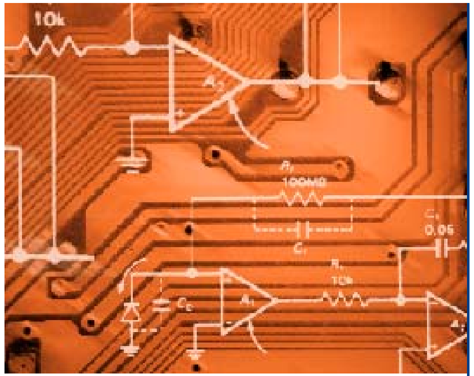

Cirrus Logic
Dimmable chips introduction

PRESENTED BY

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April 5, 2012

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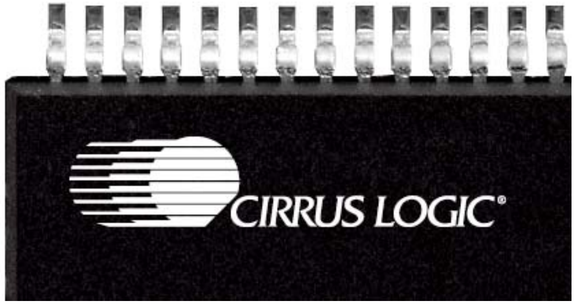

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- 1.2 Cirrus dimmable solution advantage
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- 1.4.1 Fast start-up
- 1.4.2 Source switch can match the Smart Dimmers
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Part 1:

Cirrus Dimmable Solution Advantage

1.1 Cirrus dimmable solution advantage

A：Best-in-Class Dimmer Compatibility (up to 98%)
(including single lamp and multi-lamp)

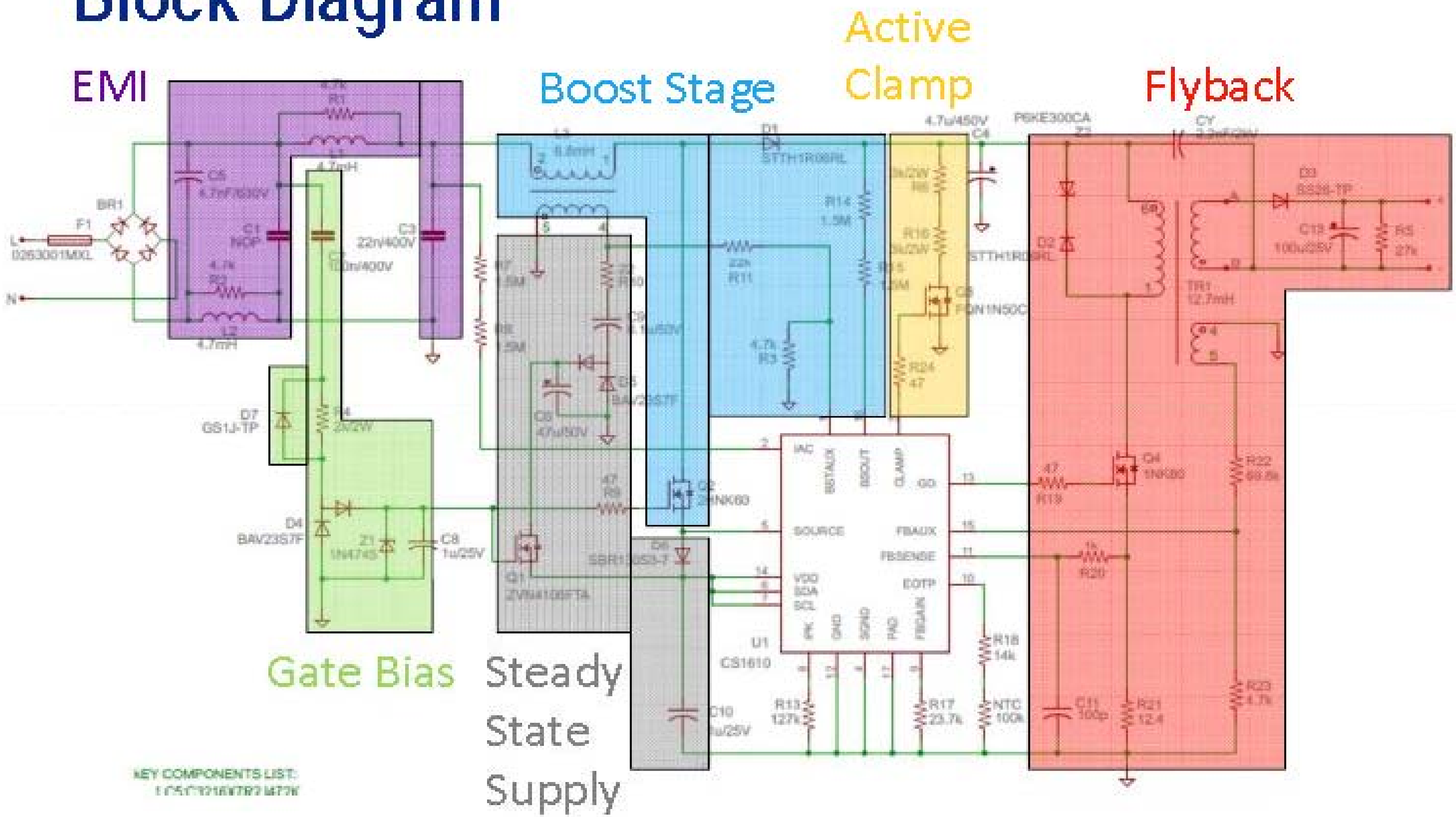
B: the range of 2%～100% output current

C: Similar to the linear current output

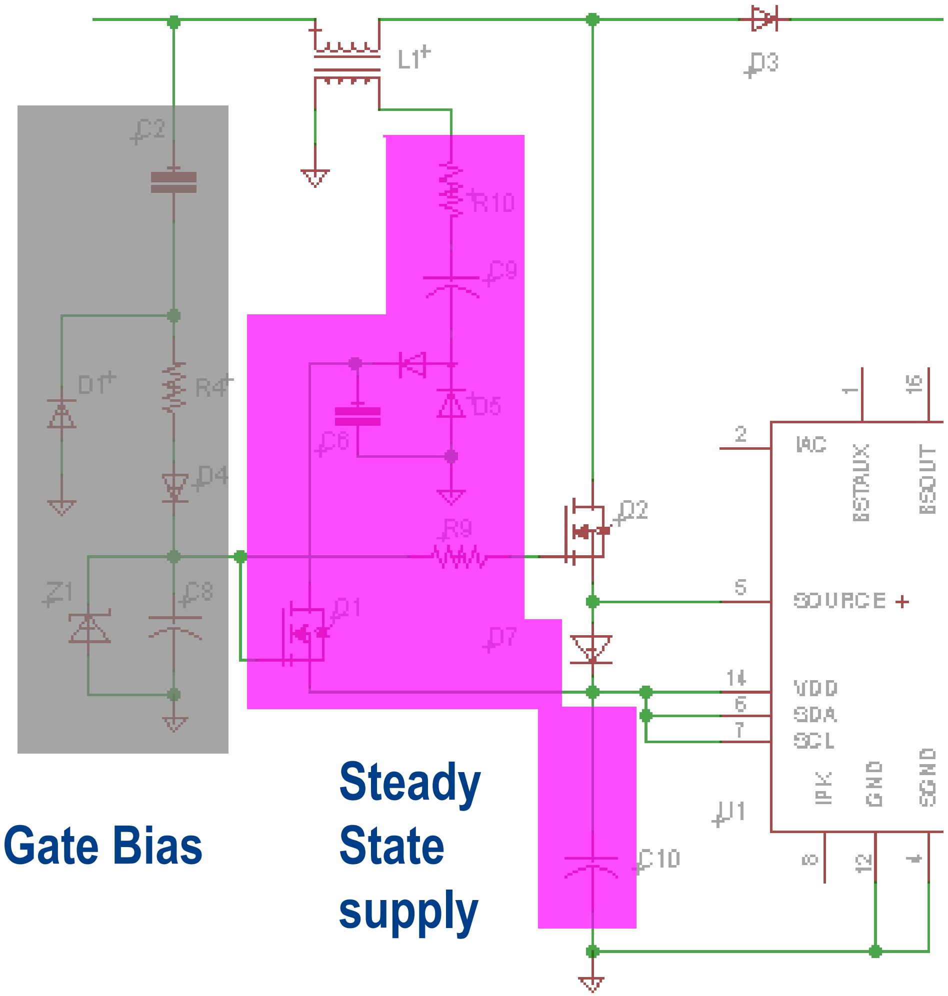
D: Fast start-up, the typical Tdelay<150mS

1.2 CS1610/11 Boost+Flyback diagram

Block Diagram

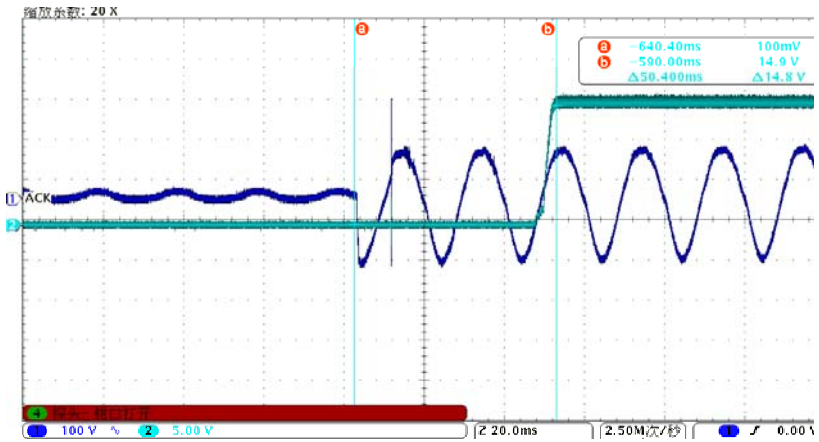


1.4 power supply



1.4.1 Fast start-up

source switch circuit make the solution start-up is very fast



start-up waveform at the 207Vac

Channel 1: AC input voltage

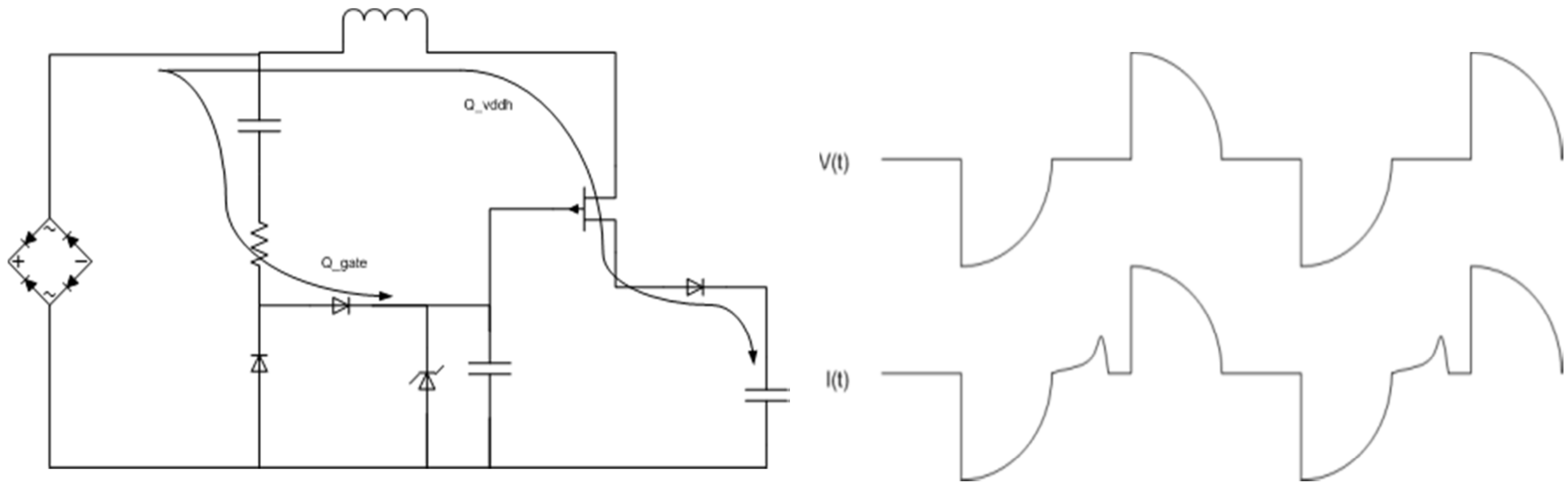
Channel 2: DC output voltage

We can see the Tdelay=50mS

1.4.2 compatibility the smart dimmers

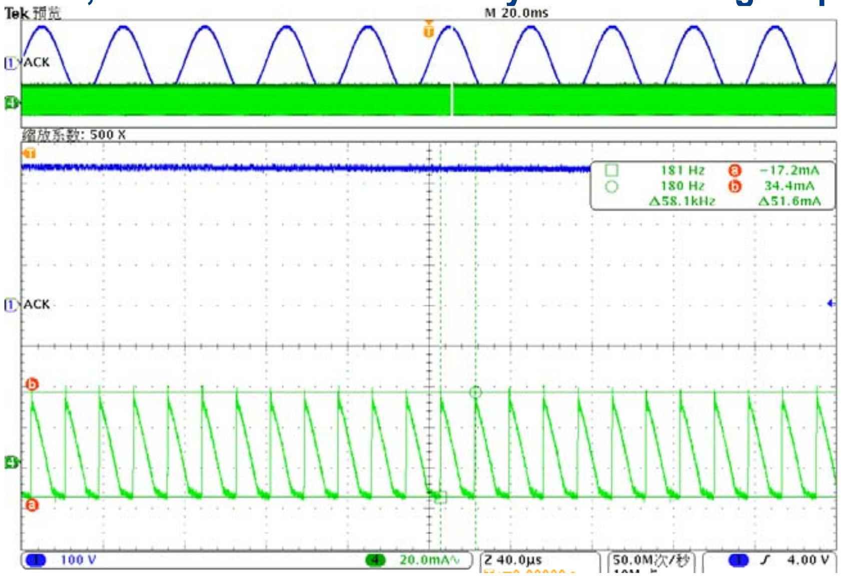
Smart Dimmers are dimmers that contain an internal microprocessor and create a power supply.

- **1, power supply is charged through the lamp**
- **2, Typically charge during the cut phase of waveform**



1.5 No dimmer mode.

1.5.1, Due to use the Boost+Flyback two stage topology, No Low frequency ripple.



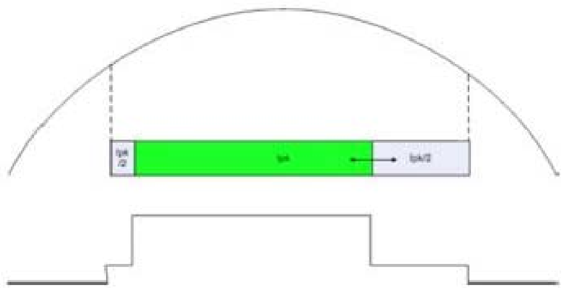
Channel 1: AC input voltage
Channel 4: DC output current

Did not find the low frequency current ripple.

1.5.2, No dimmer mode algorithm

No dimmer algorithm

The PFC operation phase from 45 to 135degrees. It can be improve the efficiency.



1.6 Perfect protection

1.6.1 OVP

1.6.2 OCP

(any component to open or short)

1.6.3 OTP

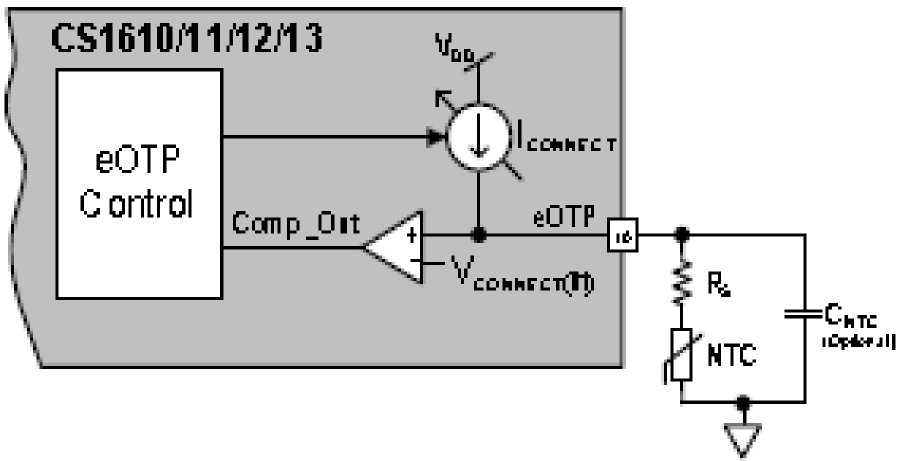


Figure 14. eOTP Functional Diagram

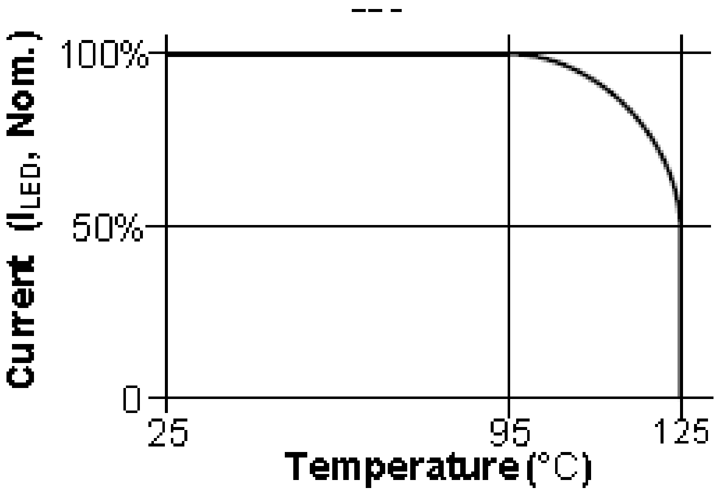
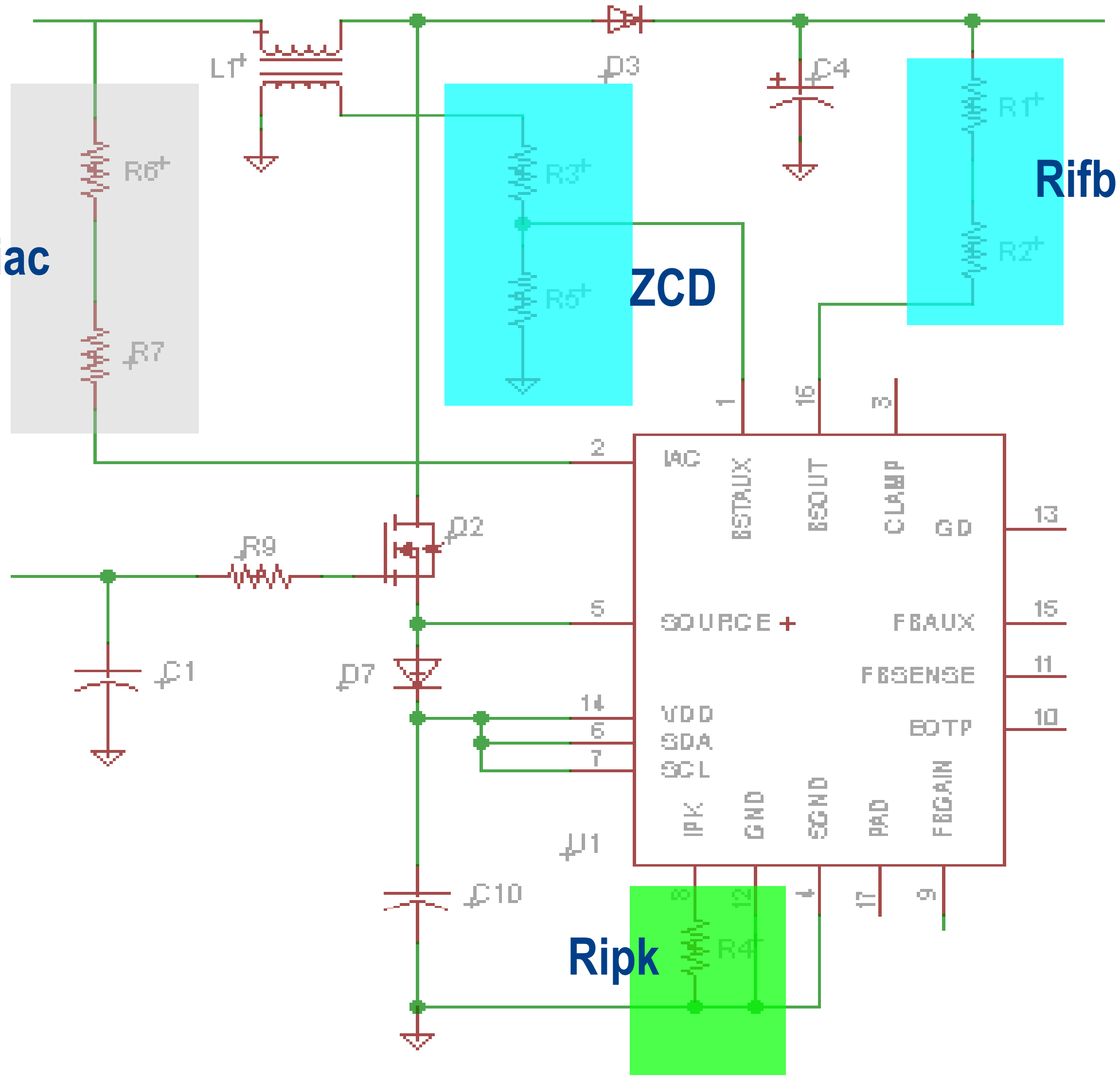


Figure 15. eOTP Temperature vs. Impedance

Part 2

Application Principle and calculation

2.1 Boost stage (circuit)



Note:

1, Riac is detected phase value and the input voltage value.

2, Rifb is feedback Link voltage.

3, ZCD is Zero-crossing detection.

4, Ripk is set the value of the Boost PK current.

5, frequency dither

2.2 Boost stage

2.2.1 Maximum Peak Current

The maximum boost inductor peak current is set using an external resistor Ripk on pin IPK,

We can use the following equation to calculate the value of the Ripk.

Here are the calculation steps

Step 1, Calculate Ipk

$$Pin,\max = \frac{\delta(Ipk \times Vrms,typical)}{2}$$

Note:

δ = correction term=0.55

Vrms,typical=nominal operating input RMS voltage

$$Ipk = Ipk(code) X 4.1mA$$

Step 2, Calculate Ripk

$$Ripk = \frac{4 * 10\hat{}6}{Ipk(code)}$$

2.2 Boost stage

2.2.2 IAC and Ibstout sense resistor

The ADC is used to measure the magnitude of the Ibstout current through resistor Rbst. The magnitude of the Ibstout current is then compared to an internal reference current(Iref) of 133uA.

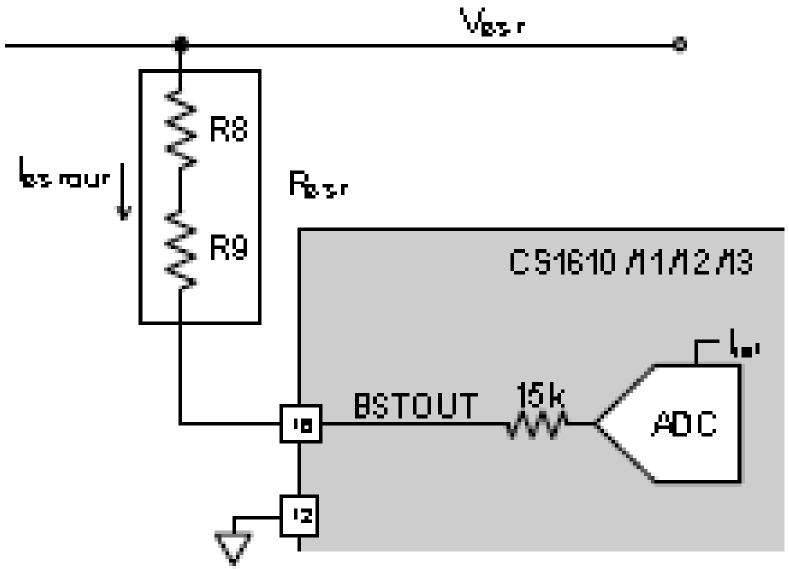


Figure 9. BSTOUT Input Pin Model

$$Rbst = \frac{Vbst}{Iref} = \frac{400V}{133uA} = 3M$$

Note:

Vbst = Nominal boost output voltage

Vbst=200V(Vin=120Vac)

Vbst=400V(Vin=230Vac)

Iref= Internal reference current

The IAC is used by the boost control algorithm, So the Riac=Rbst

$$Riac = Rbst$$

2.2 Boost stage

2.2.3 Boost inductance calculation

According to CIRRUS calculation form,Here are the calculation steps.

Step 1
Fill in the input/output data

↓

Step 2
Adjust the inductance

↓

Step 3
Calculate Np

↓

Step 4
Calculate Ns

1, fill the input power, Vrms and output Vlink voltage

2, adjust the inductance make sure the switching frequency in the range of the 55-180KHz.

3, use the equation $Np=L*\Delta I/(\Delta B*Ae)*10^8$ to get the Np.
where: ($\Delta I=0.45\sim0.6A$)

4, According to the turns ratio equation we can get the value of Ns:

$$n=Np/Ns$$

where: $n=18$ (230Vac input system)
$n=9$ (120Vac input system)

2.2.4 Active Clamp Circuit

1, Why use the clamp circuit?

A minimum power needs to be delivered from the dimmer and boost stage to the load. This power is nominally around 2W for 230V and 120V TRIAC dimmers. But at low dim angles(<=90),this excess power cannot be converted into light by the second output stage due to the dim mapping at light loads.

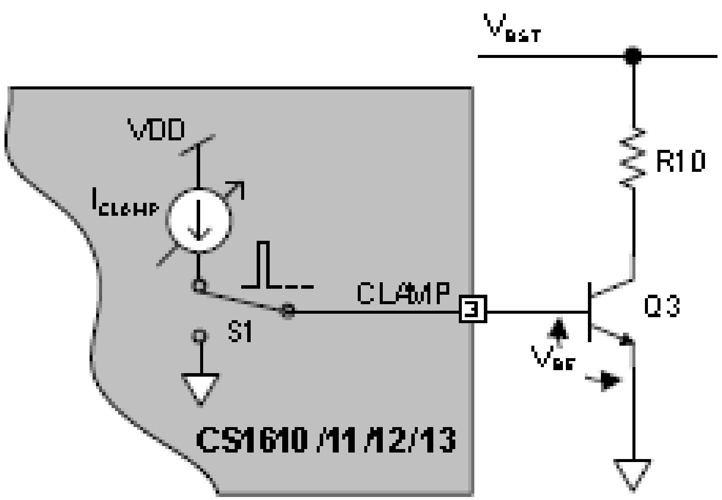


Figure 11. CLAMP Pin Model

2, What trigger the CLAMP circuit work?

A, 227V for 120Vac input system

B, 424V for 230Vac input system

3, What the value of Clamp resistor?

A, 1K resistor for 120Vac input system

B, 4K resistor for 230Vac input system

Note:

The clamp circuit cannot be continuously 'ON' for more than 13.8mS

2.3 Flyback stage

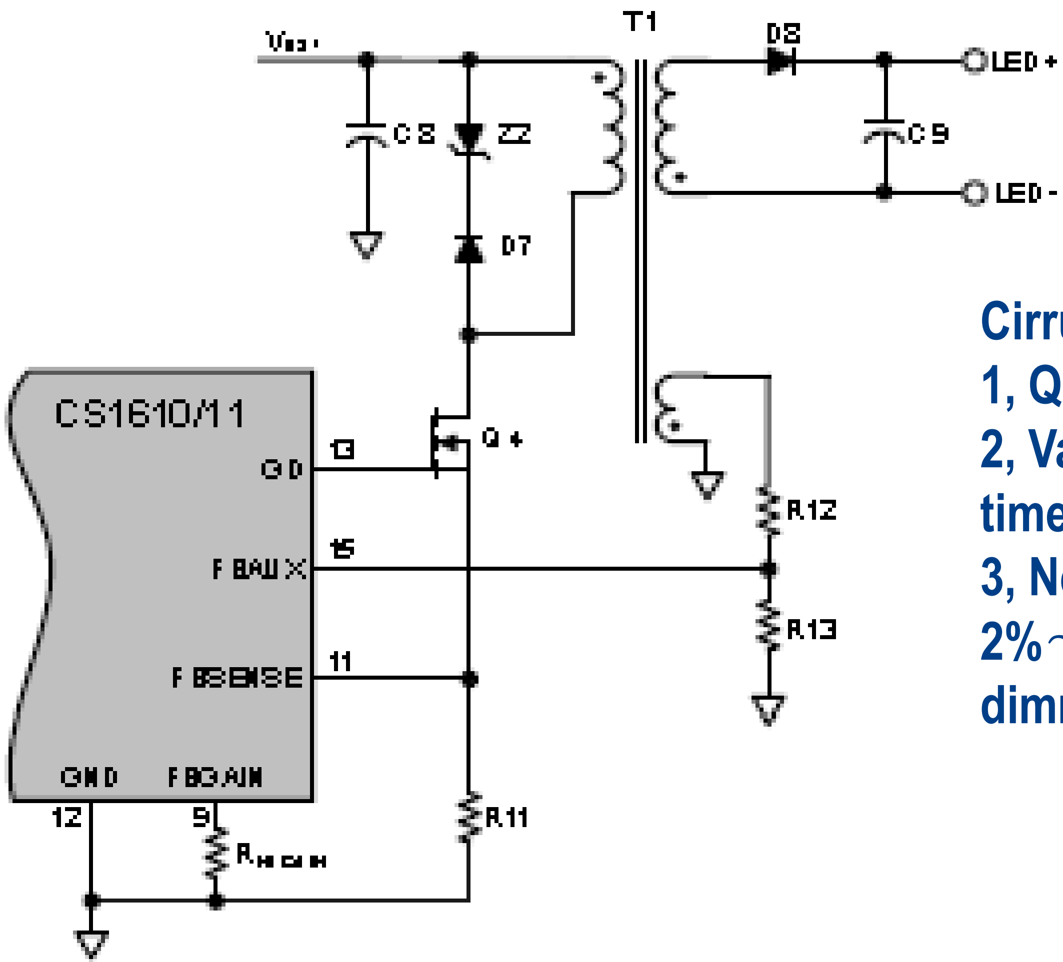


Figure 12. Flyback Model

Cirrus algorithm

1, QRC mode + frequency dither

2, Variable switching frequency, on-time and duty cycle.

3, New mapping algorithm to achieve 2%～100% output current with dimmer mode.

2.4 Flyback stage

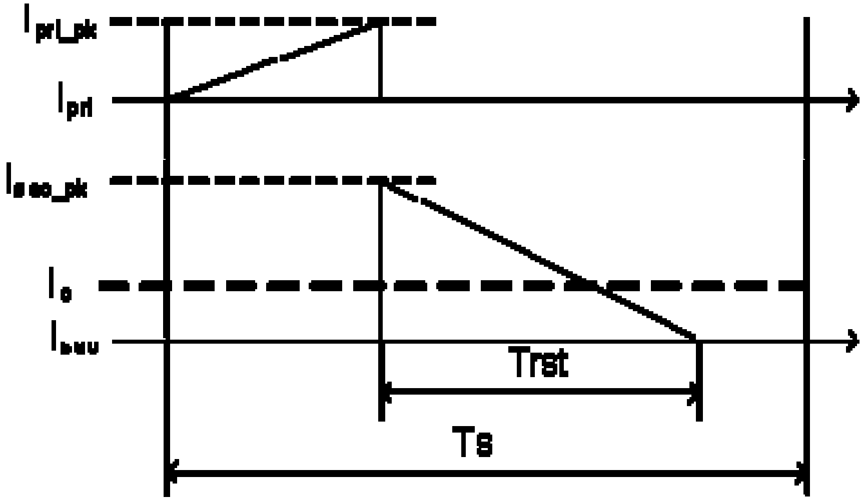
2.4.1 about the Rsense calculate

steps：

1、 calculation Isec_pk current。

2， calculation Ipri_pk=Isec_pk/Nps,get the Ipri_pk。

3， calculation Rsense=Vi_pk/Ipri_pk,



Note:

Isec_pk is secondary PK current

Ipri_pk is primary PK current

CS1610/11 Vi_pk=1.4Vdc

$$I_o = \frac{I_{sec\_pk}}{2}\frac{T_{rst}}{T_s}$$

Output current

$$I_{sec\_pk} = I_{pri\_pk} N_{ps}$$

Secondary current

$$I_{pri\_pk} = \frac{2I_o}{N_{ps}}\frac{T_s}{T_{rst}}$$

Primary peak current

$$Rsense = \frac{Vi\_pk}{Ipri\_pk}$$

2.4 Flyback stage

2.4.2 Fbgain

The Fbgain input is set using an external resistor, FBgain Resistor must be selected to ensure that the switching period Ttotal is greater than the resonant switching period Tcritical at maximum output power.

$$Ttotal > Ton + Trst$$

Fbgain resistor is calculated using the Equation

$$Rfbgain = \frac{4000000}{(FBgain \times 128) - 64}$$

Where:
Fbgain=Ttotal/Trst (1～2.5）
Trst is demagnetization time

The value of Fbgain also has bearing on the linearity of the dimming factor versus the LED current curve.

2.4 Flyback stage

2.4.3 Flyback transformer calculation

According to CIRRUS calculation form,Here are the calculation steps.

Step 1
Fill in the input/output data

↓

Step 2
Calculation Np

↓

Step 3
Calculate Ns

↓

Step 4
Others value of Rsense and R_Fbgain

1, fill the input Min link voltage ,output Vo/Io and turns Ratio and fsw switching frequnency

2, use the equation $Np=L*\Delta I/(\Delta B*Ae)*10^8$ to get the Np.

3, According to the turns ratio equation we can get the value of Ns, Nb

A), $Np/Ns=n$ B), $Ns/Nb=(Vo+Vd)/Vaux$

4, we can get the other value of Rsense and R_Fbgain

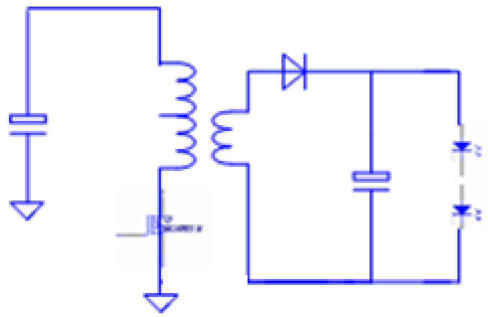
Part 3:

Application Notes

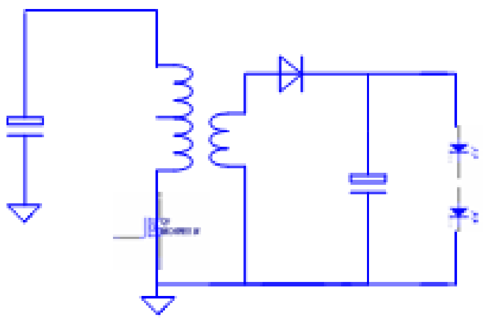
3.1 Cirrus dimmable chips Part Numbers

- **CS1610 - 120V 2 stage Boost+ Flyback**
- **CS1611 - 230V 2 stage Boost+ Flyback**
- **CS1612 - 120V 2 stage Boost+ Buck**
- **CS1613 - 230V 2 stage Boost+ Buck**

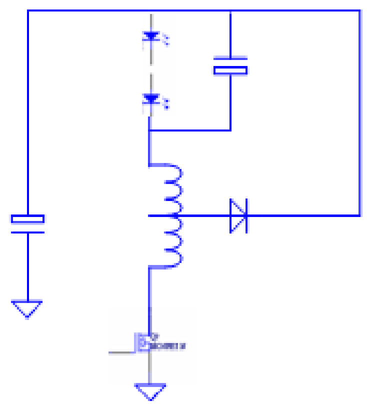
3.2 isolation and no-isolation topology



Isolation Flyback topology(CS1610/11 can do)



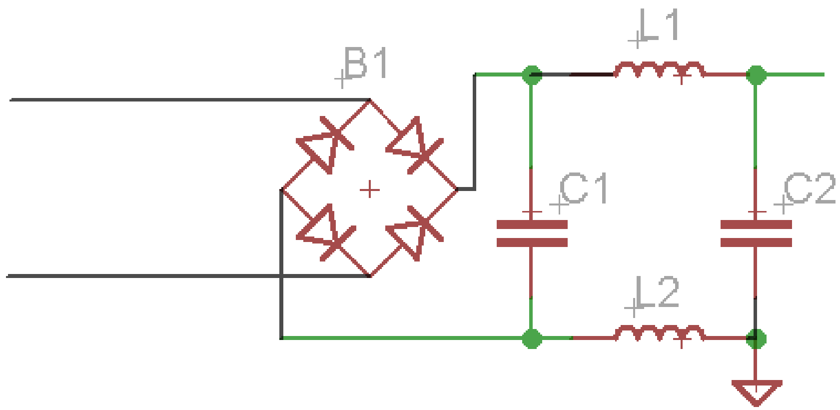
No-Isolation Flyback topology(CS1610/11 can do)
Suitable for Low output voltage



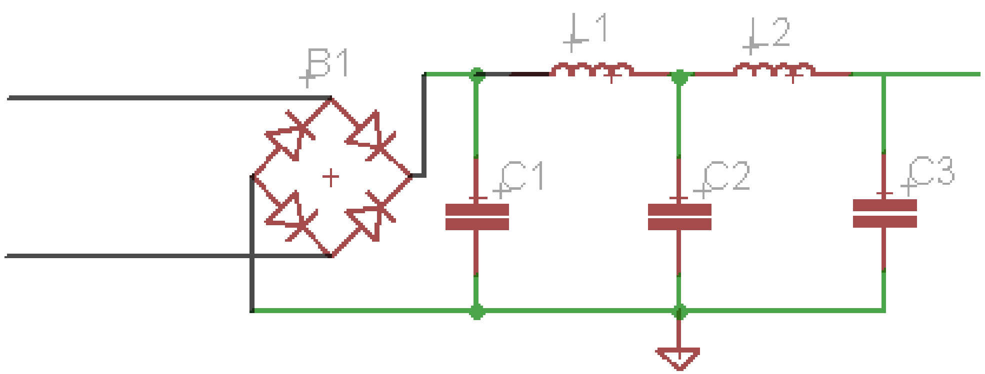
No-Isolation Buck topology(CS1612/13 can do)
Suitable for high output voltage

3.3 EMI design

EMI circuit can effect the dimmer compatibility. So we are have some requirements for EMI circuit.



230Vac system EMI circuit
C1 1nF～4.7nF
C2 33nF～68nF

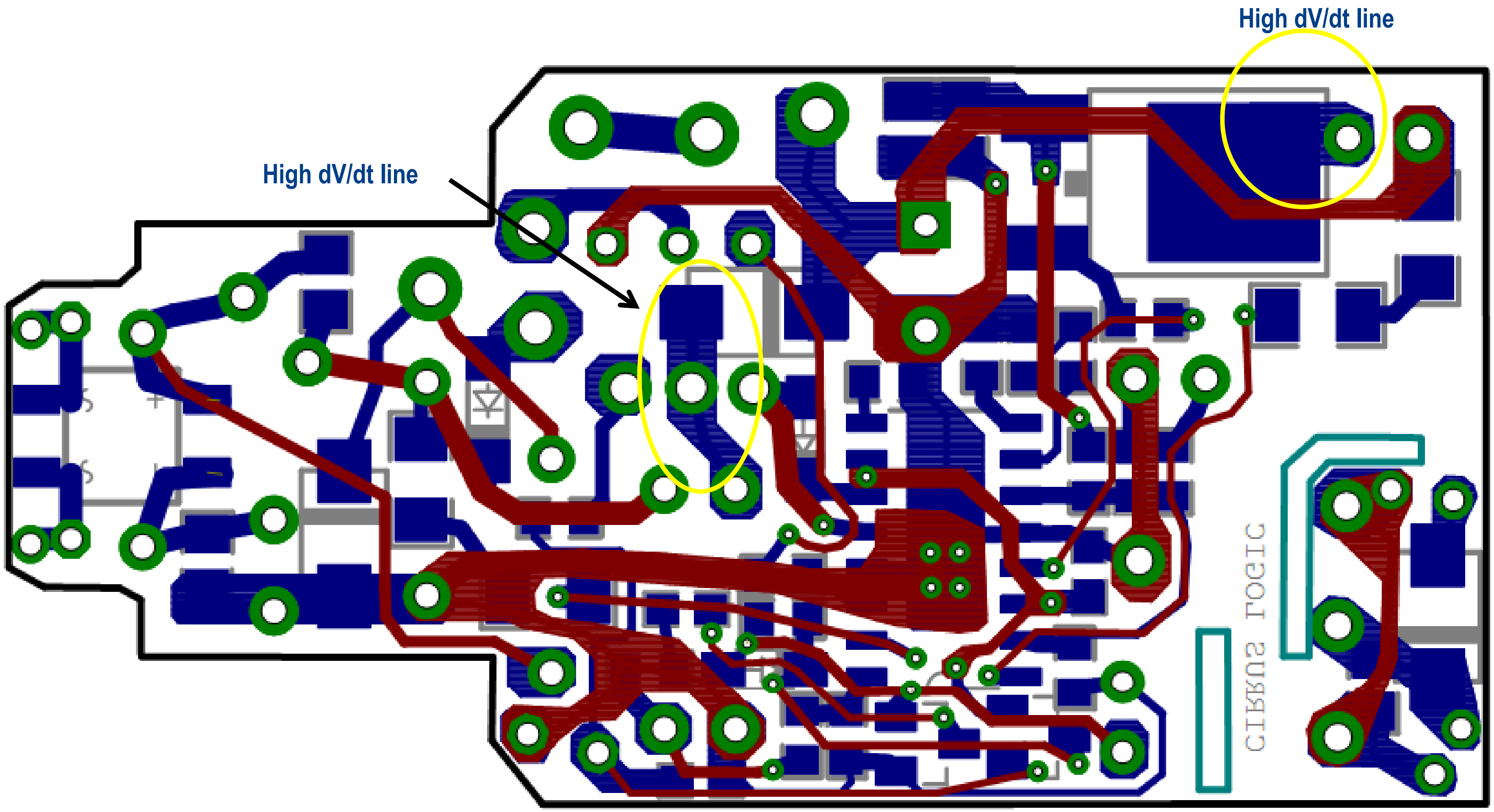


120Vac system EMI circuit
C1 4.7nF～10nF
C2 10nF～68nF
C3 68nF～150nF

3.4.1 PCB Layout

.

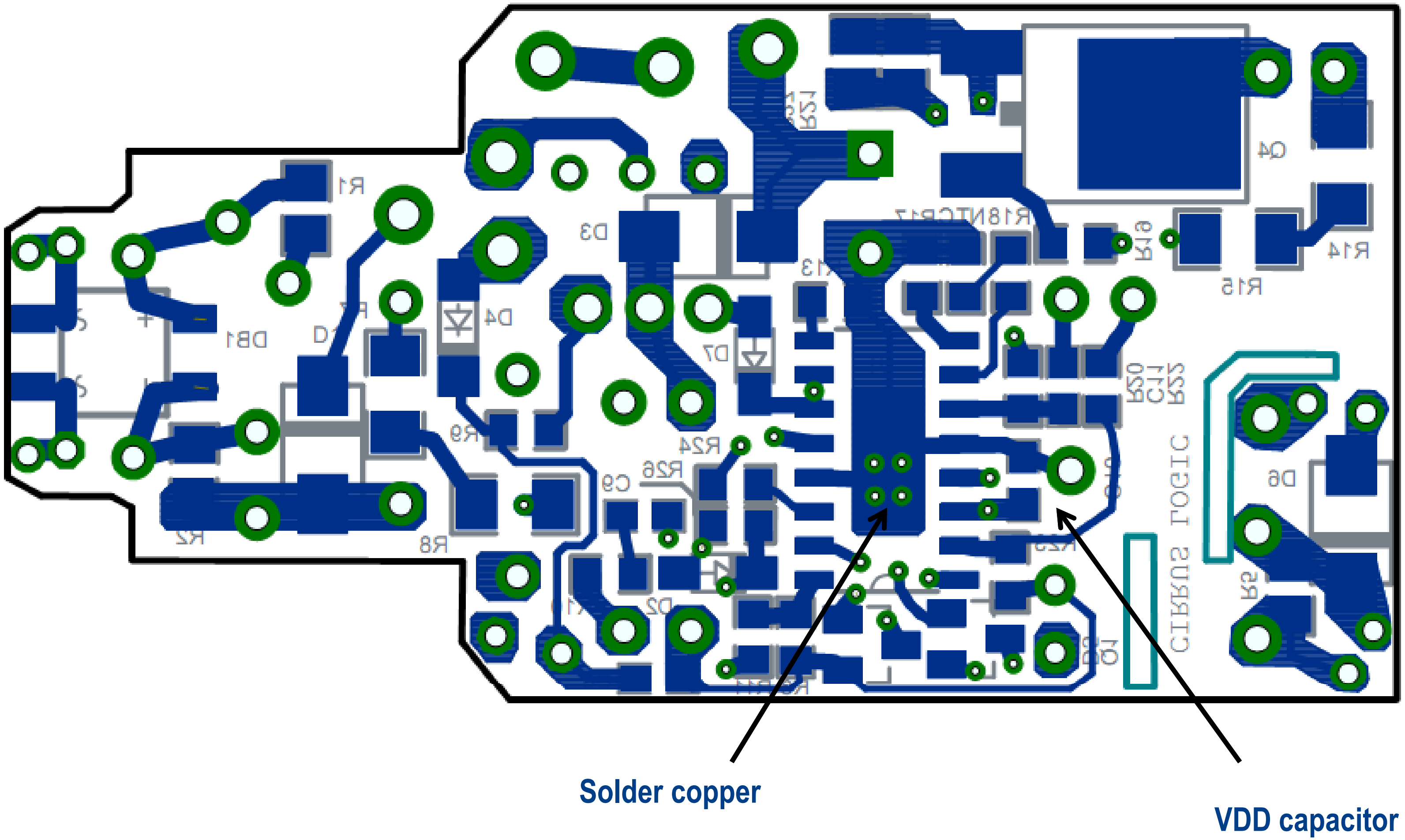
1, the High dV / dt lines do not go through the back of the IC.



3.4.2 PCB Layout

2, On the back of chips should be solder the GND copper in order to heat

3, the VDD capacitor near the VDD pin (PIN14)



Part 4:

Gibson dimmable DEMO List

- **4.1 GIBSON DIMMABLE BOARD List (Local)**

A, 230Vac input Isolation Board

1, 5-10W output board for A60 bulbs lamp

2, 12-20W output board for PAR30/38 lamp

B, 120Vac input Isolation Board

5-10W output board for A60 bulbs lamp

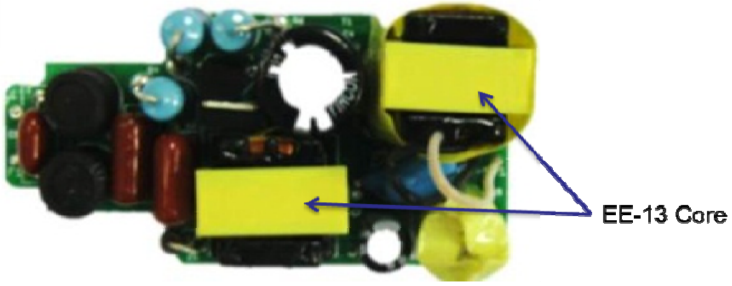
C, Non-isolation Board

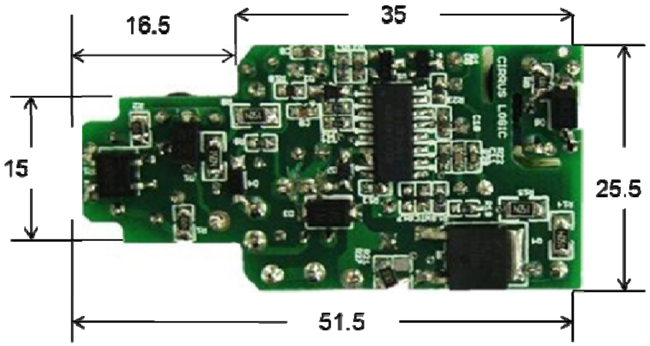
1, 5-9W output board for A60 OR BR30 lamp

2, 9-15W output board for A60 PR30/38 bulbs lamp

A, 230Vac input Isolation Board

1, output power level:5-10W board for A60 bulbs lamp





Into a diameter of 29mm cylinders.

A, Case 01 (10W board parameter)

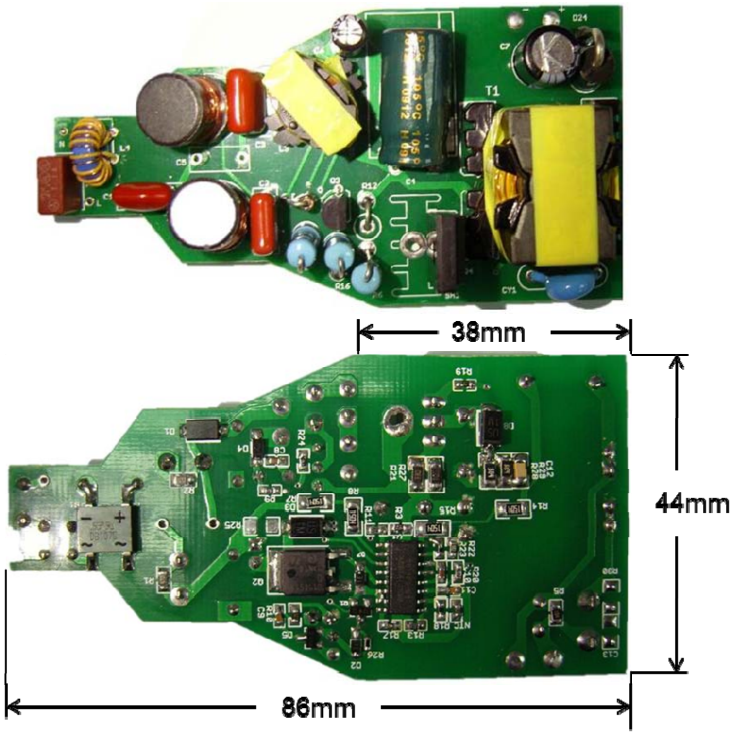
1, input voltage: 230Vac+/-10%   47Hz~63Hz
2, output voltage: 10-15.5Vdc/0.5A
3, PF>0.9 THD<30% @230Vac input
4, Eff> 79%
5, Protect: OVP,OCP,OTP and any component to open
    or short protect.
6, meet the EN55015 and IEC61000-3-2.
7, Flicker-free operation from 2% to 100% output current
with leading-edge, trailing-edge, and digital dimmers

B, Case 02 (12W board parameter)

1, input voltage: 230Vac+/-10%   47Hz~63Hz
2, output voltage: 14-18Vdc/0.48A
3, PF>0.9 THD<30% @230Vac input
4, Eff> 79%
5, Protect: OVP,OCP,OTP and any component to open
    or short protect.
6, meet the EN55015 and IEC61000-3-2.
7, Flicker-free operation from 2% to 100% output current
with leading-edge, trailing-edge, and digital dimmers

A, 230Vac input Isolation Board

2, output power level:12-20W board for PAR/30/38 lamp

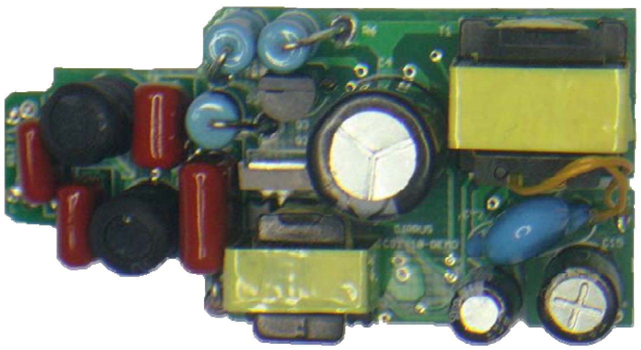


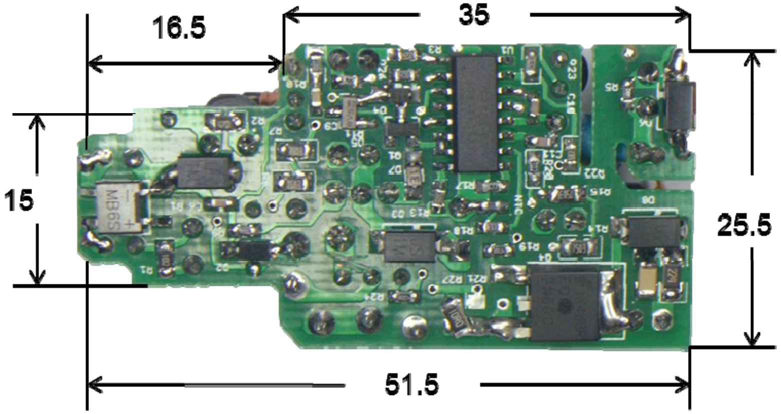
A, Case 01 (output 12X1W board)
1, input voltage: 230Vac+/-10%   47Hz~63Hz
2, output voltage: 30-40Vdc/0.34A
3, PF>0.9 THD<30% @230Vac input
4, Eff> 85%
5, Protect: OVP,OCP,OTP and any component to open
   or short protect.
6, meet the EN55015 and IEC61000-3-2.
7, Flicker-free operation from 2% to 100% output current
with leading-edge, trailing-edge, and digital dimmers

B, Case 02 (output 15X1W board)
1, input voltage: 230Vac+/-10%   47Hz~63Hz
2, output voltage: 40-48Vdc/0.34A
3, PF>0.9 THD<30% @230Vac input
4, Eff> 85%
5, Protect: OVP,OCP,OTP and any component to open
   or short protect.
6, meet the EN55015 and IEC61000-3-2.
7, Flicker-free operation from 2% to 100% output current
with leading-edge, trailing-edge, and digital dimmers

B, 120Vac input Isolation Board

1, 5-10W output board for A60 bulbs lamp





A, 10W board parameter

1, input voltage: 120Vac+/-10%   47Hz~63Hz

2, output voltage: 10-15.5Vdc/0.5A

3, PF>0.9 THD<30% @230Vac input

4, Eff> 80%

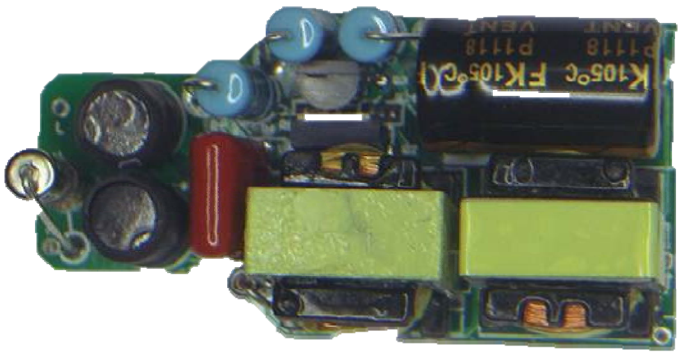
5, Protect: OVP,OCP,OTP and any component to open or short protect.

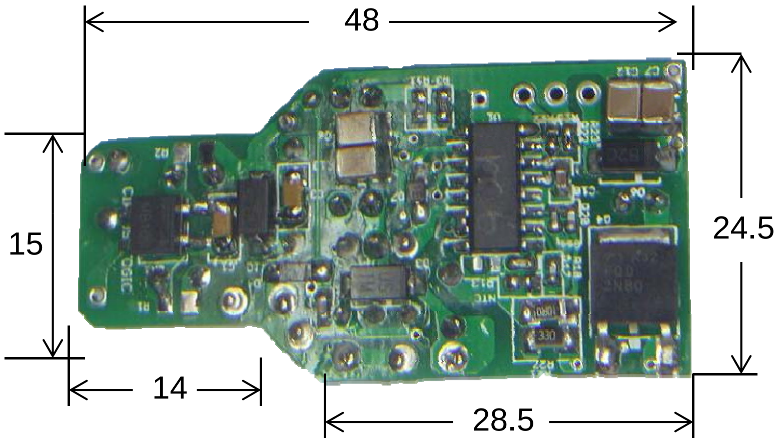
6, meet the EN55015 and IEC61000-3-2.

7, Flicker-free operation from 2% to 100% output current with leading-edge, trailing-edge, and digital dimmers

C, 230Vac input Non-Isolation Board

1, output power level: 5-9W board for A60 or BR30 bulbs lamp





A, Case 01 (9W board parameter)

1, input voltage: 230Vac+/-10%   47Hz~63Hz

2, output voltage: 14-18Vdc/0.4A

3, PF>0.9 THD<30% @230Vac input

4, Eff> 79%

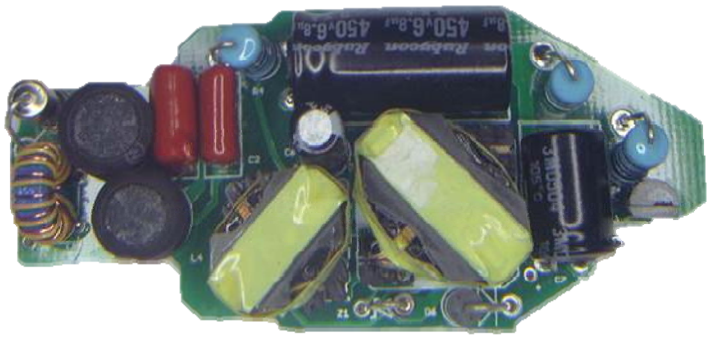
5, Protect: OVP,OCP, OTP and any component to open or short protect.

6, meet the EN55015 and IEC61000-3-2.

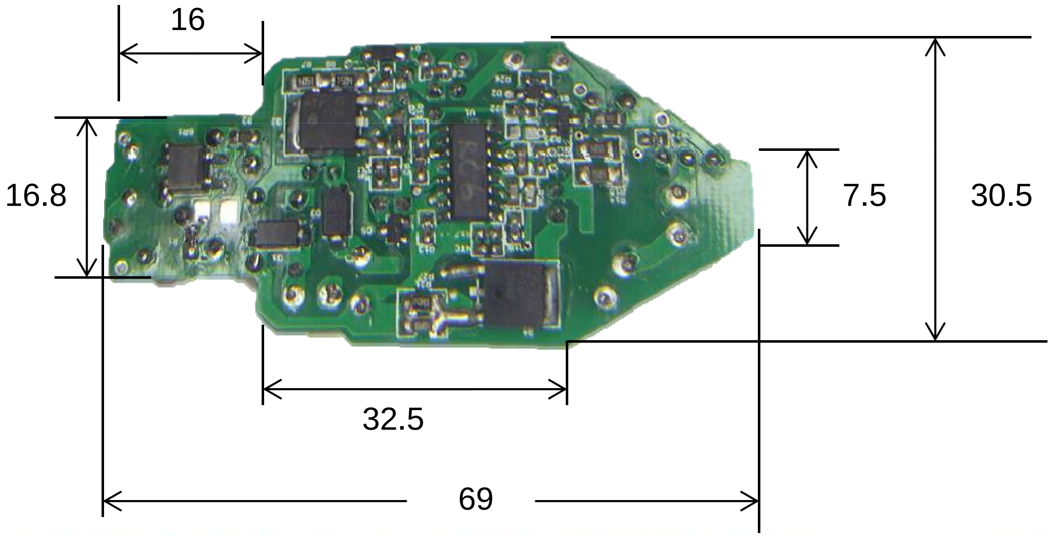
7, Flicker-free operation from 2% to 100% output current with leading-edge, trailing-edge, and digital dimmers

C, 230Vac input Non-Isolation Board

2, output power level:9-15W board for A60/BR30 bulbs lamp



A, Case 01 (12W board parameter)
1, input voltage: 230Vac+/-10%   47Hz~63Hz
2, output voltage: 28-33Vdc/0.33A
3, PF>0.9 THD<30% @230Vac input
4, Eff> 86%
5, Protect: OVP,OCP,OTP and any component to open
    or short protect.
6, meet the EN55015 and IEC61000-3-2.
7, Flicker-free operation from 2% to 100% output current
with leading-edge, trailing-edge, and digital dimmers



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IF YOU HAVE ANY QUESTION NEED TO HELP,
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