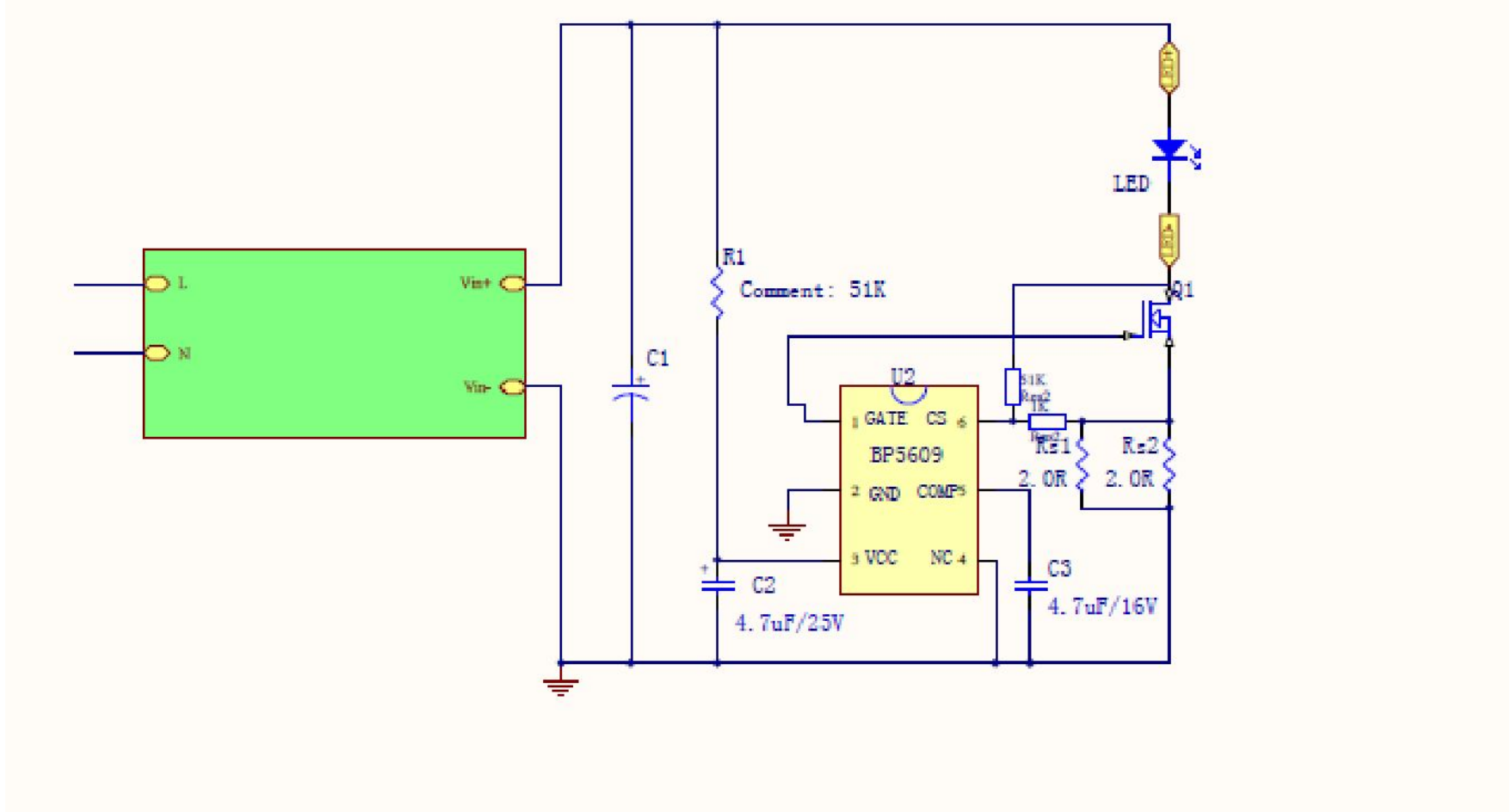


# Examples of Design



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3、From the external MOS G pole leads feedback to the IC's CS pin, it has no effect in the ripple peak

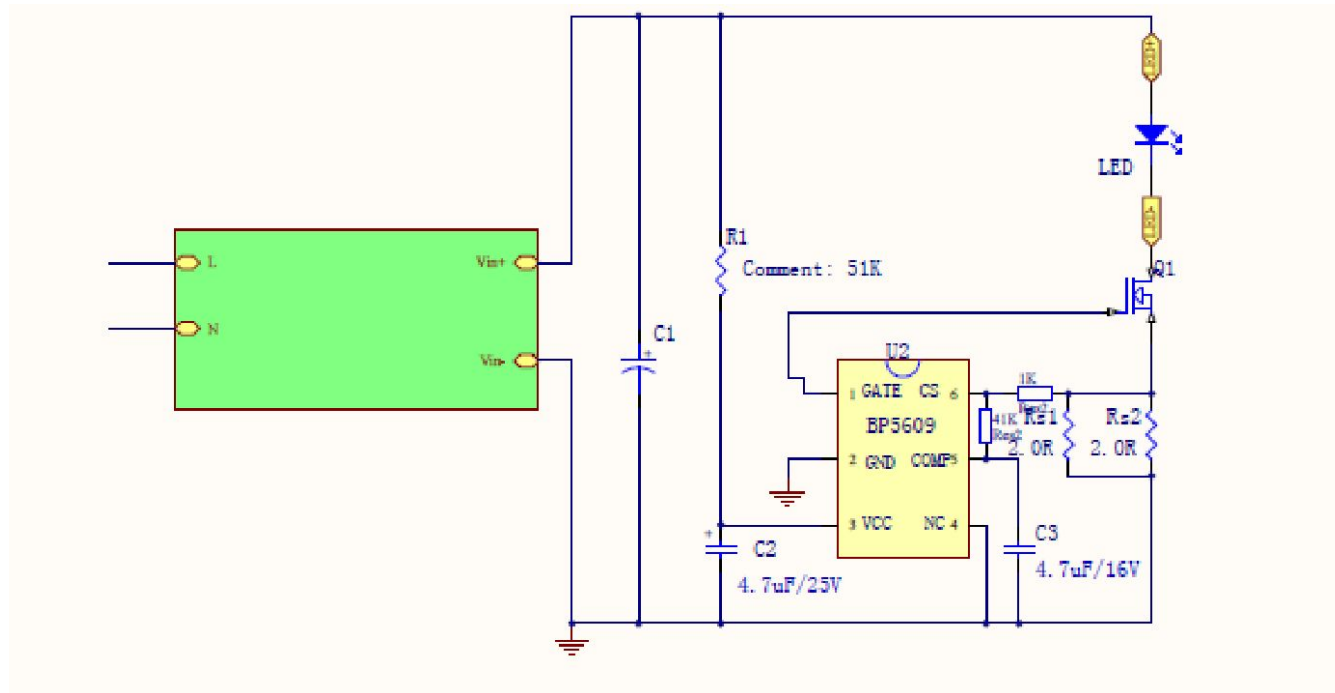


# Examples of Design

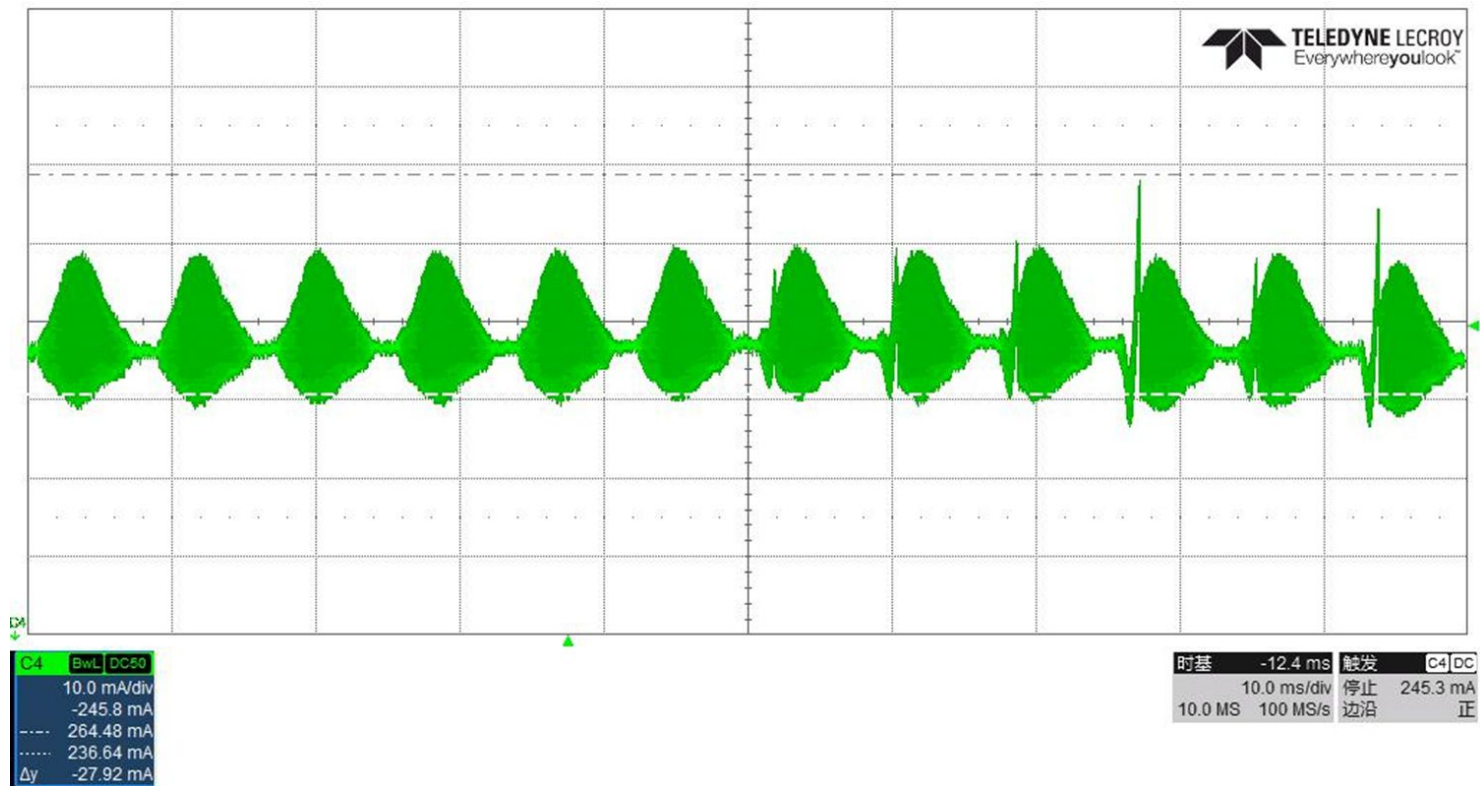


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3、 From the IC's COMP pin leads to a feedback to the CS pin, it had elimination of the role of the peak ripple. But, easy to damage the IC and external MOS.



## The output current waveform after from the IC's COMP pin leads to feedback





## Pre-APFC'S capacitor parameters requirements

- Pre-APFC'S COMP capacitor capacitance should not be greater than 1uF, otherwise the LED will flash

## Start resistor and VCC capacitor selection

- The starting resistor is selected according to the output LED voltage and should be calculated with the minimum LED voltage

$$R_{START} \approx (V_{LED} - 16V) * 1000$$

- VCC capacitor is recommended to select 4.7uF / 25V;  
Due to the voltage coefficient of the chip capacitors, electrolytic capacitors are recommended

## COMP capacitor selection

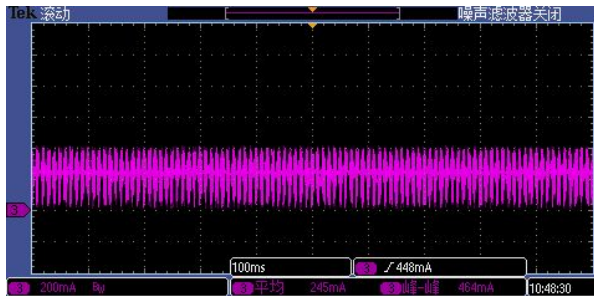
- COMP capacitor is recommended to select 4.7uF / 16V (0805)

## CS Resistor Selection

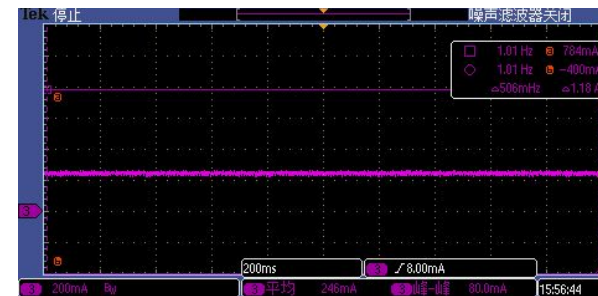
According to the output LED average current to select CS resistor

$$R_{cs} \approx \frac{0.2V}{I_{out}}$$

In the calculation of the results, increasing the CS resistor can further reduce the output ripple, but will lose efficiency, increase the temperature.



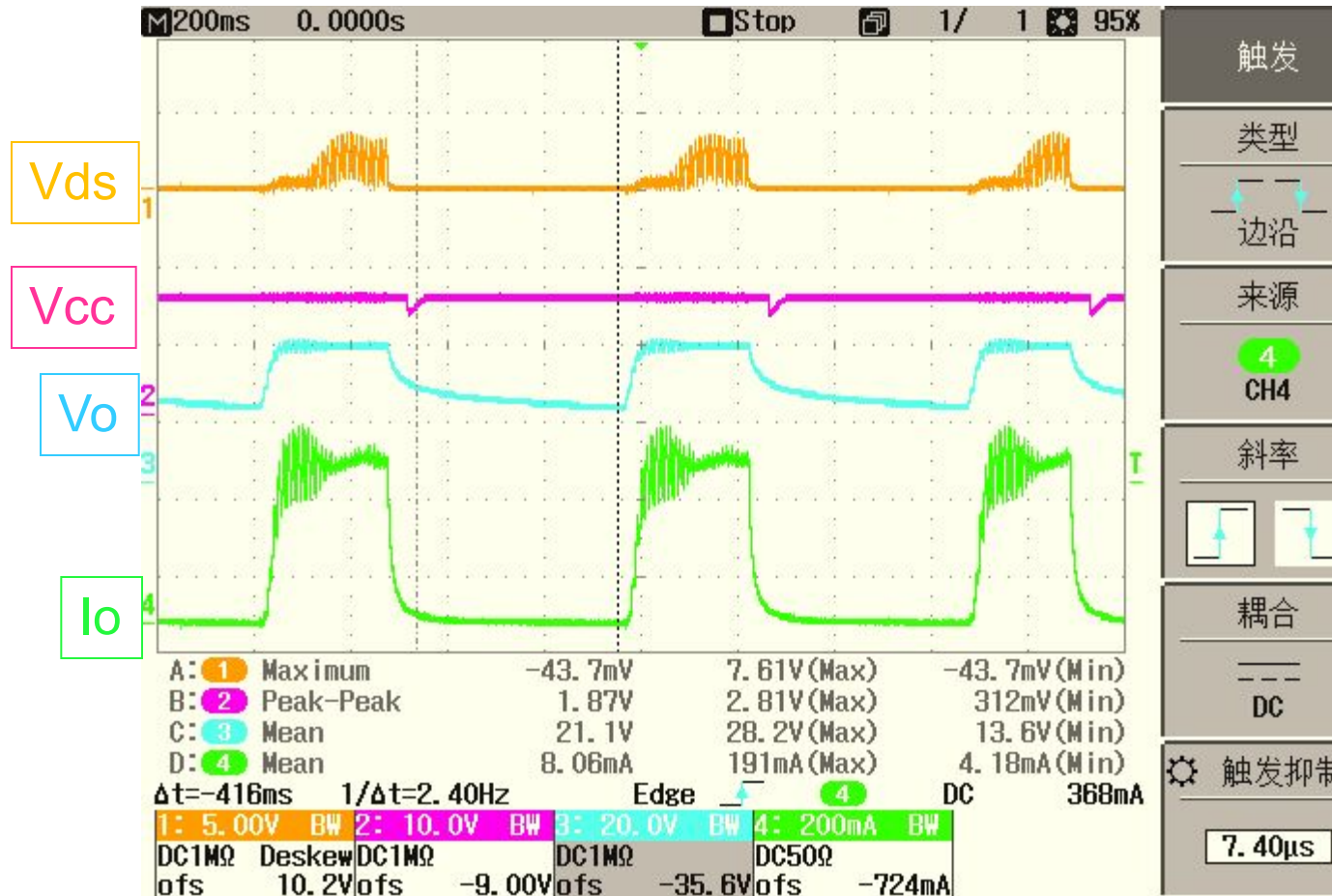
$R_{cs}=0.8R$	MOS temperature=59.6
Peak current	464mA



$R_{cs}=1.5R$	MOS temperature=78.3
Peak current	78mA

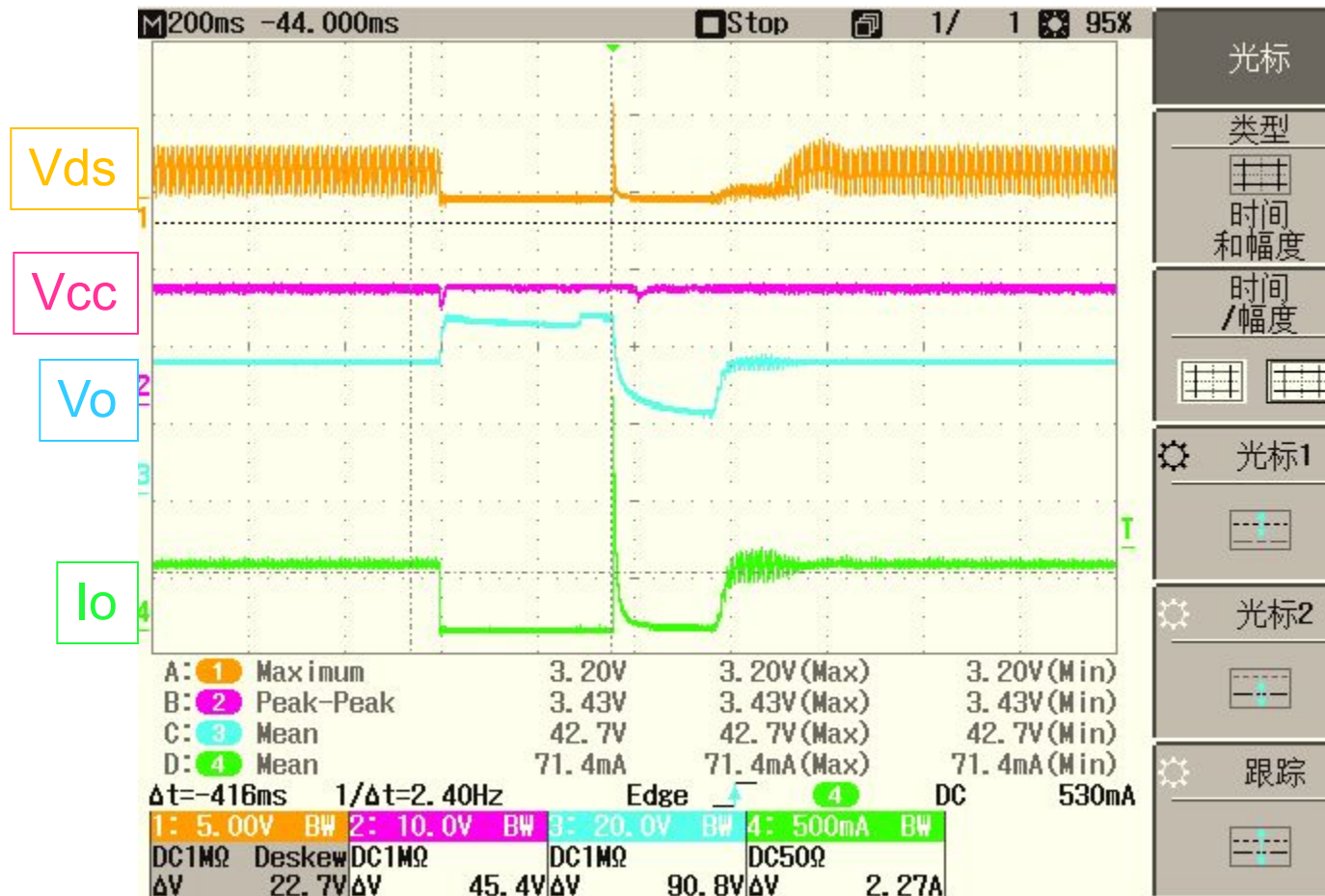
## Repeated switch

Repeated switch does not appear repeatedly start phenomenon



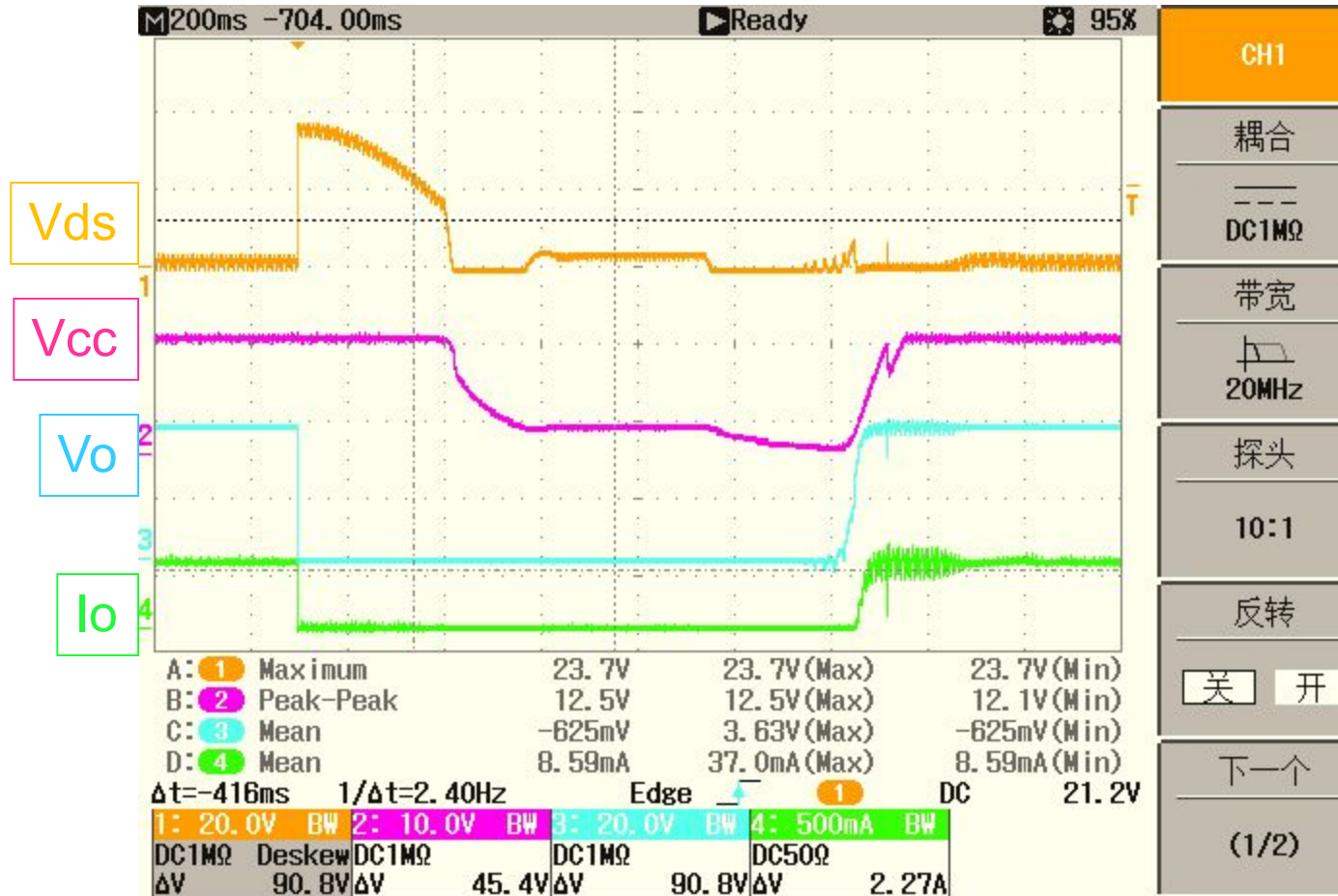
## Open circuit protection

- LED normal - open - normal; system can be automatically restored



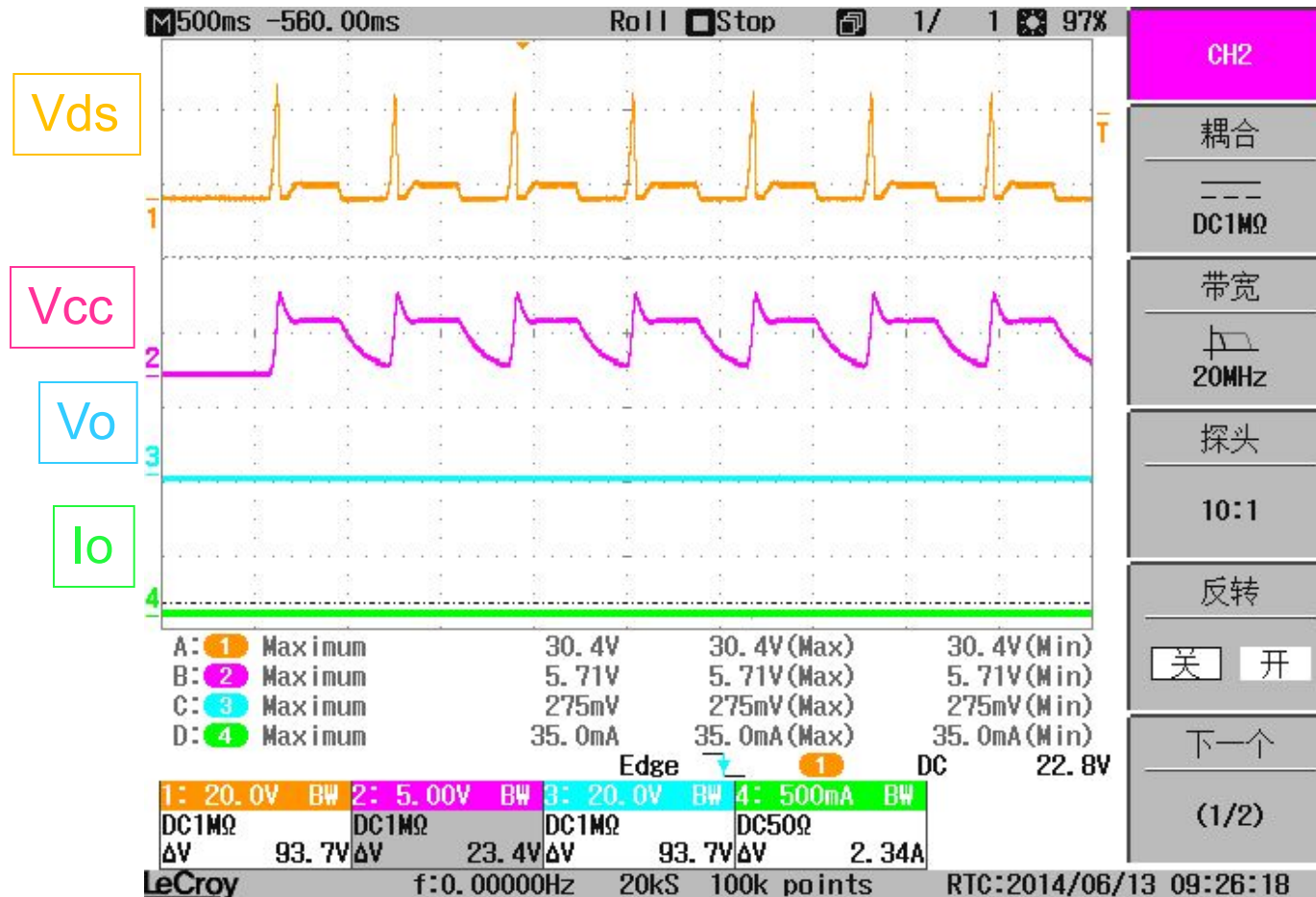
## Short circuit protection

- LED normal - short circuit - normal; the system can be automatically restored



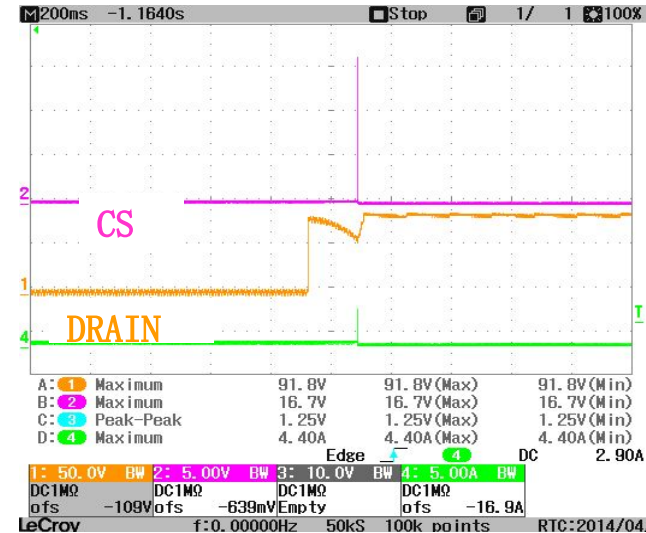
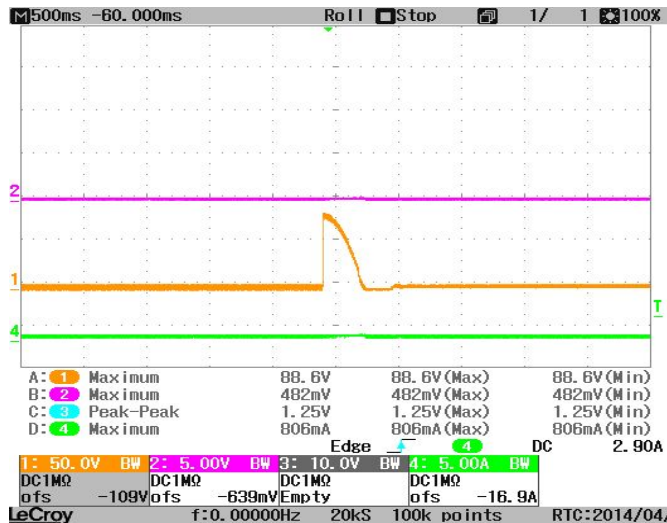
## Short circuit protection

- Short circuit, BP560X does not move, the pre-circuit into the short-circuit protection



## Short circuit protection

- From the open circuit or normal work to short circuit, all the energy of the output capacitor transferred to the MOS tube, if not instantly distributed heat, will burn the MOS, the higher the output voltage, the greater the output capacitance, the more easily burned



Short circuit , undamaged waveform      Short-circuit, damaged waveform

- Do not recommend customers to repeatedly short-circuit LED experiment; if customers have short-circuit test requirements, it is recommended 5609 + large package MOS, to ensure that MOS will not burn
- If short circuit is required, a 10V regulator can be added to GATE and GND to prevent overvoltage failures at the Gate and CS pins. But still need a larger MOS tube to withstand the release of the output capacitor energy.

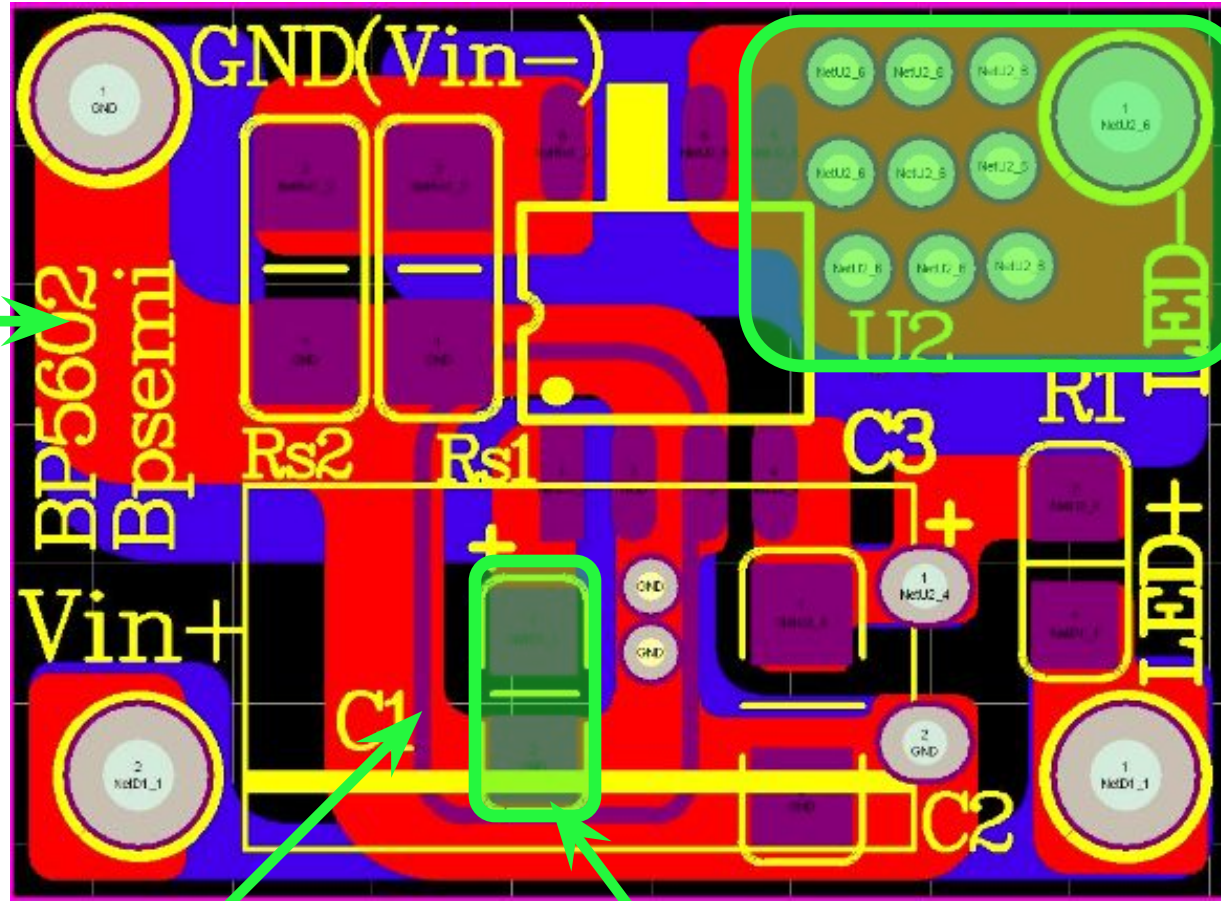


# Considerations of Design



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## Layout



Increase Drain's copper area, improve cooling capacity

GND

GND Leakage copper to prevent leakage of high voltage on the COMP

COMP capacitance