Function description

DK125 is a secondary feedback, flyback AC-DC offline switching power supply control chip. The chip adopts highly integrated CMOS circuit design, with output short circuit, secondary open circuit, over temperature, over voltage and other protection functions. Chip built-in high voltage power Tubes and self-powered lines, with very few external components, simple transformer design (the transformer does not require power supply windings), etc. point.

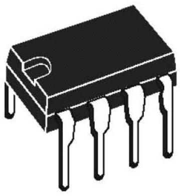
Features

- Full voltage input 90V-264V.
- Built-in 700V power tube.
- A high-voltage constant-current startup circuit is integrated in the chip, and no external startup resistor is required.
- Patented self-powered technology, no need for external winding power supply.
- Standby power consumption is less than 0.3W.
- 65KHz PWM switching frequency.
- Built-in frequency conversion function, automatically reduce the working frequency when standby, and meet the European green energy standard (<0.3W) at t
  When the output voltage ripple is reduced.
- Built-in slope compensation circuit to ensure the stability of the circuit at low voltage and high power output.
- Frequency jitter reduces the cost of EMI filtering.
- Over temperature, over current, over voltage and output short circuit, secondary open circuit protection.
- 4KV anti-static ESD test.

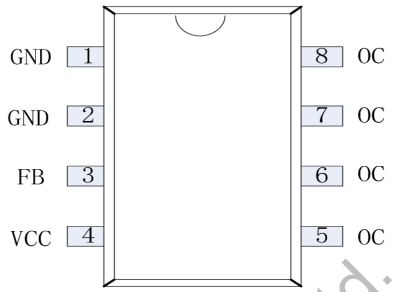
Application field

AC-DC applications below 24W include: power adapters, LED power supplies, induction cookers, air conditioners, DVDs, set-top boxes and other home appliances.

Package and pin definition (DIP8)

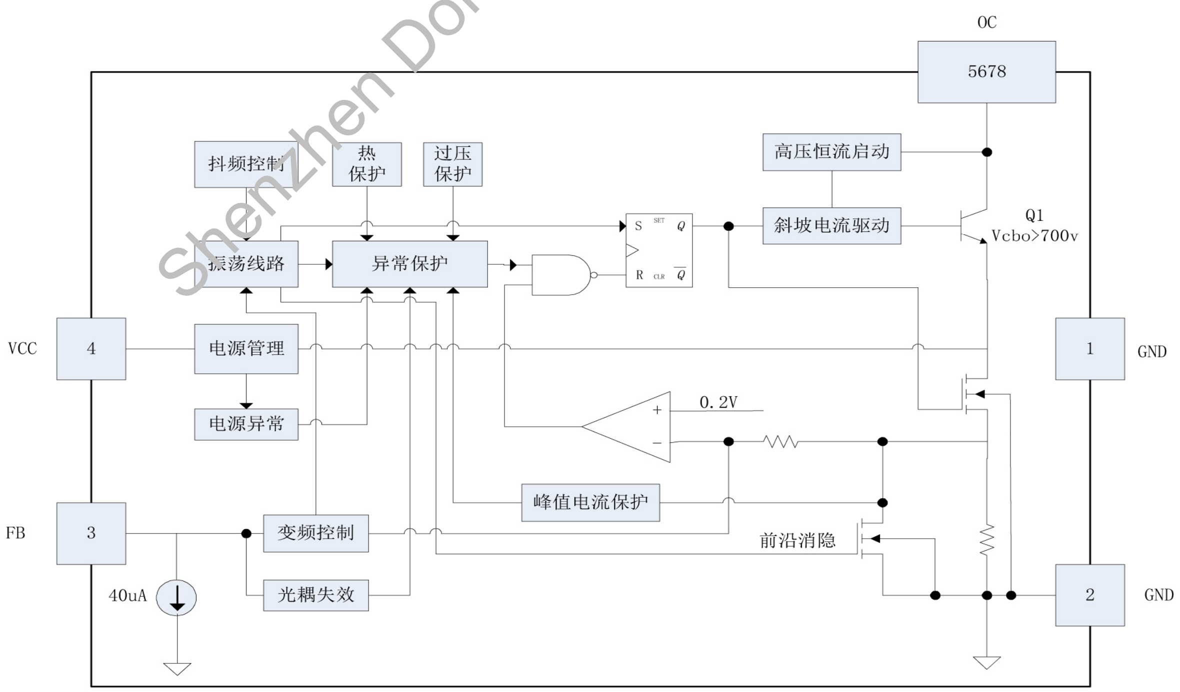


DIP-8



Pin	symbol	Function description
1	**GND**	Ground pin
2	**GND**	Ground pin
3	**FB**	Feedback control terminal pin, connect 1nF ~ 10nF
4	**VCC**	Power supply pin, external to ground connect 47uF ~ 100uF capacitor
5,6,7,8	**OC**	Output pin, connected to the high-voltage power tube in the chip, and connected to the switching transformer externally

Internal block diagram



Limit parameters

Supply voltage VDD .... -0.3V--8V

Supply current VDD 100mA

Pin voltage .... -0.3V--VDD+0.3V

Power tube withstand voltage.. -0.3V--700V

Peak current 1300mA

Total power dissipation 1000mW

Operating temperature .... -25 ° C--+125 ° C

Storage temperature .... -55 ° C--+150 ° C

Welding temperature .... + 280 ° C/5S

Electrical parameters

project	Test Conditions	The smallest	typical	maximum	unit
VCC working voltage	AC input 85V-----265V	4.5	4.7	4.9	V
VCC starting voltage	AC input 85V-----265V		4.7		V
VCC restart voltage	AC input 85V-----265V	3.30	3.60	3.90	V
VCC protection voltage	AC input 85V-----265V	6.25	6.55	6.85	V
VCC working current	VCC=5V, FB=1.5V			50	mA
High voltage starting current	AC input 85V-----265V	0.3	0.6	1.2	mA
Start Time	AC input 85V	---	---	500	mS
Power tube withstand voltage	Ioc=1mA	700	---	---	V
Power tube protection voltage	Measure OC voltage	540	600	660	V
Maximum peak current	VCC=5V, FB=1.5V---2.8V	1100	1200	1300	mA
PWM output frequency	VCC=5V, FB=1.5V---2.5V	61	65	69	KHz
	VCC=5V, FB=2.5v-2.8v	20	twenty two	twenty four	KHz
Modulation step frequency	VCC=5V, FB=1.5v-2.5v		0.5		KHz
Short circuit protection threshold	Measure FB voltage	1.15	1.33	1.50	V
Frequency conversion threshold voltage	Measure FB voltage	2.3	2.5	2.7	V
Burst Mode Threshold	Measure FB voltage	2.6	2.8	3.0	V
Temperature protection	Junction temperature	120	130	140	°C

Leading edge blanking time	VCC=5V, FB=1.5v-2.5v		250		ns
Minimum opening time	VCC=5V, FB=2.6v		500		ns
Duty cycle	VCC=5V, FB=1.5v-2.5v	5	---	70	%
Standby power consumption	AC input 265V, no load			270	mW

Function description

Power-on start

When the power is turned on, the chip charges the external VCC energy storage capacitor through the high-voltage current source connected internally to the OC and VCC pins. When the VCC voltage rises to 4.7V, the high-voltage current source is turned off. The start-up process ends, and the control logic Start to output PWM pulses.

Soft start

After power-on, the chip starts to output PWM pulses. In order to prevent instantaneous output voltage overshoot, the transformer core is saturated And, the stress of the power tube and the secondary rectifier tube is too large, the chip is built-in 16 MS Soft start circuit, at 16 MS Within, will gradually increase Add the PWM on time to make the peak current of the power tube from 100 M A increases linearly to the maximum peak current.

Feedback control

The chip adopts the PWM control method that limits the peak current cycle by cycle, and adjusts the limit current by detecting the feedback voltage of FB. When PWM is turned on, the chip detects the output current of the power tube until the output current of the power tube reaches the current l After controlling the current, turn off the power tube and wait for the next PWM turn-on cycle. FB voltage is at 1.5 V- 2.5 V The current will be linearly adjusted to limit the current. 1.5 V Corresponding to the maximum limit current, 2.5 V Corresponds to the minimum limit current. When the load increases, FB The voltage will gradually decrease; otherwise, the FB voltage will gradually increase. When the load is too heavy, FB voltage is less than 1.5 V When the time, the chip will enter the judgment of short circuit or overload protection. When the load is very light, the FB voltage is greater than 2.5 V Time, the control circuit will change the PWM switching frequency from 65 KHZ Reduced to 22 KHZ, And opened with the minimum opening time. When the load is lighter, the FB voltage will continue to rise; when the FB voltage is higher than 2.8 V When the control circuit stops PWM output, the chip enters the standb

Standby burst mode

In standby, FB voltage will rise to 2.8 V Above, the chip stops PWM output. When the output voltage drops slightly, the FB voltage is lower than 2.8 V When the time, the chip will re-output some PWM pulses to maintain the set output voltage; this burst output mode can achieve lower standby power consumption.

Frequency modulation

In order to meet the design requirements of EMI and reduce the design complexity and cost of EMI, a frequency modulation circuit is installed in the chip, and the frequency of PWM will be 65KH z Centered at 0.5KH z The step frequency of running at 16 frequency points.

Self-powered

The chip uses a patented self-powered technology to control the voltage of VCC at about 4.7V and provide the current consumption of the chip itself, so that the external transformer auxiliary winding can be omitted and the design of the transformer can be simplified.

Peak current protection

Whenever the chip detects that the peak current of the internal power tube exceeds 1.3A, it will immediately turn off the power tube to protect The power tube and corresponding devices are protected from damage.

Constant power control

In order to prevent over power output at high voltage, the chip has a built-in high and low voltage power compensation circuit to enable different grid voltages The maximum output power at input time is basically the same.

Abnormal power supply

When the VCC voltage is lower than 3.6V due to an external abnormality, the chip will turn off the power tube and restart it. When the VCC voltage is higher than 6.5V due to an external abnormality, the VCC over-voltage protection will be activated immediately and the output pulse will be stopped until the VCC over-voltage condition is removed.

Power tube overvoltage protection

The secondary open circuit, the input bus voltage is too high, and the transformer leakage inductance is too large, which will cause the high peak of the power Voltage; To protect the power tube from being damaged, when the circuit detects that the OC voltage of the power tube exceeds 600 V At this time, it will immediately pull up the FB voltage and stop outputting PWM pulses until the overvoltage condition of the power tube is removed.

Short circuit and overload protection

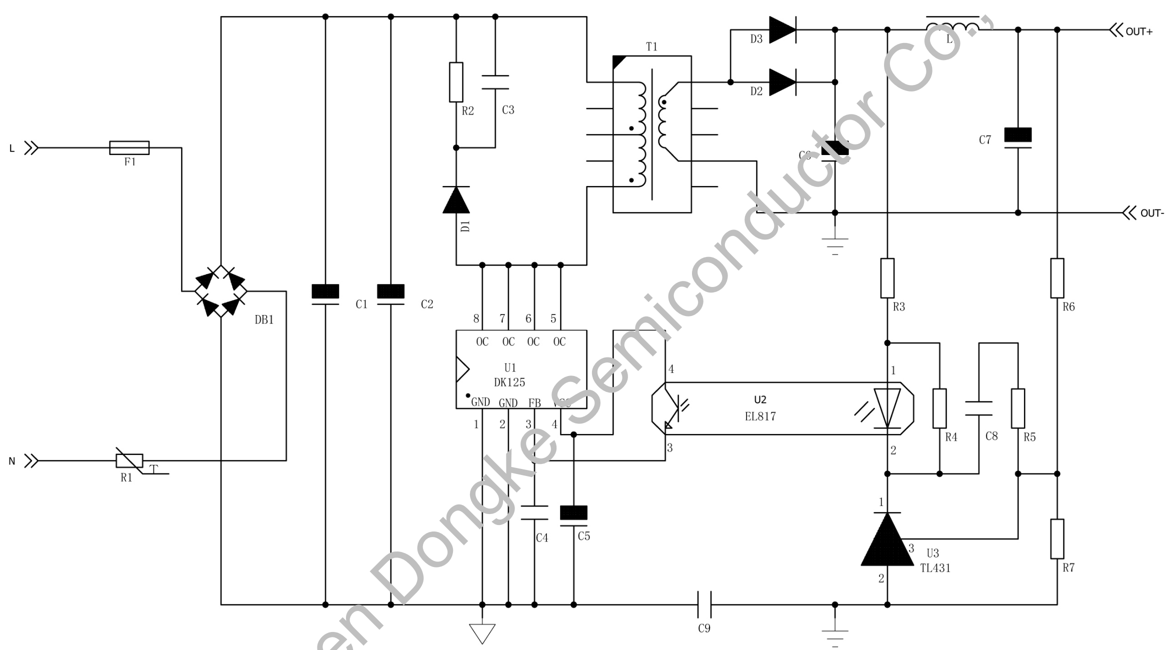
When the secondary output is short-circuited or overloaded, the FB voltage will be lower than 1.3 V; In some applications, inductive loads such as motors require higher starting current when starting, which may cause short-term overload of the circuit, so the chip is overloaded for the first time The judgment time of the protection is 512mS. If the FB voltage returns to normal within 512mS, the chip will not judge overload or short circuit; If the FB voltage is always lower than 1.3 within 512mS V, It is judged that the secondary output is short-circuited, the short-circuit protection is activated immediately, The short-circuit protection judgment time is shortened to 32mS until the short-circuit condition is removed.

Over temperature protection

Any time it detects that the temperature of the chip exceeds 130℃, the over-temperature protection will be activated immediately, and the output pulse will be

The temperature condition is lifted.

Typical application (12V2A output offline flyback switching power supply)



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Component list:

Serial number	Component name	Specification/Model	Tag	Quantity	Remarks
1	fuse	T2A/AC250V	F1	1	
2	Bridge rectifier	DB107	DB1	1	
3	diode	FR107	D1	1	
		SR5100	D2,3	2	
4	Electrolytic capacitor	22uF/400V	C1,2	2	
		100uF/16V	C5	1	
		1000uF/25V	C6	1	

		470uF/25V	C7	1	
5	inductance	10uH/2.5A	L1	1	
6	Ceramic capacitor	2G103J	C3	1	
		103 tiles	C4	1	
		104 tiles	C8	1	
		Y capacitor 102	C9	1	
7	NTC	10D-9	R1	1	
8	Color ring resistance	75K/0.5W	R2	1	
		1K	R3	1	
		2.2K	R4	1	
		4.7K	R5,7	2	
		18K	R6	1	
9	DK IC	DK125	U1	1	
10	DK heat sink	DIP-8 dedicated	U1	1	
11	IC	EL817C	U2	1	
12	IC	TL431	U3	1	
13	transformer	EE25/19	T1	1	

Transformer design (for reference only)

When designing a transformer, some parameters need to be determined first:

(1) Input voltage range AC90 ~ 264V

(2) Output voltage and current DC12V/2A

(3) Switching frequency F=65KHz

1. The choice of magnetic core:

First calculate the input power of the power supply $P_i = \frac{P_o}{\eta}$ (η Refers to the efficiency of the switching power supply, set to 0.8)

$P_i = \frac{P_o}{\eta}$ =24W/0.8=30W, the overcurrent point is 1.1 times, the actual calculation is calculated as 33W

Select through the chart provided by the manufacturer of the magnetic core, or through calculation, the input power is 30W

When the power supply can be used EE25/19 core.

2. Calculate the transformer primary coil inductance Lp, the peak current in the chip is set to 1100mA, so

Lp=2*Pi/(Ip*Ip*f)=2*33/(1.1*1.1*65000)=840(uH)

3. Calculate the number of primary turns Np:

$$N_P = \frac{L_P * I_P max}{\Delta B * A_e} = 840*1.3/0.28/40=98T$$

among them:

Np – – – – – – Primary side turns

L – – – – – – Primary side inductance value

Ip_max ––––––Maximum current of primary side

△B – – – – – – Alternating working magnetic density (mT), set to 0.28,

Ae – – – – – – – Magnetic core effective area (mm2), EE25/19 magnetic core is 40mm2

4. Calculate the number of turns Ns on the secondary side:

Ns – – – – Number of secondary side turns

Np – – – – Primary side turns

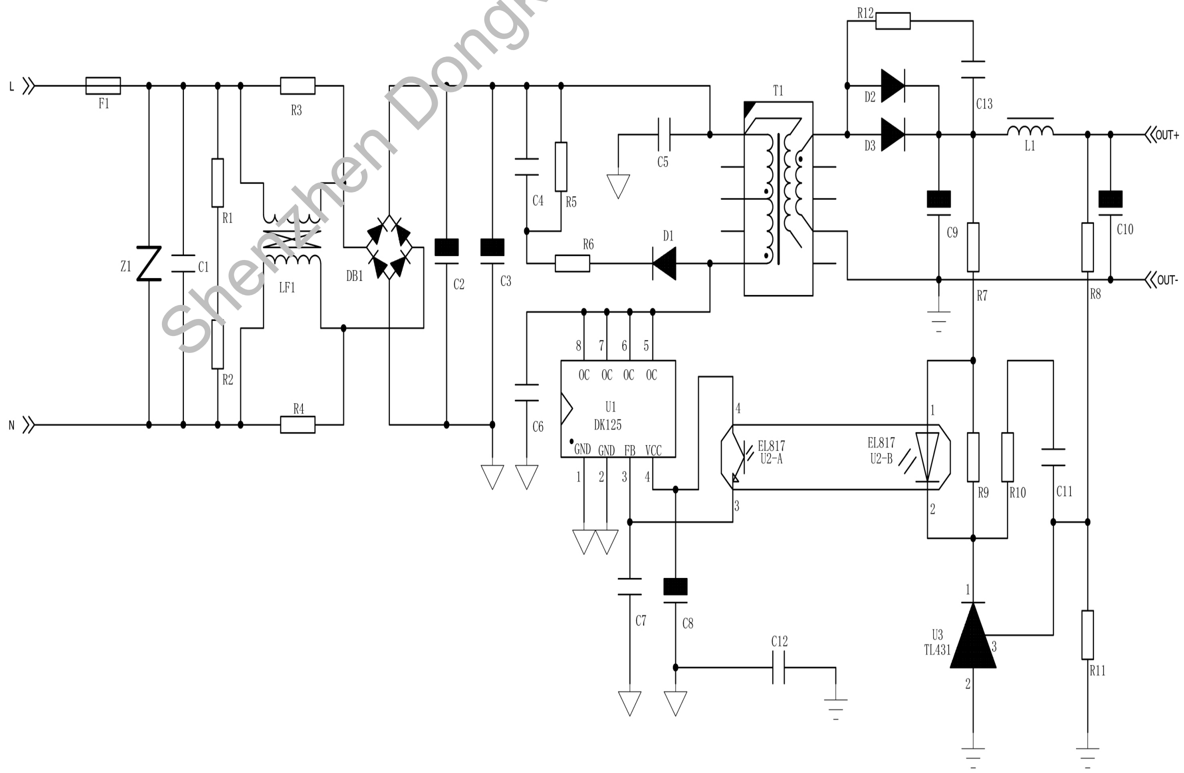
Vout – – – – Output voltage (including line voltage drop and rectifier voltage drop, 12V+0.7V=12.7V)

Vor – – – – Flyback voltage (set the voltage not higher than 120V to avoid damage to the chip due to overvoltage, this set

Set to 90V in the calculation)

Ns=(Vout*Np)/Vor=(12.7*98)/90 = 14 turns.

Typical application (12V2A certified switching power supply)



Component list:

Serial number	Component name	Specification/Model	Tag	Quantity	Remarks
1	fuse	T2A/AC250V	F1	1	
2	Varistor	10D471	Z1	1	
3	Bridge rectifier	DB107	DB1	1	
4	diode	FR107	D1	1	
		SR5100	D2,3	2	
5	Electrolytic capacitor	33uF/400V	C2,3	2	
		100uF/16V	C8	1	
		1000uF/25V	C9,10	2	
6	inductance	10uH/2.5A	L1	1	
		UU9.8 20mH 0.6A	LF1	1	
7	capacitance	2G103J	C4	1	
		103 50V	C7	1	
		104 50V	C11	1	
		222 500V	C5	1	
		X2 capacitor 224	C1	1	
		102 1KV	C13	1	
		22pF 1KV	C6	NC	Please reserve position (EMC/I)
		Y1 capacitor 222	C12	1	
8	Color ring resistance	75K/0.5W	R2	1	
		1K	R3,4,7	3	
		680K	R1,2	2	
		47R	R6	1	
		2.2K	R9	1	
		4.7K	R10,11	2	
		18K	R8	1	
9	DK IC	DK125	U1	1	
10	DK heat sink	DIP-8 dedicated	U1	1	
11	IC	EL817C	U2	1	
12	IC	TL431	U3	1	
13	transformer	EF25	T1	1	

Transformer design (reference)

When designing a transformer, some parameters need to be determined first:

(1) Input voltage range AC90 ~ 264V

(2) Output voltage and current DC12V/2A

(3) Switching frequency F=65KHz

1. The choice of magnetic core:

First calculate the input power of the power supply $Pi = \frac{Po}{\eta}$ (η Refers to the efficiency of the switching power supply, set to 0.8)

$Pi = \frac{Po}{\eta}$ =24W/0.8=30W, the overcurrent point is 1.1 times, the actual calculation is calculated as 33W

The choice is made by the chart provided by the manufacturer of the magnetic core, or it can be selected by calculation, because the certification requirements

For the issue of strictness and certification costs, when the input power is 30W, the power supply selects the core EF25 with a larger

margin. 2. Calculate the transformer primary coil inductance Lp, the peak current in the chip is set to 1100mA, so

Lp=2*Pi/(Ip*Ip*f)=2*33/(1.1*1.1*65000)=840(uH)

3. Calculate the number of primary turns Np:

$$N_P = \frac{L_P * I_P max}{\Delta B * A_e} = 840*1.3/0.28/52=75T$$

among them:

Np – – – – – – Primary side turns

L – – – – – – Primary side inductance value

Ip_max ––––––Maximum current of primary side

△B – – – – – – Alternating working magnetic density (mT), set to 0.28,

Ae – – – – – – Effective area of magnetic core (mm2), EF25 magnetic core is 52mm[2]

5. Calculate the number of turns Ns on the secondary side:

Ns – – – – Number of secondary side turns

Np – – – – Primary side turns

Vout – – – – Output voltage (including line voltage drop and rectifier voltage drop, 12V+0.7V=12.7V)

Vor – – – – Flyback voltage (set the voltage not higher than 120V to avoid damage to the chip due to overvoltage, this set

Set to 90V in the calculation)

Ns=(Vout*Np)/Vor=(12.7*75)/90 = 10 turns.

Design considerations

1. Power devices need to dissipate heat. The main heat of the chip comes from the power switch tube, the power switch tube and the OC lead The pins are connected, so when PCB wiring, the area of the copper foil external to the pin OC should be enlarged and tinned to increase the heat dissipation capacity.

2. The OC pin of the chip is the high-voltage part of the chip, and the highest voltage can reach more than 600V. Therefore, the circuit layout must ensure a safety distance of more than 1.5mm from the low-voltage part of the IC's FB, VCC, and GND to avoid circuit damage. Through discharge phenomenon.

3. The process of transformer

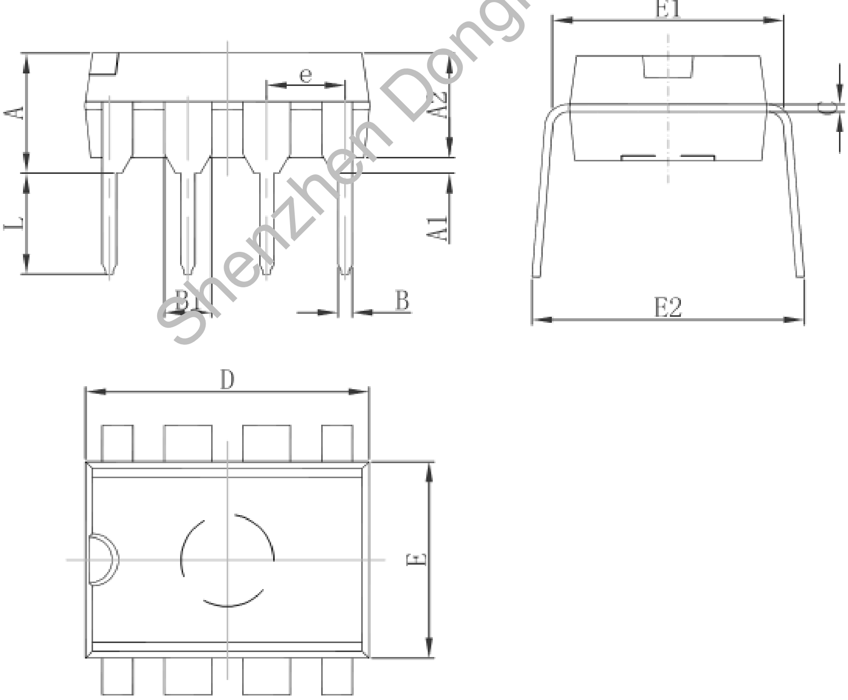
Since the transformer is not an ideal device, there must be leakage inductance during the manufacturing process, which will affect the stability of the product. It is stable and safe, so it should be reduced. The leakage induction is controlled within 5% of the inductance. The sandwich winding method can reduce the leakage. In addition, try to be as reasonable as possible when arranging the transformer, and arrange the inner winding layer as much as possible.

4. PCB Layout design:

The OC pin of the IC is working in high frequency AC state. During layout, keep the OC pin away from the AC input part as much as possible. At the same time, consider the thermal layout problem, try to keep it fixed with the heating elements such as transformer, diode, NTC, common mode induc Distance to avoid thermal effects.

Package size (DIP8)

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	9.200	0.331	0.354



Packaging Information

The chip is packaged in an anti-static tube.