SPECIFICATION

1. DESCRIPTION

The DK813 is a LED Driver IC designed specially for Non-Isolated high PFC BUCK circuit. It integrates 700V high voltage power transistor and primary peak current detecting circuit. It also includes Active Power Factor Correction, Output Voltage Control, Self-Power supply and LED loading circuit auto detection functions, can avoid LED loading damage. Its integrated Active Power Factor Correction circuit can reach high Power Factor and low Total Harmonic Distortion. And because of its highly integrated MOS circuit design, lots of external components are saved.

2. APPLICATIONS

1-20W LED Lighting

3. MAIN FEATURES

· ±3% LED Output Current Accuracy.

· Build-in 700V power transistor.

· 85V—265V wide range AC power input.

· Quasi-resonant mode, high circuit efficiency, ƞ>90%.

· Patent self-power supply circuit design, no need for external winding power supply.

· Single-Stage Active PFC(Power Factor Correction) for High Power Factor(PF>0.95) and Low THD.

· Over current, Over loading, Over temperature, Over voltage, LED short circuit and LED open circuit Protection.

· Automatic detection of constant current loading when power is on, to prevent electrical LED lamp burning.

4. CONNECTION DIAGRAM
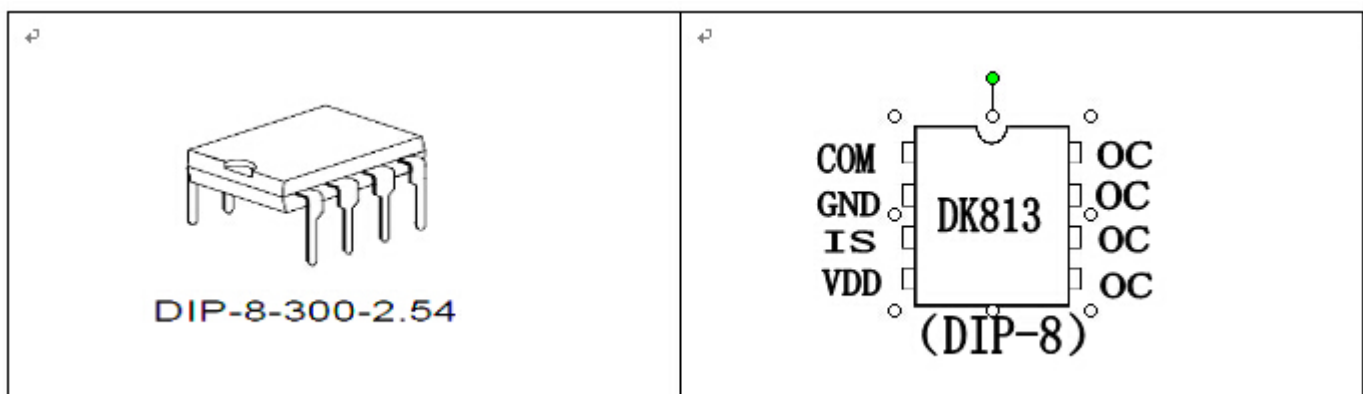
5. PIN FUNCTION

Pin NO. DIP-8	Pin Name	Function
1	COMP	Loop Compensation Node. This pin connects a 0.1uF-1uF capacitor to GND.
2	GND	Ground reference
3	IS	Current correction pin. It connects a resistor to GND to sense and control the output current.
4	VDD	Power supply pin. This pin connects a 47uF-100uF capacitor to GND.
5,6,7,8	OC	Output pin. Connected with internal high voltage Collector point and switch mode transformer.

6. ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
VDD	Supply voltage	-0.3--8	V
Ivcc	Current of supply voltage	100	mA
Vpin	Pin voltage	-0.3--Vcc+0.3	V
Vcol	Collector to GND voltage	-0.3--730	V
Ip	Peak current	1000	mA
Pd	Total Dissipation power	1000	mW
Tc	Case operating temperature	-25--125	℃
Tstg	Storage temperature	-55--150	℃
Tsol	Soldering temperature	+280	℃/5S

7. ELECTRICAL CHARACTERISTIC

Parameter	Condition	Value			Unit
		Min.	Typ.	Max.	
Vcc (Work Power Supply)	AC input: 85V-265V	4	5	6	V
Start threshold Voltage	AC input: 85V-265V	4.8	5	5.2	V
Stop threshold Voltage	AC input: 85V-265V	3.6	4	4.2	V
Current of Vcc	Vcc=5V, COM=2.2V	10	20	30	mA
Start time	AC input: 165V	--	--	500	mS
Collector Protection Voltage	L=4.8mH	460	480	500	V
BJT Breakdown voltage	Ioc=1mA	700	--	--	V
Switch tube Current	Vcc=5V			1000	mA
Peak Current Protection	Vcc=5V, Rs=1.5ohm		600		mA
Temperature protection	Vcc=5V	120	135	150	℃

8. OPERATION PRINCIPLE

8.1 Start Up

Build-in high voltage starting up power: after power on, outside VDD capacitor will be charged, when VDD's voltage reaches 5V, IC begin to test the input voltage of bus line. If bus line's input voltage is lower then 80V, IC would not start up. Until the bus line's input voltage is higher then 80V, starting up will finish, pulse comes out. At the same time, it would test whether the output circuit is loaded or not. If not, output would be stop for 500mS whenever the output voltage reaches the set maximum volume. Until it is loaded, then it comes to normal working mode.

8.2 Constant Current output control

With patented output current control mode, no need for feedback circuit.

It is easy to set up the LED output current according to below formula:

$$Io = \frac{200mV}{Rs} * \eta$$

（mA）， η can be set to be 0.95，then we can calculate the Rs , for example：

$Io = 200mA$, then it comes out $Rs = 1ohm$.

8.3 Power Factor Correction

With build-in Power Factor Regulation section, in a whole cycle of the bus line input, power transistor's working time Ton keep the same. Because Vin=Lp*Ip/Ton, Peaking current Ip is proportional to bus line's input voltage Vin, so that it can reach high Power Factor. No need to connect high volume capacitor with bus line input and ground, just a 33nf-100nf CBB capacitor can help to reach high PF.

8.4 Working Frequency

The IC's pulse output frequency varies in the bus line input cycle, average working frequency is proportional to bus line's peak input voltage and inversely proportional to primary winding's inductance. According to different application, average working frequency can be adjusted by changing primary winding's inductance, and the Max. frequency of the IC is 100KHz.

8.5 Self-Power Supply Circuit (National patent owned)

There is self-power supply circuit inside the IC, which can hold the VDD at about 5V for the electricity consumption of the IC itself. So that can save external winding power supply.

8.6 Peak Current Protection

When ever the build-in power transistor's peak current is more then $Ip = \frac{1V}{Rs}$, it will be cut off so as to protect itself and the other components, and Rs is suggested to be not less then 1Ω .

8.7 Abnormal Voltage Protection

Whenever the power voltage (Vcc) abnormally exceeds 6V and drops under 4V, the controller would stop operation and restart again.

8.8 Non-loading Protection

When it is not loaded, the circuit would begin loading testing. If output circuit is not connected with LED or empty loaded, it would enter intermittent working mode until loading is detected. As to protect the capacitor and LED damage from over output voltage, can set the maximum voltage for the circuit, so that the output voltage will not exceed it when it is not loaded, here below is the formula for calculating this $Vovp$: $Vovp = \dfrac{50 * Lp}{Rs}$, Lp is the inductance's volume，we can get suitable Lp according to this formula.

For example, in 20W（100V /200mA）application，$Rs = 1ohm$, so $Vovp = 1.3 * Vo = 130v$

$$Lp = \frac{Rs * Vovp}{50} = \frac{1 * 130}{50} = 2.6mH$$

8.9 Short Circuit Protection

Whenever short circuit is detected, it stops the switching operation immediately and enters into the stop status. The controller will restart to switching operation and pulse output when the temperature falls down.

8.10 Over Temperature Protection (OTP)

When the IC temperature is detected to be over 135℃, OTP is activated. It stops the switching operation immediately and enters into the stop status. The controller will restart to switching operation and pulse output when the temperature falls down.

9. TYPICAL APPLICATION SAMPLE

20W—100V/200mA NON ISOLATED HIGH PF LED DRIVER CIRCUIT DESIGN
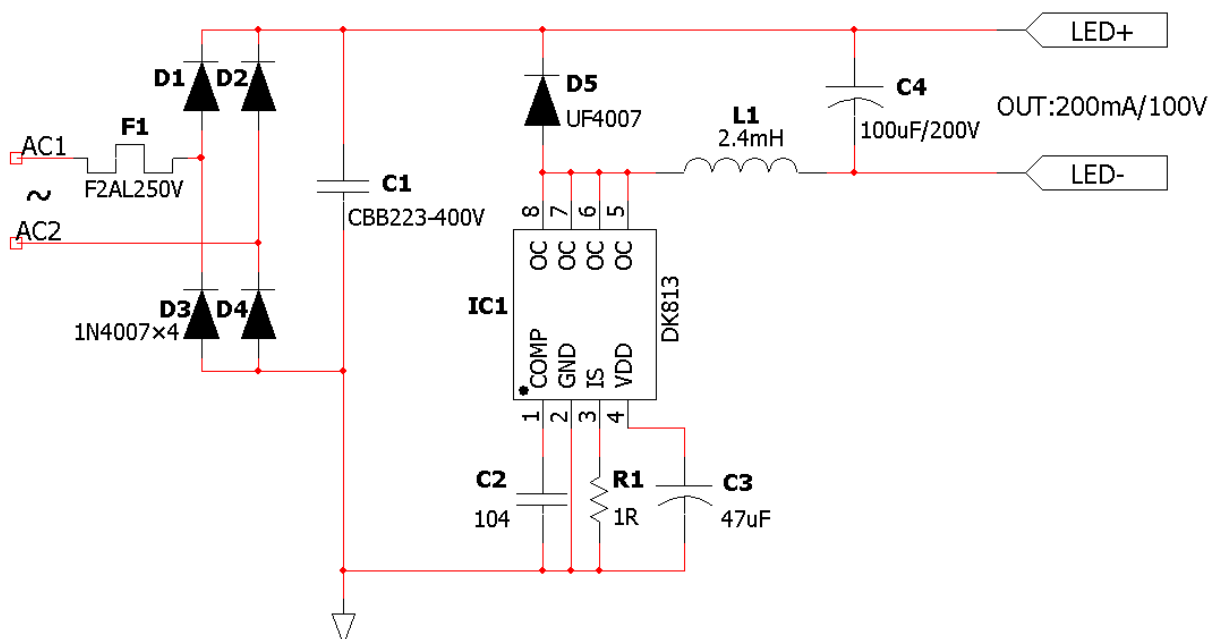
9.1 Components list

NO.	NAME	SPEC. / MODEL NO.	POSITION	USED QTY	REMARK
1	Fuse	F2AL250V	F1	1	
2	Rectifier diode	1N4007×4	D1~D4	4	
3	Fast recovery diode	UF4007	D5	1	
4	Electrolytic capacitor	CBB223/400V	C1	1	
5	Electrolytic capacitor	104	C2	1	
6	Electrolytic capacitor	47uF/6.3V	C3	1	
7	Electrolytic capacitor	100uF/200V	C4	1	
8	Resistance	1R/0.25W	R1	1	1% accuracy
9	IC	DK813	IC1	1	
10	Lp Inductance	EE16	L1	1	

9.2 TRANSFORMER DESIGN (NON ISOLATED HIGH PF BUCK CIRCUIT)

9.2.1 Parameter confirmation: confirm the below parameter before transformer design

(1) Input voltage range   (for example :AC165V-265V)

(2) Output Voltage and current   (for example DC100V 0.2A)

9.2.2 Core selecting

(1) Input power calculation

P=Pout/η (η is the efficiency of the power supply, take it 0.92 here), Pout=Vout*Iout=100V*0.2A=20W, so P_{in}=20/0.92≈22W.

(2) Choose the core:

Because Lp Inductance is a winding set, when using transformer for winding, the available rate| is 0.7, so we can choose any core that can hold the number of turns that we need to wind, here we can choose EE16 core.

9.2.3 Current-limiting resistance calculation

$$Io = \frac{200mV}{Rs} * \eta \quad , \text{so} \quad Rs = \frac{200mV}{Io} * \eta$$

$Rs = \frac{200mV}{200mA} * 0.92 = 0.92\Omega$, as to make the calculation easier, we take $Rs = 1\Omega$.

9.2.4 Non loading limited voltage (V_{ovp}) confirmation and input inductance value (Lp) calculation

Output Voltage is 100V, we take V_{ovp} to be 1.2 times of it, 120V.

$$Vovp = \frac{50*Lp}{Rs} \quad , \text{so} \quad Lp = \frac{Vovp*Rs}{50} = \frac{100V*1.2*1}{50} \approx 2.4mH$$

9.2.5 Number of the original(input) turns (Np)

Because the saturation magnetization of Ferrite material is about 0.4T, the designed Magnetic flux density in transformer should be no more then 0.4T. Also, Single-ended Flyback circuits works in the first quadrant of B-H, residual magnetism of the core is about 0.1T, so the maximum working magnetic flux density should be 0.4-0.1=0.3T. We take 0.3T for below calculation.

According to formula B$_{max}$= $(I_p*L_p)/(N_P*Ae)$=0.3T,, A$_e$ in EE16 transformer is 19.2mm^2,

$$Ip = \frac{1V}{Rs} = 1000/1 = 1000, \quad \text{so we can get that } N_P = (I_P*L_P)/(B_{max}*Ae) = (1000*2.4)/(0.3*19.2) \approx 416$$

9.2.6 Copper wire diameter

The current capacity of copper wire is 6A/mm², we can get its diameter as below:

$$\Phi = 2 \times \sqrt{\frac{Iout}{6 \times 3.14}} = 2 \times \sqrt{\frac{0.2}{6 \times 3.14}} \approx 0.21 \, mm^2$$

10. SPECIAL NOTICE FOR PBC LAYOUT DESIGN

10.1 Heat dissipation: A good estimate is that the controller will dissipate the output power. So enough cooper area connected to the OC pin and tin-plating are necessary to provide the controller heat sink.

10.2 The OC pin is high voltage part of the IC, peak voltage is as high as 600V, so it should be at least 1.5mm far away from the low voltage part in the PCB as to avoid circuit breakdown and discharging.

10.3 The self-power supply circuit in IC works in high frequency situation, too long or too thin cable would cause abnormal working of the IC, so the capacitor connected to pin No. 4 should be near to IC and the cable area should be enlarged.

11. MECHANICAL AND PACKING INFORMATION

DIP-8

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524 (BSC)		0.060 (BSC)	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540 (BSC)		0.100 (BSC)	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354
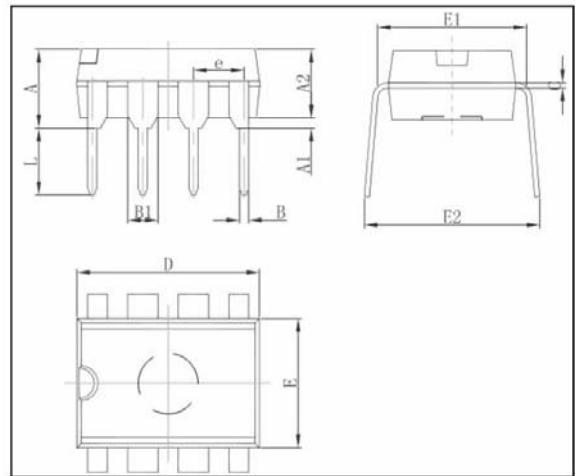
· **Packing quantity**

QTY/tube	QTY/inner carton	QTY/master carton
50	2000	20000