SPECIFICATION

1. DESCRIPTION

The DK212 is specially design for switch mode power supply with requirement of Efficiency Level Ⅵ (Europe). It is a secondary side flyback type AC-DC Quasi-Resonant Mode Power Controlling IC. With i ntegrated 700V high voltage power transistor, patented self-power supply circuit and integrated MOS circ uit design, lots of external components are saved, transformer design is simple, only two windings are n eeded in transformer for isolated output circuit.

2. APPLICATIONS

·AC/DC power adapters
·Air conditioner power supply
·DVB power supply
·TV/Monitor power supply
·DVD/VCD power supply
· Electromagnetic oven power supply
· LED driver applications

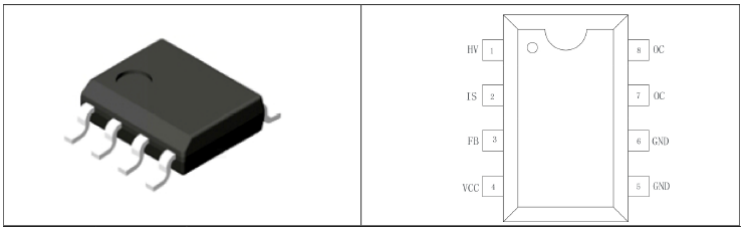
3. MAIN FEATURES

· 85V—265V wide range AC power input.
· Build-in 700V power transistor.
· 4 KV Anti-Static ESD test.
· CE, FCC, C-Tick, ERP level 6, RoHS compliant design
· Patented self-power supply design to saves transformer auxiliary winding and associated bias supply components
· Special “SLEEP” technology circuit integrated to support supper low standby power consumption (<0.1W).
· Integrated Quasi-Resonant Pulse-Width Modulation (PWM) circuit, to increase power switching efficiency and improve EMC characteristic.
· Over current, Over loading, Over temperature, Over voltage, secondary side open circuit and output short circuit Protection.

4. POWER RANGE

Input Voltage	85-265V AC	180-265V AC
MAX. output power	12W	18W

5. CONNECTION DIAGRAM (SOP-8)



PIN FUNCTION

Pin NO.	Pin Name	Function
1	HV	Need to contact with driving resistor of 4.7M
2	IS	Current detecting pin. Connecting method 1: connect it with grounded resistor, Rs>0.47Ω, max. current Ip=Vlim/Rs. Connecting method 2: connect it with ground directly, max. current Ip=700mA.
3	FB	Feedback control pin, connected with 1nF～10nF capacitor
4	VCC	Power supply pin, contacted with an external grounded capacitor of 10uF~47uF
5,6	GND	Ground reference
7,8	OC	Output pin. Connected with internal high voltage power transistor and external switch mode transformer.

6. ABSOLUTE MAXIMUM RATINGS

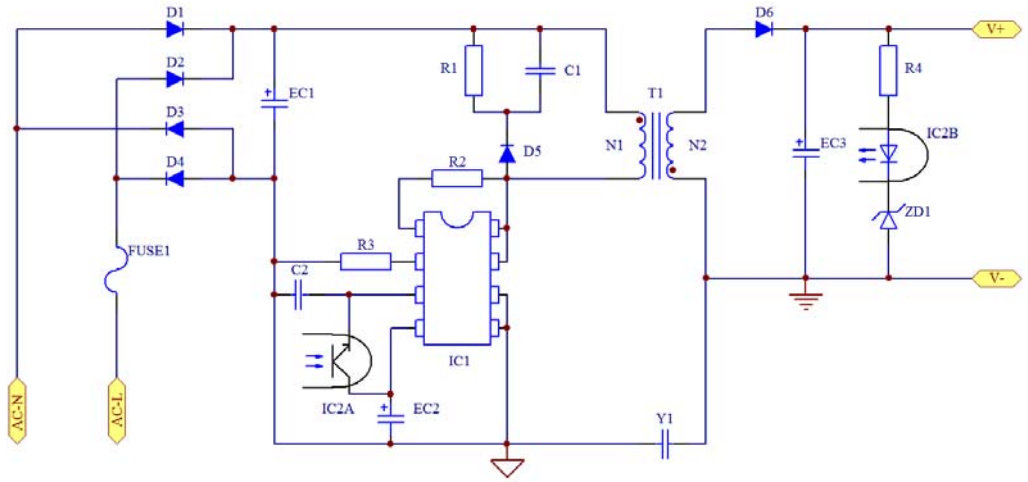
Parameter	Value	Unit
Supply voltage (VDD)	-0.3V--8	V
Current of supply voltage	100	mA
Pin voltage	-0.3--VDD+0.3	V
Power transistor withstand voltage	-0.3--730	V
Peak voltage of IS	400	mV
Dissipation power	600	mW
Case operating temperature	-25--+125	℃
Storage temperature	-55--+150	℃
Lead Soldering temperature	+280	℃/5S

7. ELECTRICAL CHARACTERISTIC

Parameter	Condition	Value			Unit
		Min.	Typ.	Max.	
Vcc (Working Voltage)	AC input: 85V-265V	4.5	4.7	5.8	V
Start threshold Voltage(VCC_Start)	AC input: 85V-265V	4.9	5.0	5.2	V
Restart Voltage(VCC_Min)	AC input: 85V-265V	3.4	3.5	3.7	V

Protect Voltage (VCC_Max)	AC input: 85V-265V	5.7	5.8	6.0	V
Current of Vcc (I)	Vcc=4.7V, Fb=2.8V			40	mA
Start up current (I_Start)	AC input=265V			0.5	A
Start up time (T_Start)	AC input=85V, C=22uF	--	--	250	mS
BJT Voc Breakdown voltage	Ioc=1mA	700	--	--	V
Max. Voltage of IS -Vlim	VCC=4.7V, FB=2.8V,AC input=85V	360	380	400	mV
Vor Protection Voltage (Vor_Max)	Lp=1.68mH, Rs=0.57	100	133	160	V
PWM Output frequency (F_PWM)	Vcc=4.7V, Fb=1.33V---4.7V	20	--	70	Khz
Short Circuit Protect voltage(Vfb_L)	FB voltage		1.33		V
Standby voltage (Vfb_H)	VCC=4.7V		4.3		V
Temperature protection	Operating Junction Temp.	120	130	140	℃
Leading edge blanking time (Ton_Leb)	VCC=4.7V		250		ns
Min. turn-on time (Ton_Min)	VCC=4.7V		500		ns
Max. turn-on time (Ton_Max)	VCC=4.7V, FB=2.8V,AC input=85V		15		Us
Min turn-off time (Toff_Min)	VCC=4.7V, FB=2.8V,AC input=85V		8		Us
Standby power consumption				60	mV
Internal resistor Max. Ip current	IS grounded directly		700		mA

8. OPERATION PRINCIPLE



8.1 Start Up

With its internal high voltage constant current driving circuit, external VDD capacitor (C4) would be charged when power on (VDD voltage is less then VCC_Start), when the voltage of VDD reaches Vcc_Start, starting up process finished. Controlling logic begins output of PWM to test the IS resistor: if IS is grounded via resistor RS, Ip_Max=Vlim/RS (Vlim is the max. tested voltage value of pin 6); if IS is grounded directly, Ip_Max=700mA.

8.2 Soft Start

After starting up process, transformer's magnetic core saturation would cause too much pressure on transsitor, so there is soft start circuit integrated in the IC as to avoid this situation. Peak current of primary side is 0.5 time of Peak current (Ip) at this stage.

8.3 Quasi-Resonant Output

There are 3 parts in one PWM cycle:

8.3.1 Inductance charging stage (transistor on): $T_1 = \frac{L_p * I_p}{V_{in}}$

8.3.2 Inductance discharging stage (transistor off) : $T_2 = \frac{L_p * I_p}{V_{vor}}$

8.2.3 OC resonant stage, resonant cycle $T = 2\pi\sqrt{L_p * C_{oc}}$

With this Quasi-Resonant mode, when OC voltage reaches its lowest level, PWM works and charges inductance, so that to reduce the consumption of the resistor while switching and increase the efficiency of the power.

8.4 Fb pin detecting and control

Pin Fb should be connected with an external capacitor to smooth its voltage. The external capacitor would affect the circuit's Feedback transient and stability, typical application could be between 1nF and 10nF.The IC controls PWM output peak current and working frequency according to the voltage of Fb pin.

8.5 SLEEP Mode

When output power decreases and reached 50mW, the IC will enters into SLEEP mode, so that can make sure of the special low standby power consumption of less then 60mW.

8.6 Self-Power Supply Circuit (National patent owned)

There is self-power supply circuit inside the IC, which can control the VDD voltage at about 4.7V for the electricity consumption of the IC itself. So that can save external winding power supply. It can only afford the electricity consumption of itself but not for external circuit.

8.7 Over Temperature Protection (OTP)

When the controller detects the device temperature exceeds 130℃, OTP is activated. It stops the switching operation immediately and enters into the stop status. The controller will restart to switching operation when the temperature falls down.

8.8 Short Circuit and Over Load Protection (OCP)

Whenever there is short circuit on secondary side or over loaded, if FB's voltage is lower then the Vfb_L for more then 0.8s, IC will cut off resistor and enter into protection status.

8.8 Primary side Short Circuit Protection

After soft start process, on point of 500ns after PWM on, if the detected current value of primary side winding in

transformer is higher then the MAX. Peak current value Ip_Max, IC willcut off resistor and enter into protection status.

8.9 Abnormal IC Power supply Protection

When the VCC voltage is lower then VCC_Min, transistor will be cut off and IC restart.

When the VCC voltage is higher then VCC_Max, IC will stop output and enter into protection status.

8.10 Secondary side open circuit and Optocoupler-Effectiveness Protection (OVP)

When Secondary side open circuit or optocoupler is effectiveness, if detected Vor >Vor_Max, IC will cut off PWM output and enter into protection status.

When the optocoupler is effectiveness, output protection voltage could be calculated as:

$$Vo\_\max = \frac{45000 * Lp}{RS * N} - Vd$$

Vo_max: output protecttion voltage

Lp: primary side winding's inductance value

N: ratio of winding for primary and secondary side

Vd: secondary rectifying tube's pressure drop V

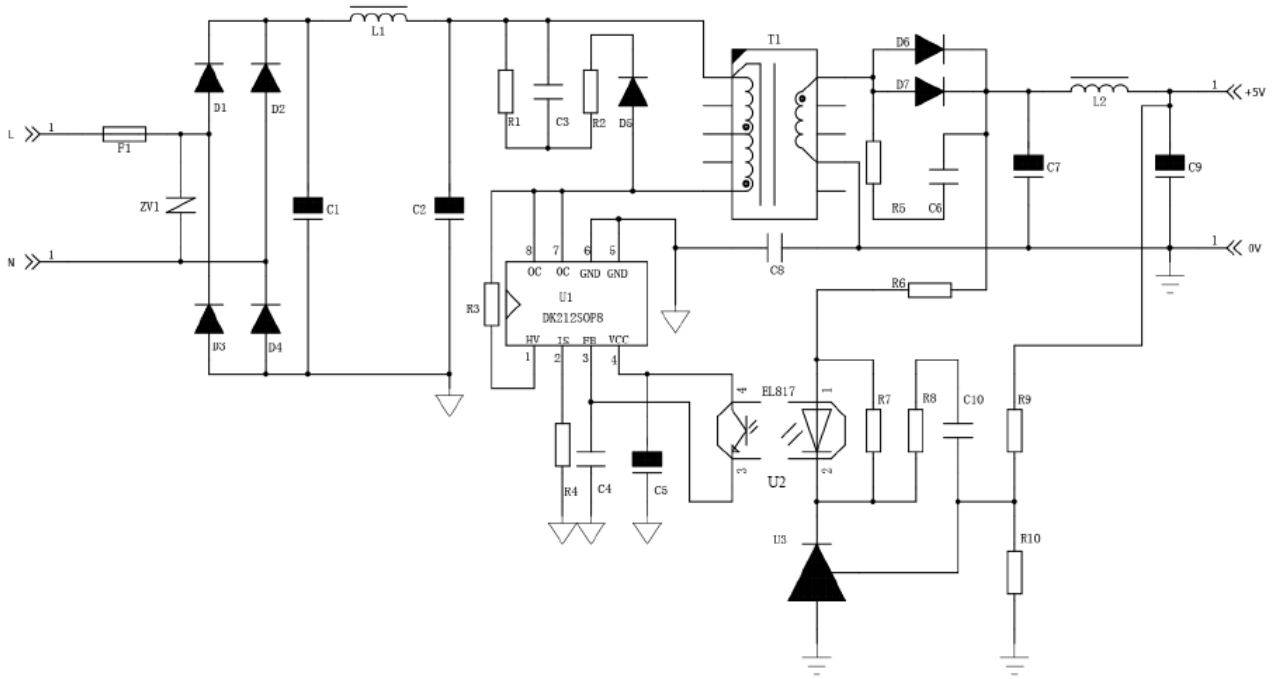
When IS is grounded with resistor, output protection voltage could be calculated as: $Vo\_\max = \frac{86400 * Lp}{N} - Vd$

8.11 Abnormal protection's working mode

Whenever the IC enters abnormal protection status, it will cut off PWM output and start a timer of 800ms. In the 800ms, VCC drops and keeps on 4.6V, after the 800ms, the IC will recover.

9. TYPICAL APPLICATION SAMPLE

(5V 2A OUTPUT OFF LINE FLYBACK TYPE SWITCH MODE POWER SUPPLY)



9.1 Components list

NO.	NAME	SPEC. / MODEL NO.	POSITION	USED QTY	REMARK
1	Fuse	T2A / AC250V	F1	1	
2	Diode	IN4007	D1~D4	4	
3	Diode	FR107	D5	1	
4	Diode	SR540	D6,D7	2	
5	Electrolytic capacitor	10uF/400V	C1,C2	2	
6	Electrolytic capacitor	22uF/16V	C5	1	
7	Electrolytic capacitor	1000uF/10V	C7, C9	1	
8	Inductance	10uH / 2.5A	L2	1	
9	Inductance	2mH	L1	1	
10	capacitor	102 / 250V	C6	1	
11	capacitor	103 / 500V	C3	1	
12	capacitor	103	C4	1	
13	Y capacitor	222	C8	1	
14	capacitor	104	C10	1	
15	resistor	4.7M	R3	1	
16	resistor	47	R2	1	
17	resistor	100K	R1	1	
18	resistor	470	R6	1	
19	resistor	2K	R7	1	
20	resistor	10K	R9	1	Accuracy=1%
21	resistor	9.3K	R10	1	Accuracy=1%
22	resistor	5.1K	R8	1	
23	resistor	22R	R5	1	

24	resistor	0.5	R4	1	Accuracy=1%
25	varistor	7D471	ZV1	1	
26	Opto-coupler	PC817C	U2	1	
27	Voltage reference	TL431	U3	1	
28	IC	DK212(SOP-8)	U1	1	
29	Transformer	EF20	T1	1	NP=128T,NX=9T, LP=1.6mH

9.2 TRANSFORMER DESIGN (for reference only)

9.2.1 Parameter confirmation: confirm the below parameter before transformer design

(1) Input voltage range: AC85V-265V

(2) Output Voltage and current: DC5.2V 2A

9.2.2 Flyback voltage Vor

In DK212, Vor_max. is 133V, as to avoid disturbance, output protect voltage should be 1.2 times more then output voltage, so in normal working, Vor_Max=133/1.2=110V. Also output voltage should lower then the withstand voltage value of output capacitor, when capacitor's withstand voltage is 10V, Vor_Min=133*5.2/10=70V. So we set Vor=80V in this calculation.

9.2.2 Rs calculation

PWM output is of Quasi-Resonant mode, the lower the output voltage is, the slower the frequency it becomes, and higher Ip is needed.

When in low voltage status, $RS=\frac{0.135*Vin\_\min*Vor}{Po*(Vin\_\min+Vor)}$, in this design: $RS=\frac{0.135*Vin\_\min*Vor}{Po*(Vin\_\min+Vor)}=\frac{0.135*86*80}{5.2*2*(86+80)}=0.538\approx 0.54$

PS: * Po--output voltage

* Vor--Flyback voltage

* Vin_min: average value of DC voltage that after filter of AC voltage, this voltage is relater with input filter capacitor's value. In AC 85V input, Vin_min=85*0.9*1.414-20=86V. Here we take 2uF/W value capacitor, if it is 3uF/W, voltage should increase accordingly.

9.2.3 Ratio of winding (N) calculation

The forward voltage of transformer's output point=5.2+0.35(10V45's pressure drop)+0.1(cable's pressure drop)=5.65V. When Vor=80V, N=80/5.65=14.16.

9.2.4 Primary inductance (Lp) calculation

In DK212, Lp is of direct relationship with Rs, Lp=0.003*RS=0.003*0.54=1.6mH

9.2.5 Core selecting

$$A_P=A_e*A_W=\frac{6500*P_O}{\Delta B*J*f}=\frac{6500*10.4}{0.25*5*45}=1201=1201\text{mm}^4$$

PS: *Ae--effective area of core (mm^2)

*Aw--window area of core(mm^2)

*△B/△Bac is set to be 0.25(mT) in this design

*J--current density, set to be 5A/mm^2

*f--working frequency F, the lowest value in Quasi-Resonant model in DK212 is 45KHz

Checking via supplier or the correlative chart can know that EE19's AP=1423mm^4, EF20 core's AP=2231 mm^4, considering to improve EMI characteristic and isolation of primary and secondary side, EF20 type is better and chosen. Rated Ae value of EF20 is 33.5, we can check with actual product.

9.2.6 Number of the Primary side(input) turns (Np) and output turns (Ns)

$$N_P = \frac{380 * L_P}{A_e * \Delta B * R_S} = \frac{380 * 1.6}{33.5 * 0.25 * 0.54} = 134$$

Ns=Np/N=134/14.16=9.46, we take it 9.

So that the final value is : Ns=9, Np=Ns*N=9*14.16=128

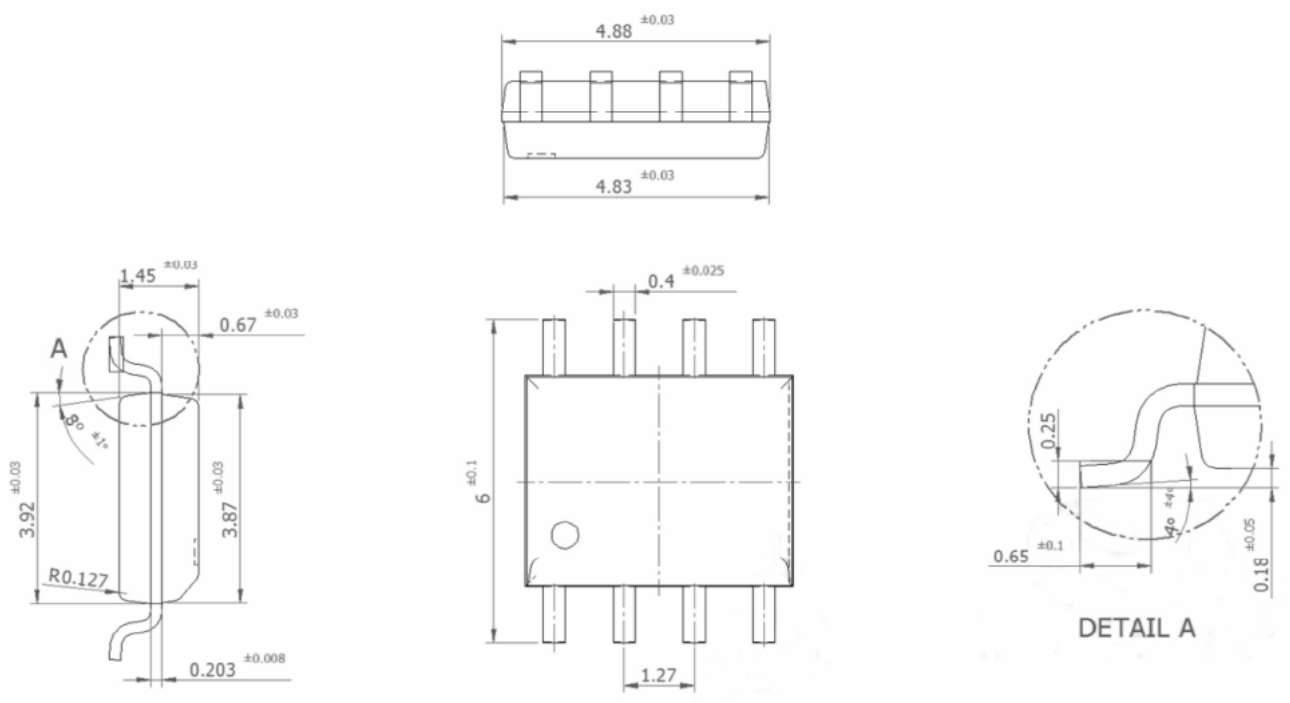
10. SPECIAL NOTICE FOR PBC LAYOUT DESIGN

10.1 Heating of IC mainly comes from transistor, as the transistor is connected with OC pins, so enlarge the copper area around the OC pin and tin-plating requirement are necessary in PCB design for heat releasing. At the same time, this part is also DC signal part, EMC/EMI components (as the left part of L1 in above design) should be as far as possible to it.

10.2 OC pins are 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. It is suggested to make 1mm open slot between pin 5,6 and pin 7,8, so that to avoid circuit breakdown and discharging.

10.3 As there is inductance leakage in transformer, It is suggested to use P/S/P way to wind the transformer so that to reduce the leakage inductance.

11. MECHANICAL AND PACKING INFORMATION (SOP-8)



·Packing: 2500pcs/reel