# SPECIFICATION

## 1. DESCRIPTION

The DK112 is specially design for low power switch mode control, it is widely use in small household electrical appliances.

## 2. APPLICATIONS

·Battery charger                                     ·DVD/VCD power supply

·Power AC/DC adapters                       ·Air conditioner power supply

·STB power supply                               ·AC/DC LED driver applications

·Electromagnetic oven power supply      ·TV/Monitor power supply

## 3. MAIN FEATURES

· 85V—265V wide range AC power input.

· 65KHz Oscillation Frequency.

· Double chip design with Bipolar Junction Transistor (BJT) to save cost.

· Large scale MOS digital circuit design with E pole BJT driving, so that to enhance its High Voltage Resistance capability.

· Self-power supply design, no need for additional IC to supply the electricity.

· Internal integrated constant high voltage current driving circuit, no need for additional resistance.

· Over current, Over loading, Over temperature, Over voltage, Output short circuit and photo-coupler Failure Protection.

· Internal Ramp Compensation circuit to keep the stability of the circuit in low voltage and high power condition.

· Internal PMW oscillation circuit with Frequency jittering control to keep EMC characteristics.

· Internal Frequency Conversion. Frequency-down in low load condition, comply with the Europe Standard (stand power<0.3W), also reduce the output voltage ripple.

· Ramp current drive circuit included to reduce IC power loss and raise circuit efficiency.

· 4KV Anti-Static ESD test.

## 4. POWER RANGE

| Input Voltage | 85-264V AC | 85-145V AC | 180-264V AC |
|---|---|---|---|
| MAX. output power | 12W | 18W | 18W |

## 5. CONNECTION DIAGRAM
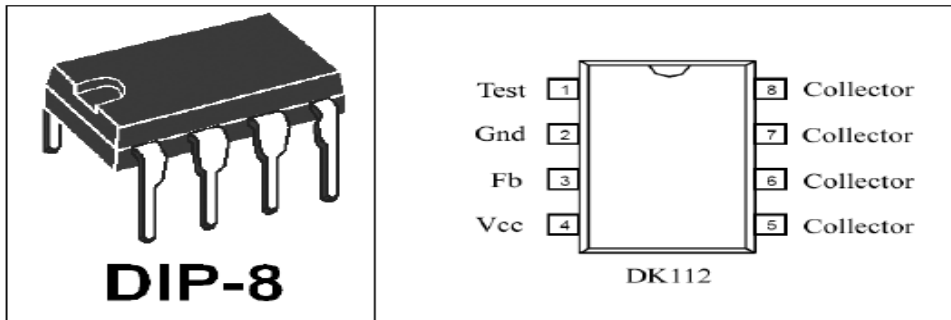


**PIN FUNCTION**

| Pin NO. | Pin Name | Function |
|---------|----------|----------|
| 1 | Test | Testing pin, suggested to be unloaded.(Prohibited to be connected to other circuits) |
| 2 | GND | Ground reference |
| 3 | Fb | Feedback control pin |
| 4 | Vcc | Power supply of the control circuits |
| 5,6,7,8 | Collector | Output pin. Connected with internal high voltage Collector point and switch mode transformer. |

## 6. BLOCK DIAGRAM
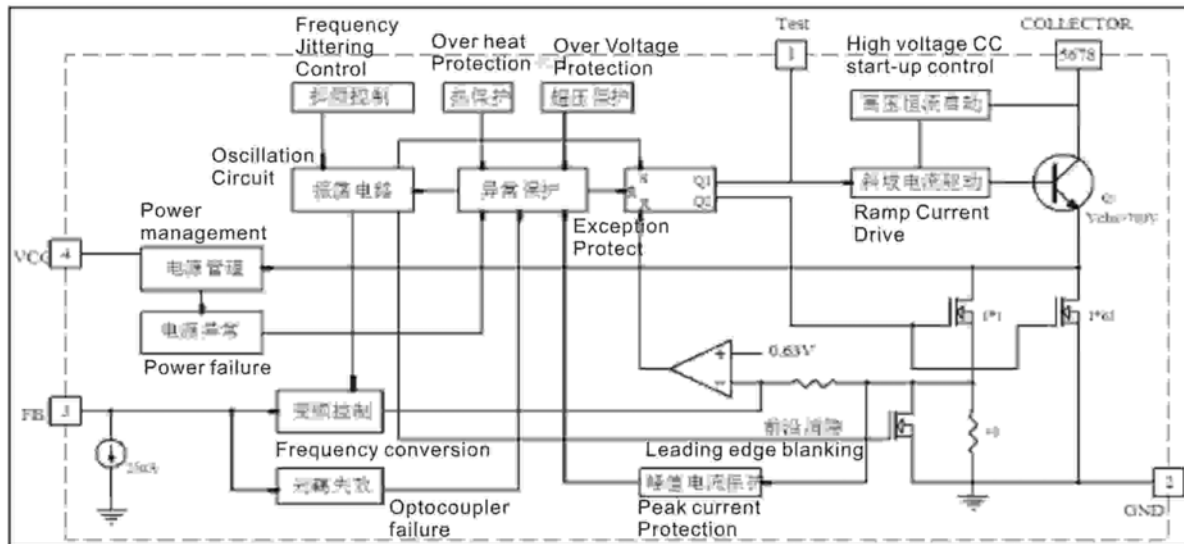


## 7. ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|--------|-----------|-------|------|
| Vcc | Supply voltage | -0.3V--9 | V |
| Ivcc | Current of supply voltage | 100 | mA |
| Vpin | Pin voltage | -0.3--Vcc+0.3 | V |

| Vcol | Collector to GND voltage | -0.3--780 | V |
|---|---|---|---|
| Ip | Peak current | 800 | mA |
| Pd | Dissipation power | 1000 | mW |
| Tc | Case operating temperature | 0--125 | ℃ |
| Tstg | Storage temperature | -55--150 | ℃ |
| Tsol | Soldering temperature | +280 | ℃/5S |

## 8. 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, Fb=2.2V | 20 | 30 | 40 | mA |
| Start time | AC input: 85V | -- | -- | 500 | mS |
| Collector Protection Voltage | L=1.2mH | 460 | 480 | 500 | V |
| BJT Breakdown voltage | Ioc=1mA | 700 | -- | -- | V |
| Switch tube Current | Vcc=5V, Fb=1.6V---3.6V | 600 | 650 | 700 | mA |
| Peak Current Protection | Vcc=5V, Fb=1.6V---3.6V | 650 | 720 | 800 | mA |
| Oscillation Frequency | Vcc=5V, Fb=1.6V---3.6V | 60 | 65 | 70 | KHz |
| Changing PWN switch Frequency | Vcc=4.6V, Fb=2.8V---3.6V | 0.5 | -- | 65 | KHz |
| Step of jittering frequency | Vcc=4.6V, Fb=1.6V---3.6V | 0.8 | 1 | 1.2 | KHz |
| Temperature protection | Vcc=4.6V, Fb=1.6V---3.6V | 120 | 125 | 130 | ℃ |
| Duty cycle of PWM | Vcc=4.6V, Fb=1.6V---3.6V | 5 | -- | 50 | % |
| Fb control voltage | AC input: 85V-265V | 1.6 | -- | 3.6 | V |

## 9. OPERATION PRINCIPLE

### 9.1 Start Up

When power on, high voltage AC current transferred to pin of COLLECTOR (pin 5,6,7,8) through switching transformer. Then it is transferred to transistor's (Q1 in Start up principle diagram) B pole via internal high voltage constant current driving circuit. The amplified current (about 20 times amplified by transistor Q1) enters power management circuit, charges the $V_{CC}$ external capacitor C1 via D1, and supply a spare voltage of 3.6V for Fb (Fb PIN to ground should be connected with a filter capacitor). When $V_{CC}$ voltage comes up to 5V, oscillator begins to work and controller offers a 25uA ground connecting power for Fb, the circuit enters into normal working mode.
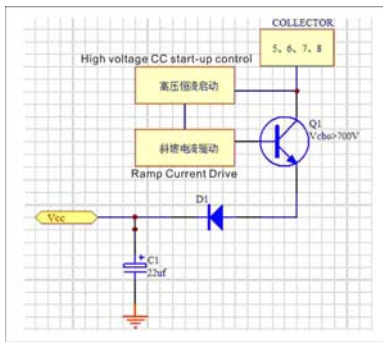
Start up principle diagram
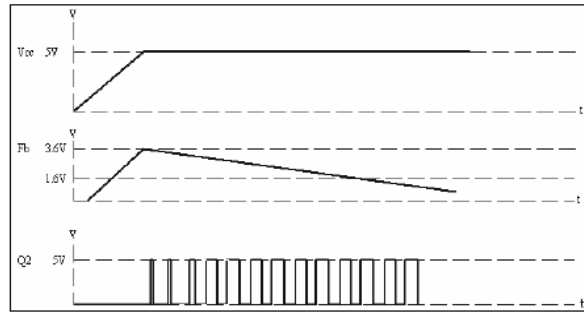


Start up sequence diagram

## 9.2 Normal Working

After circuit driving, oscillator begins to work, high level output comes out from Q1 and Q2, high voltage transistor and power MOS transistor are both connected, so that the switching current is transfer to the 40Ω current sampling resistor and creates a voltage accordingly. After Ramp Compensation, voltage of pin Fb added with voltage of the sampling resistor would be compared with basic voltage of 0.6V, if their total voltage is higher then the basic voltage, both comparator and trigger output low level current, both high voltage transistor and power MOS transistor cut off, pin COLLECTOR's voltage increase, circuits enters flyback mode. Only in the next oscillation cycle, the circuit will reset.

As to avoid its wrong action, leading edge blanking (LEB) circuit would be active and delete the peak current when the circuit is power on, time is 250mS.
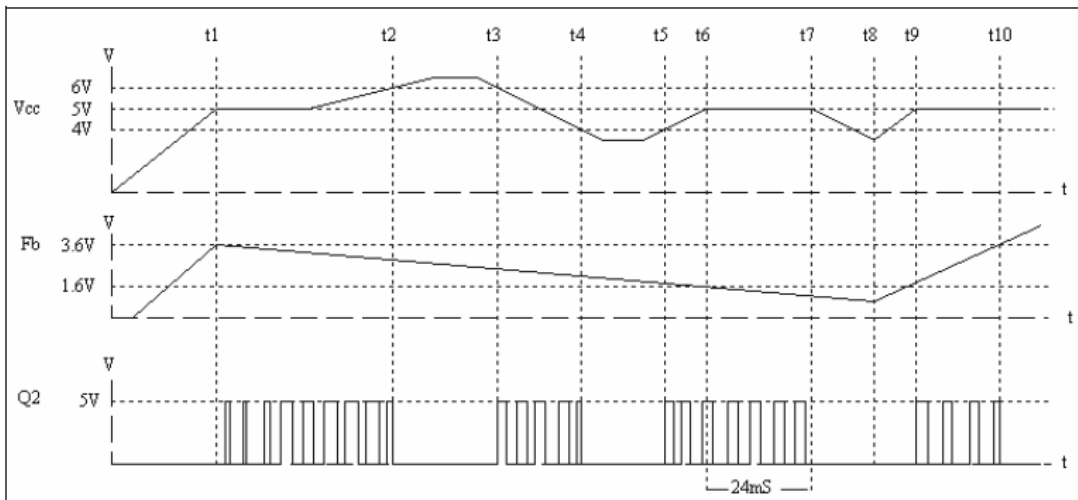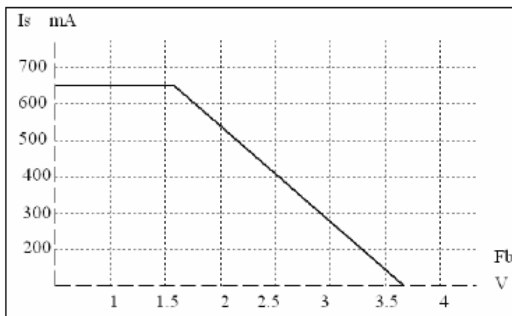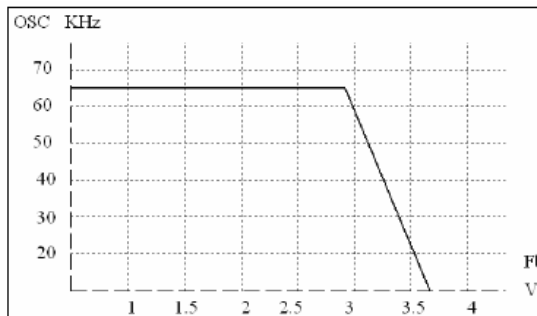


Normal Working Sequence Diagram

At t1, Vcc's voltage reaches 5V，the circuit starts working，Q2 outputs PWM signal. Between t2 and t3, Vcc's voltage is higher then 6V, the circuit stops outputting, Q2 outputs low level current. Between t3 and t4, Vcc's voltage comes back to normal, the circuit works normally. Between t4 and t5, Vcc's voltage is lower then 4V, the circuit stops outputting, Q2 outputs low level current. At t6, voltage of Fb is lower then 1.6V, open circuit activates a 24mS timer, PMW outputs at highest duty cycle. If until t7, the Fb's voltage is still lower then 1.5V, the circuit would restart, Vcc's voltage increases and reached 5V at t9 and work again. At t10, Fb's voltage is lower then 3.6V, the circuit stops outputting again.

### 9.3 Control Pin---Fb

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 10nF and 100nF. When voltage of Fb is higher then 1.5V and below 2.8V, the circuit would be work under 65KHz frequency. When voltage of Fb is higher then 2.8V and below 3.6V, the circuit's working frequency would decrease accordingly. When voltage of Fb is higher then 3.6V, the circuit stops oscillation. When voltage of Fb is lower then 1.5V, time-delay circuit would be activated, and the circuit would resume working if voltage of Fb comes up to 1.5V during this time, otherwise the IC will restart, optocoupler failure protection completes.



Is & Fb sequence diagram      Fb & working frequency (PWM) sequence diagram

### 9.4 Self-Power Supply Circuit (National patent owned)

There is self-power supply circuit inside the IC, which can control the power voltage about 5V for the electricity consumption of the IC itself. It can only afford the electricity consumption of itself only but can not afford for the external circuit.

### 9.5 Leading Edge Blanking (LEB)

As to reduce IC power loss and raise circuit efficiency, Ramp current drive technology is use in the B pole of high voltage transistor for current supply. When switching current Is is 0, B pole current is about 20mA, and its value increases accordingly to the increasing of switching current. When switching current Is reaches 300mA, B pole current is 50mA.
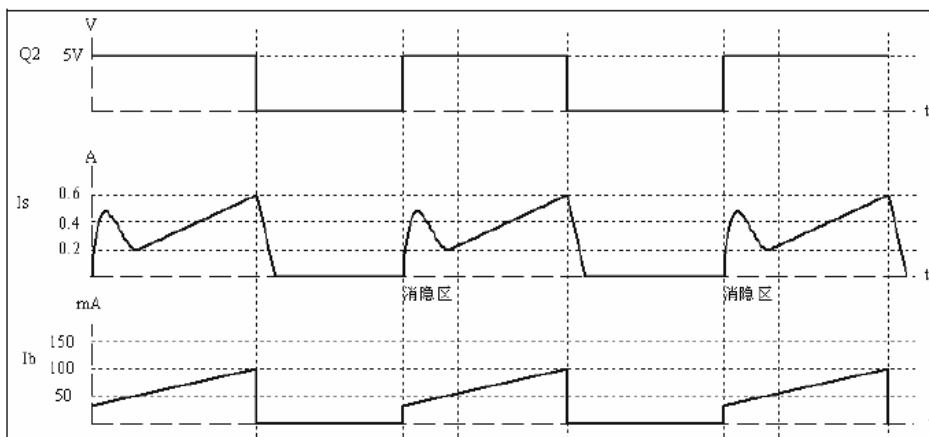


Ib & Is sequence diagram

### 9.6 Frequency Jittering Circuit

By sweeping the switching frequency around its nominal value 65KHz, it spreads the energy content

on adjacent frequencies rather then keeping it centered in one single ray. This offers the benefit to artificially reduce the measurement noise on a standard EMI/EMC receiver and pass the tests more easily.

### 9.7 Over Temperature Protection (OTP)

When the controller detects the device temperature exceeds 125℃, 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 to 120℃.

### 9.8 Over Current Protection (OCP)

Whenever the collector current (Ip) abnormally exceeds the maximum current limit of 720mA, the controller would stop operation and enters into stop status.

### 9.9 Abnormal Voltage Protection

Whenever the power voltage (Vcc) abnormally exceeds 6V and drops under 4V, the controller would stop operation and enters into stop status.
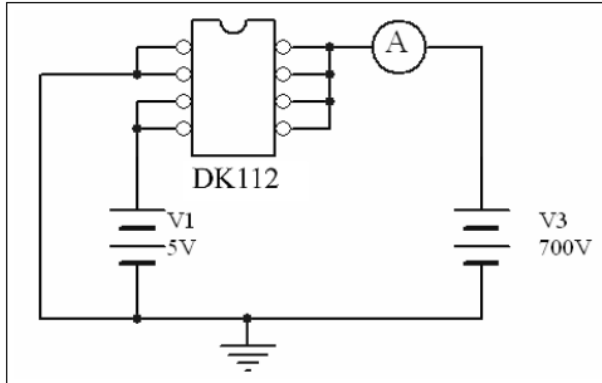
### 9.10 Over Collector Voltage Protection

Whenever the voltage of the collector pin exceeds the limit, the controller will decrease the power output to make sure the collector pin coming back to normal. It could reduce the stress of the power transistor and the protect power transistor from avalanche damage.
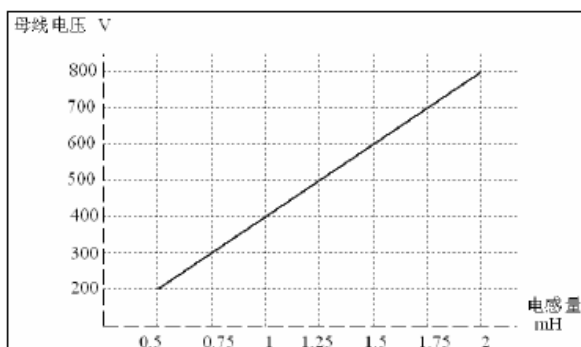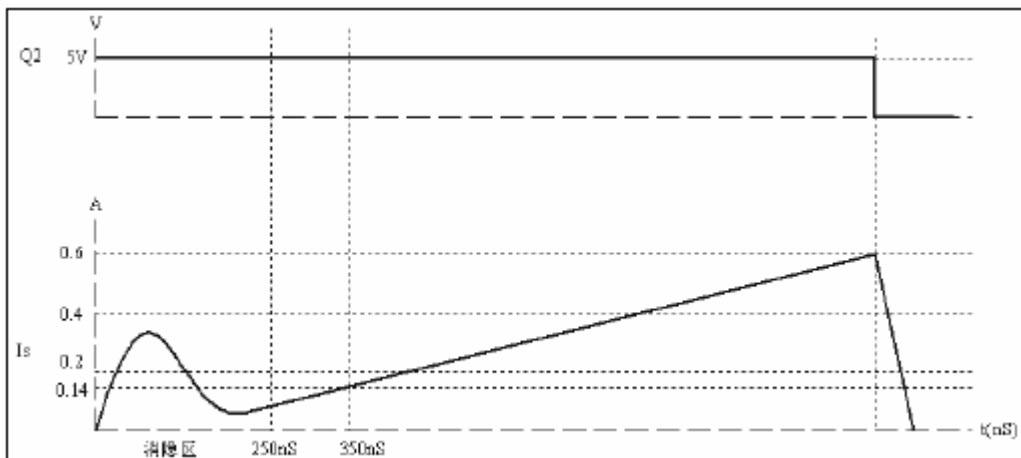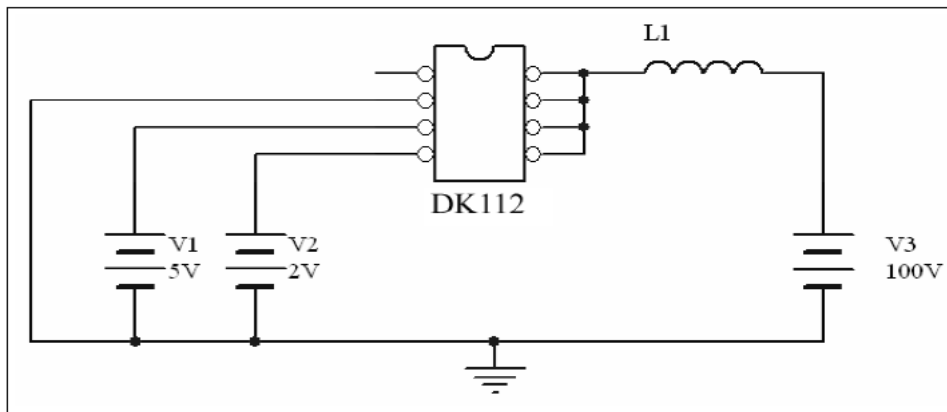
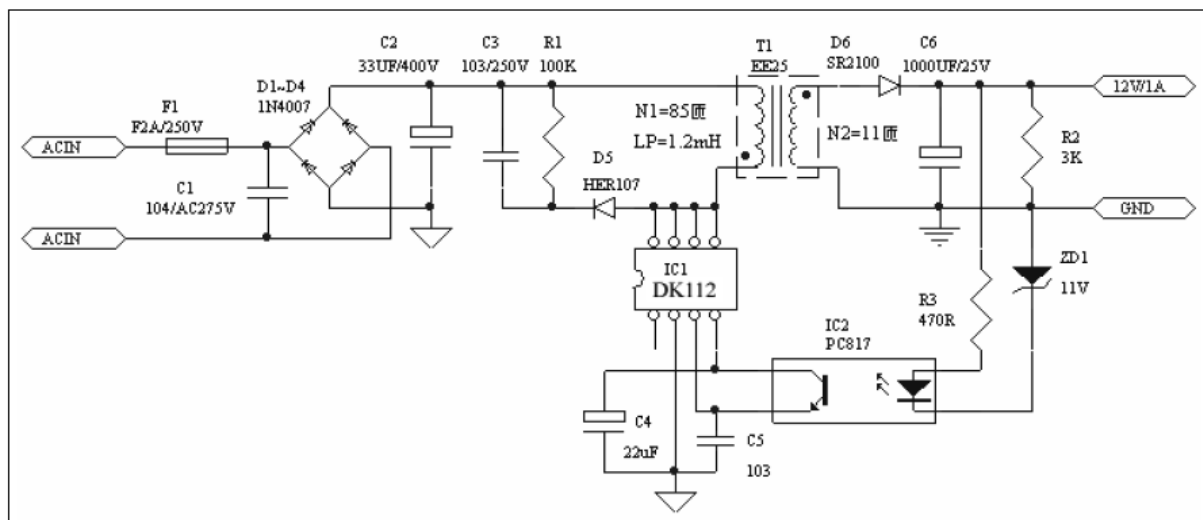## 10. IC TESTIING

### 10.1 High Voltage Resistance Test



### 10.2 Electrical Test



## 11. TYPICAL APPLICATION SAMPLE I

**(12V1A OUTPUT OFF-LINE FLYBACK TYPE SWITCHING POWER SUPPLY)**



### 11.1 Components list

| NO. | NAME | SPEC. / MODEL NO. | POSITION | USED QTY | REMARK |
|-----|------|-------------------|----------|----------|--------|
| 1 | Fuse | F2A/AC250V | F1 | 1 | |
| 2 | X capacitor | 104/AC275V | C1 | 1 | |
| 3 | Diode | IN4007 | D1~D4 | 4 | |
| 4 | Diode | HER107 | D5 | 1 | |
| 5 | Diode | SR2100 | D6 | 1 | |
| 6 | Zener Diode | 11V/0.5W | ZD1 | 1 | |
| 7 | Electrolytic capacitor | 33UF/400V | C2 | 1 | |
| 8 | Electrolytic capacitor | 22UF/16V | C4 | 1 | |
| 9 | Electrolytic capacitor | 1000UF/25V | C6 | 1 | |
| 10 | Ceramic capacitor | 103/250V | C3 | 1 | |
| 11 | Ceramic capacitor | 103/25V | C5 | 1 | |
| 12 | IC | DK112 | IC1 | 1 | |
| 13 | IC | PC817 | IC2 | 1 | |
| 14 | Resistance | 100K/0.25W | R1 | 1 | |
| 15 | Resistance | 3K/0.25W | R2 | 1 | |
| 16 | Resistance | 470R/0.25W | R3 | 1 | |
| 17 | Transformer | EE25 | T1 | 1 | |

## 11.2 TRANSFORMER DESIGN (For reference only)

### 11.2.1 Parameter confirmation: confirm the below parameter before transformer design

(1) Input voltage range    (for example :AC85V-265V)

(2) Output Voltage and current    (for example DC12V 1A)

(3) Switching frequency    (for example F=65KHz)

(4) MAX. duty cycle    (for example D=0.5)

### 11.2.2  Core selecting

(1) Input power calculation

P=Pout/η (η is the efficiency of the power supply, take it 0.8 for example), Pout=Vout*Iout=12V*1A=12W, P=12/0.8=15W.

(2) Choose the core:

Checking via supplier or the correlative chart can know that EE20 or EE25 core is suitable for 15W power supply. Now we choose EE25 for below calculation.

### 11.2.3  Input voltage setting

Input voltage is AC85V-265V, as to get the MAX. power value according to the lowest voltage and take the voltage loss(from wires and rectification) into consideration,    Vs=85*1.3=110V.

### 11.2.4  Conduction time     Ton=1/F*D=1/65*0.5=7.7μS

### 11.2.5  Number of the original(input) turns (Np)

$$Np = \frac{Vs * Ton}{\Delta Bac * Ae} = \frac{110 * 7.7}{0.2 * 50} = 84.7 \approx 85$$

PS: △Bac---Alternating working magnetic flux density (mT), set to be 0.2

Ae--------Core effective area (m m²), EE25's Ae is 50 m m²

### 11.2.6  Number of the output turns (Ns)

$$Ns = \frac{Vout * Np}{Vor} = \frac{13 * 85}{100} = 11$$

PS: Vout----Output voltage=12V+1V=13V, take the voltage loss (from wires and rectification) into consideration.

Vor-----Flyback voltage=100V, set it lower then 150W for the safety of IC.

### 11.2.7  Input inductance value (Lp)

$$Lp = \frac{Vs * Ton}{Ip} = \frac{110 * 7.7}{720} = 1.18 \approx 1.2 \ (\ mH\ )$$

PS: Ip----Input peak current (it is set to be 720mA in the IC)

### 11.2.8  Verification of the design

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. However, Single-ended Flyback circuits works in the first quadrant of B-H, and residual magnetism of the core is about 0.1T, so the maximum working magnetic flux density should be 0.4-0.1=0.3T.

$$Bmax = \frac{Lp * Ip}{Np * Ae} = \frac{1.2 * 720}{85 * 50} = 0.203$$
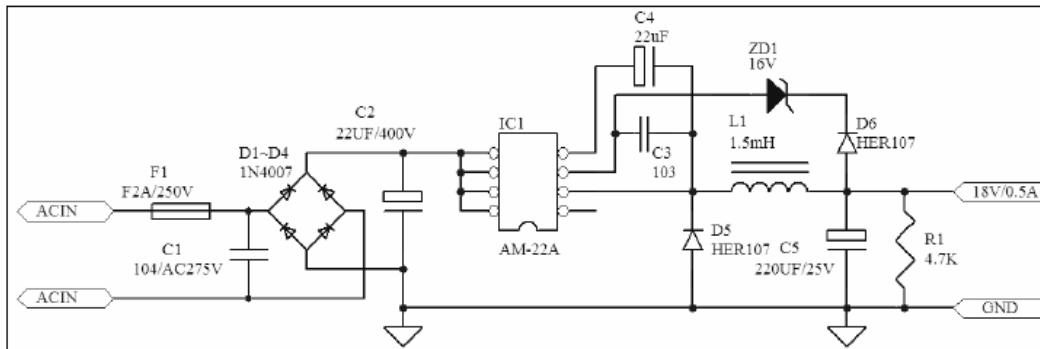
Bmax＜0.3, so the design is workable.

### 11.2.9  Leakage inductance of a transformer

It is suggested to use P/S/P way to wind the transformer so that to reduce the leakage inductance.

## 12. TYPICAL APPLICATION SAMPLE II

### (NON OFF-LINE SWITCHING POWER SUPPLY)



**Components list**

| NO. | NAME | SPEC. / MODEL NO. | POSITION | USED QTY | REMARK |
|-----|------|-------------------|----------|----------|--------|
| 1 | Fuse | F2A/AC250V | F1 | 1 | |
| 2 | X capacitor | 104/AC275V | C1 | 1 | |
| 3 | Diode | IN4007 | D1~D4 | 4 | |
| 4 | Diode | HER107 | D5,D6 | 2 | |
| 5 | Zener Diode | 16V/0.5W | ZD1 | 1 | |
| 6 | Electrolytic capacitor | 22UF/400V | C2 | 1 | |
| 7 | Electrolytic capacitor | 22UF/16V | C4 | 1 | |
| 8 | Electrolytic capacitor | 220UF/25V | C5 | 1 | |
| 9 | Ceramic capacitor | 103/25V | C3 | 1 | |
| 10 | IC | AM-22A | IC1 | 1 | |

| 11 | Resistance | 4.7K/0.25W | R1 | 1 | |
| 12 | Inductor | 1.5mH | L1 | 1 | |

## 13. SPECIAL NOTICE FOR PBC LAYOUT DESIGN

**13.1** Heat dissipation: A good estimate is that the controller will dissipate the output power. So enough cooper area connected to the 5, 6, 7, 8 COLLECTED pins and tin-plating are necessary to provide the controller heat sink.

**13.2** The 5, 6, 7, 8 COLLECTED pins 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.

**13.3** Pin No.1 is for testing only. It is prohibited to be connected with other circuits when in use.

## 14. MECHANICAL AND PACKING INFORMATION

| 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 |
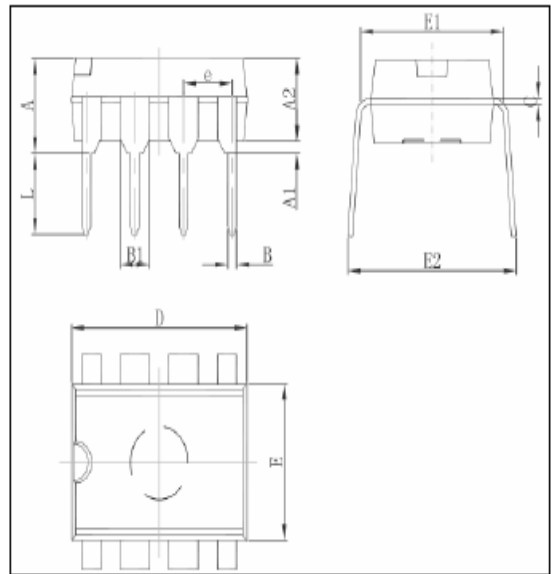
· **Anti-static tube packing**
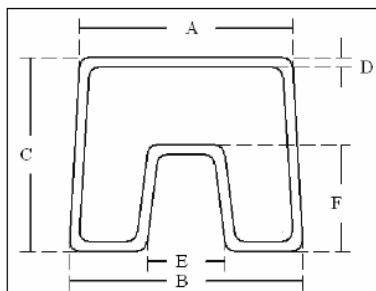
| CODE | Min.(mm) | Typ.(mm) | Max.(mm) |
|---|---|---|---|
| A | 11 | 11.5 | 12 |
| B | 11.5 | 12 | 12.5 |
| C | 10 | 10.5 | 11 |
| D | 0.4 | 0.5 | 0.6 |
| E | 3.5 | 4 | 4.5 |
| F | 5 | 5.5 | 6 |

· **Packing quantity**

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