南京拓品微电子有限公司

NanJing Top Power ASIC Corp.

DATASHEET

Accurate CV/CC Primary Side Converters - TP1000

Rev1.2

Accurate CV/CC Primary Side Converters

GENERAL DESCRIPTION

TP1000 is a high performance AC/DC power converters ,using frequency (PFM) mode,flyback circuit operates under discontinuous current mode (DCM) .TP1000 built all kinds of fault protection circuit, so it has high reliability.

TP1000 provide accurate constant voltage/constant current (CV/CC) controller ,regulation without requiring the opto-coupler and the secondary control circuitry. It also eliminates the need of loop compensation circuitry while maintaining stability.

The TP1000 achieves excellent regulation and high power efficiency, the no-load power consumption is less than 120mW@220V.

FEATURES

- Primary side control for rectangular constant current and constant voltage output
- Eliminates opto-coupler and secondary CV/CC control circuitry
- No external compensation components required
- Built-in cable resistance compensation（0、+3%、+6%）
- Low start-up current (8uA)
- Direct drive of low-cost BJT switch
- Flyback topology in DCM operation
- Built in the port fault protection
- Over Voltage Protection
- Short Circuit Protection

APPLICATIONS

Chargers for cell/cordless phones, PDAs, MP3/portable audio devices, adapters, LED drivers, etc.

TYPICAL APPLICATION

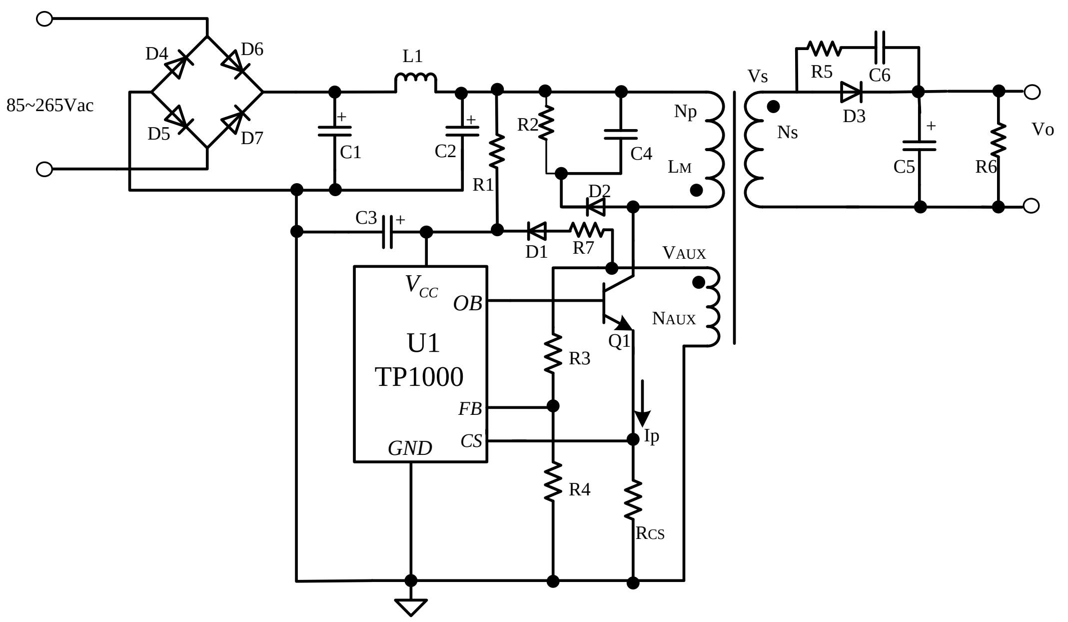
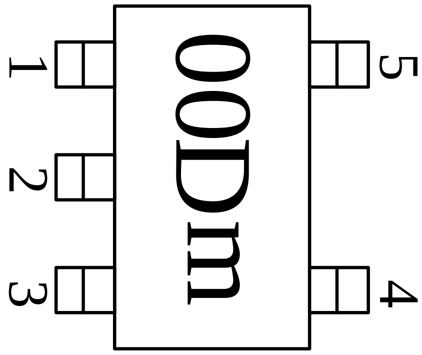


Figure1 Typical Application Circuit

PIN CONFIGURATION & PIN DESCRIPTION

Top View



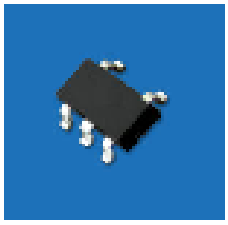
SOT23-5L-Package

Order Part Number

TP1000D-SOT23-5L-R

Part Marking

00Dm



Pin Number	Name	Function
1	V_{CC}	Power supply for control logic
2	GND	Ground
3	FB	The voltage feedback from the auxiliary winding
4	CS	The primary current sense
5	OB	Base drive for BJT

ORDER DESCRIPTION

Part Marking	Part Number	Cable compensation(Vout=5V)		Package	Description
00Am	TP1000A	0%	0mV	SOT23-5L	REEL
00Dm	TP1000D	3%	150mV	SOT23-5L	REEL
00Gm	TP1000G	6%	300mV	SOT23-5L	REEL

FUNCTIONAL BLOCK DIAGRAM

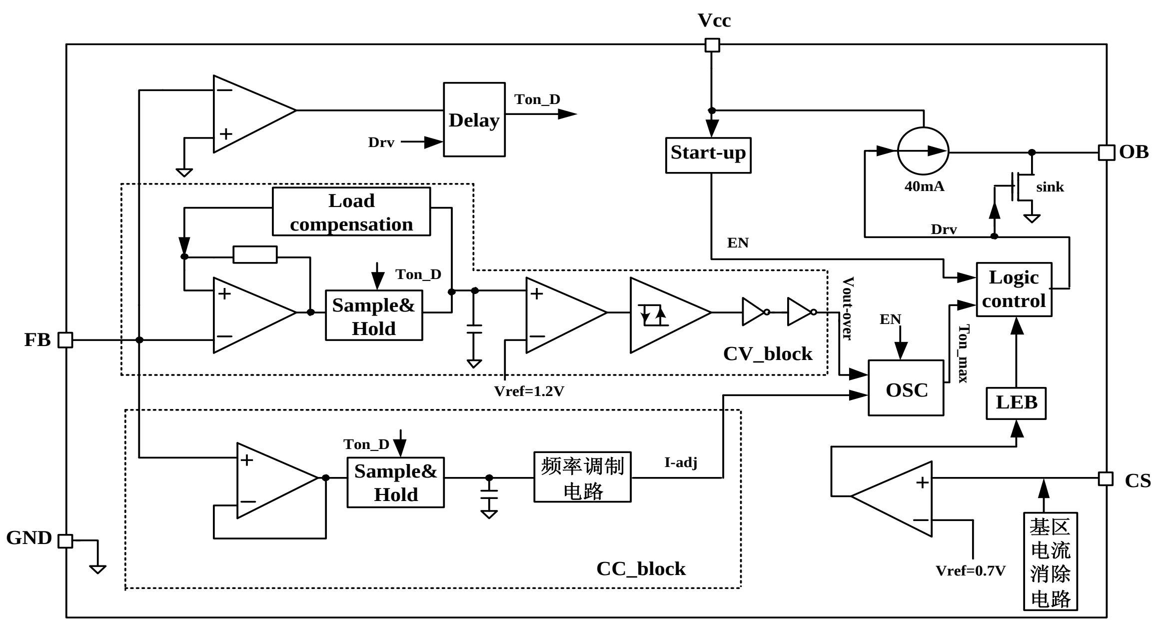


Figure2 Functional Block Diagram

ABSOLUTE MAXIMUM RATING

Parameter	Value	Unit
Supply Voltage V_{CC}	-0.3 to 30	V
Voltage at FB, BD, IS	-0.3 to 7	V
Thermal Resistance Junction-to-Ambient	190	℃/W
Operating Junction Temperature	150	℃
Storage Junction Temperature	-55 to 150	℃
Lead Temperature (Soldering, 10 sec)	300	℃

ELECTRICAL CHARACTERISTICS

(V_{CC}=15V, T_A=25℃,Vout=5V, TP1000D , unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
V_{CC} Section						
Start-up Threshold	$V_{CC(ST)}$	V_{CC} rising from 0	13.5	14.5	16	V
Minimal Operating Voltage	$V_{CC(MIN)}$	V_{CC} falling after turn on	3.5	4.5	5.5	V
Maximum Operating Voltage	$V_{CC(MAX)}$		17.5	18.3	22	V
Supply Current	$I_{CC(OPR)}$	V_{CC} =15V， after turn off		350	500	uA
Start-up Supply Current	I_{ST}	V_{CC} =10V， before turn off		8	20	uA
Feedback Section						
Feedback Threshold Voltage	V_{FB}		1.188	1.2	1.212	V
Feedback Pin Input Leakage Current	I_{FB}	V_{FB}=4V			0.5	uA
Current Sense Section						
Current Sense Threshold	V_{IS}	Rcs=1.5Ω		700		mV
Current Sense Pin Input Leakage Current	I_{IS}	V_{IS}=4V			0.5	uA
Base Drive Section						
OB Drive Current		I		40		mA
OB low level ON-resistance	R_{ON}	I_{SINK}=0.48A		0.83	1.5	Ω
Switching Frequency	f_{SW}	Output load		68		KHz
Cable Compensation Voltage	$f_{SW} = 68kHz$			0.15		V

TYPICAL PERFORMANCE CHARACTERISTICS

（T_A=25℃，Vout=5V，TP1000D unless otherwise specified.）

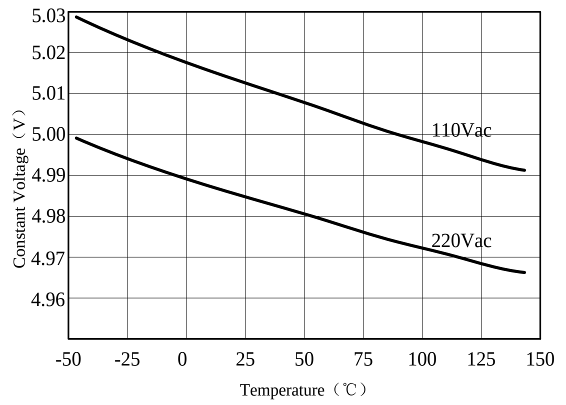


Figure 3.1 Constant Voltage Output VS Temperature

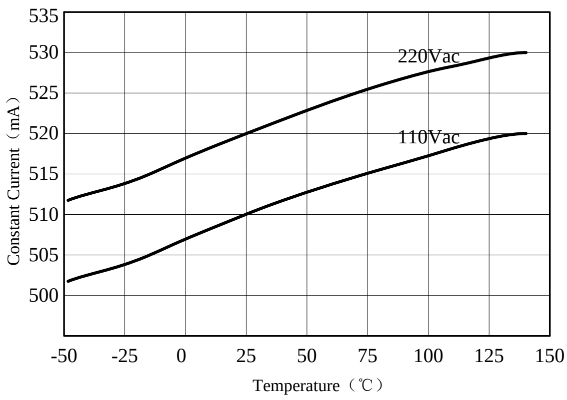


Figure 3.2 Constant Current Output VS Temperature

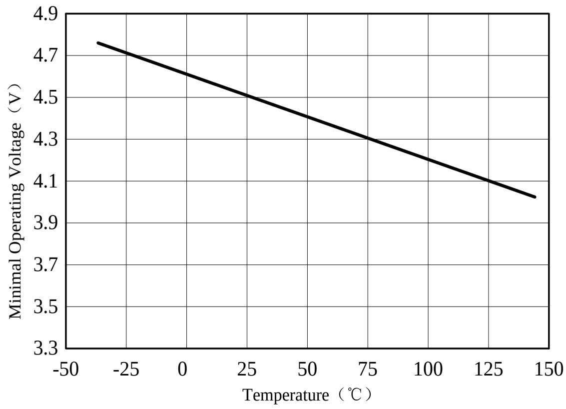


Figure 3.3 Minimal Operating Voltage VS Temperature

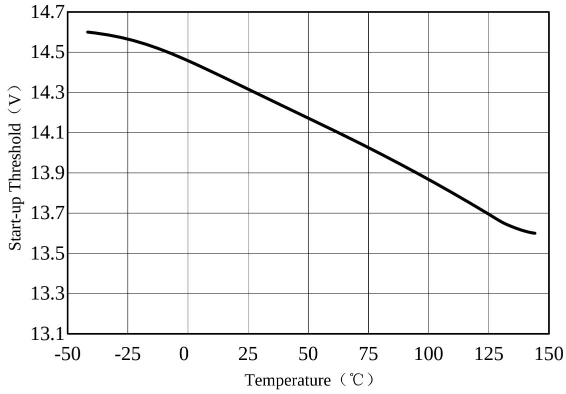


Figure 3.4 Start-up Threshold VS Temperature

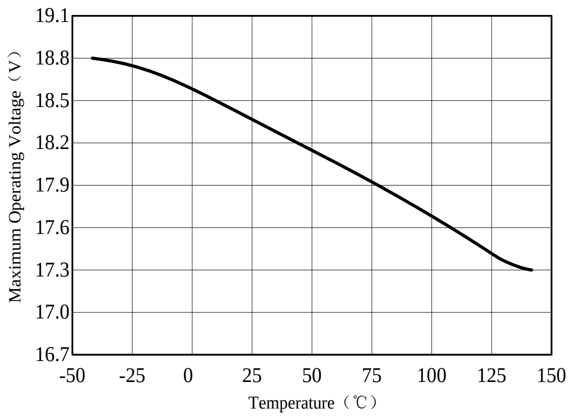


Figure 3.5 Maximum Operating Voltage VS Temperature

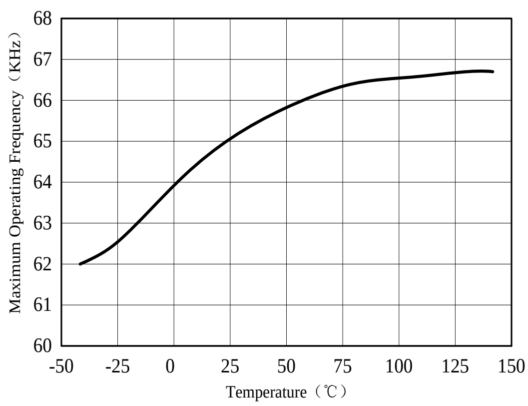


Figure 3.6 Maximum Operating Frequency VS Temperature

START-UP

Prior to start-up, the V_{CC} pin is charged typically through start-up resistors. When V_{CC} bypass capacitor is fully charged to a voltage higher than the start-up threshold $V_{CC(ST)}$, the ENABLE signal becomes active to enable the control logic.

If at any time the V_{CC} voltage drops below $V_{CC(MIN)}$ threshold then all the digital logic is reset. At this time ENABLE signal become low and the V_{CC} capacitor is charged up again towards the start-up threshold.

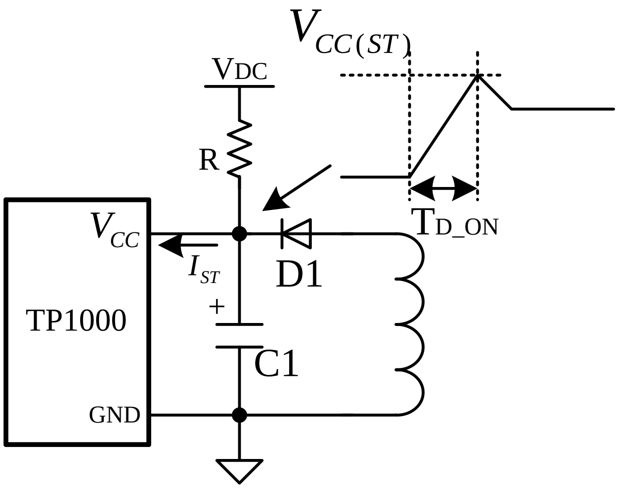


Figure 4 Start-up circuit

In the process, as illustrated in figure 4,the maximum starting time delay can be calculated by the equation follow：

$$T_{D\_ON} = -R \times C_1 \times \ln\left(1 - \frac{V_{CC(ST)}}{V_{DC} - I_{ST} \times R}\right) \quad (1)$$

CONSTANT PRIMARY PEAK CURRENT

The primary current is sensed by a current sense resistor Rcs as shown in Figure 5

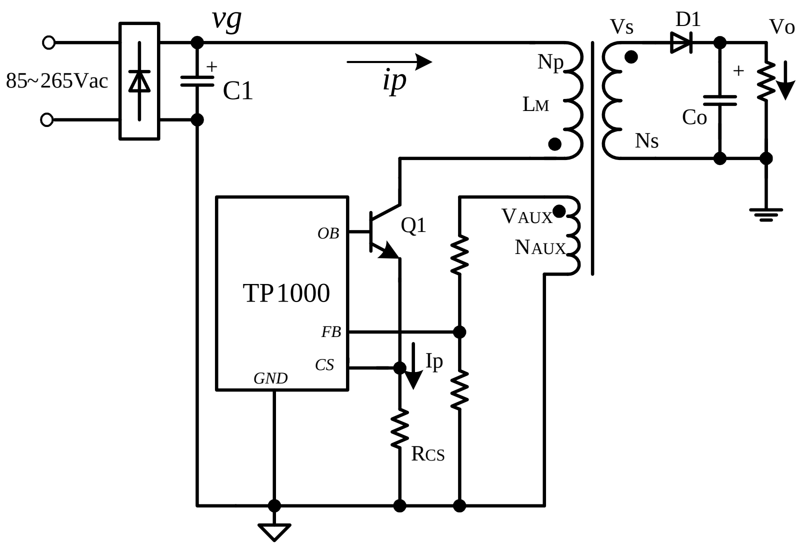


Figure 5 The Principle Of Operation

The current rises up linearly at a rate of:

$$\frac{dip(t)}{dt} = \frac{vg(t)}{L_M} \qquad (2)$$

when the current ip(t) rises up to Ipk, the switch Q1 turns off. The constant peak current is given by:

$$Ipk = \frac{V_{CS}}{R_{CS}} \qquad (3)$$

The energy stored in the magnetizing inductance L_M each cycle if therefore:

$$Eg = \frac{1}{2} \times L_M \times Ipk^2 \qquad (4)$$

So the power transferring from the input to the output is given by:

$$P = \frac{1}{2} \times L_M \times Ipk^2 \times f_{SW} \qquad (5)$$

where f_{SW} is the switching frequency. When the peak current Ipk is constant, the output power depends on the switching frequency f_{SW}.

CONSTANT VOLTAGE OPERATION

The TP1000 captures the auxiliary winding feedback voltage at FB pin and operates in constant voltage (CV) mode to regulate the output voltage. Assuming the secondary winding is master, the auxiliary winding is slave during the D1 on-time.

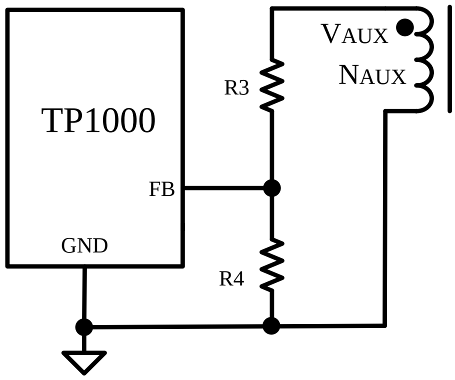


Figure 6 Constant Voltage Sampling Circuit

The auxiliary voltage is given by:

$$V_{AUX} = \frac{N_{AUX}}{N_S} \times (V_O + Vd) \quad (6)$$

Where Vd is the diode forward drop voltage.

So
$$V_{FB} = V_{AUX} \times \frac{R4}{R3+R4} = \frac{N_{AUX}}{N_S} \times (V_O + Vd) \times \frac{R4}{R3+R4} \quad (7)$$

$$V_O = V_{FB} \times \frac{N_S}{N_{AUX}} \times \frac{R3+R4}{R4} - Vd \quad (8)$$

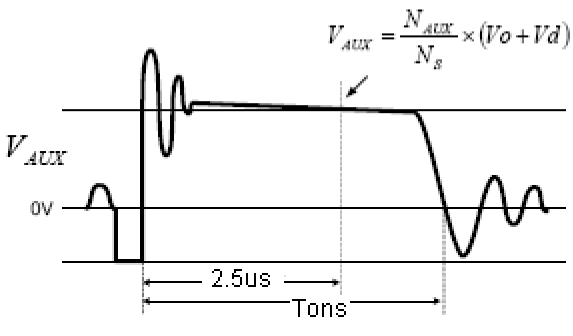


Figure 7 Auxiliary Voltage Waveform

The output voltage is different from the secondary voltage in a diode forward drop voltage that depends on the current. If the secondary voltage is always detected at a fixed secondary current, the difference between the output voltage and the secondary voltage will be a fixed Vd. The voltage detection point is at two-thirds of the D1 on-time. The CV loop control function of TP1000 then generates a D1 off-time to regulate the output voltage.

CONSTANT CURRENT OPERATION

During this mode of operation the TP1000 will regulate the output current at a constant level regardless of the output voltage ,while avoiding continuous conduction mode.

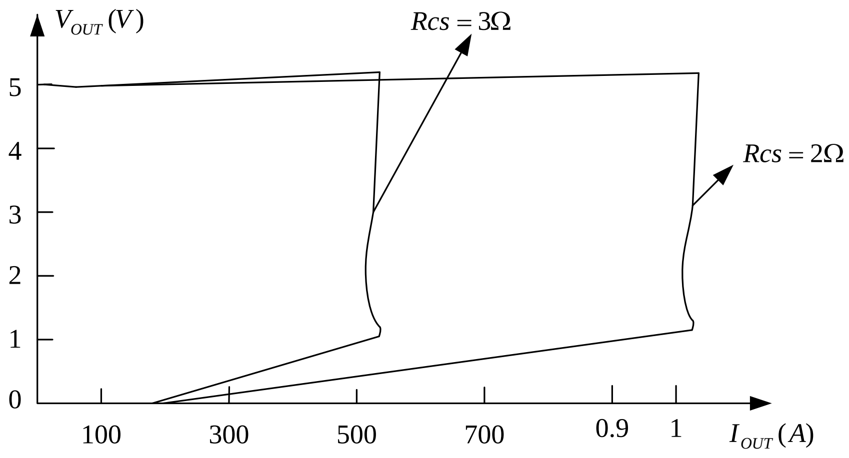


Figure 8 The Output Power Can Be Regulated Through Rcs

LEADING EDGE BLANKING

When the power switch is turned on, a turn-on spike will occur on the sense-resistor. To avoid false-termination of the switching pulse, a 430ns leading edge blanking is built in. During this blanking period, the current sense comparator is disabled and the gate driver can not be switched off.

5V/520mA LED DRIVER SOLUTION USING TP1000

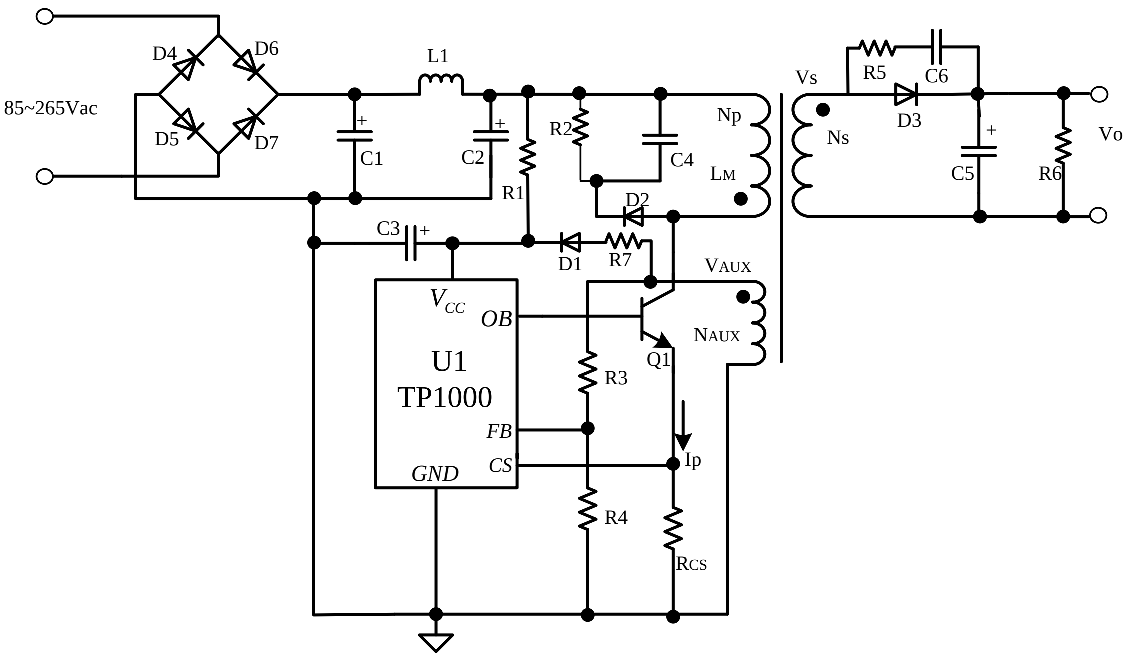
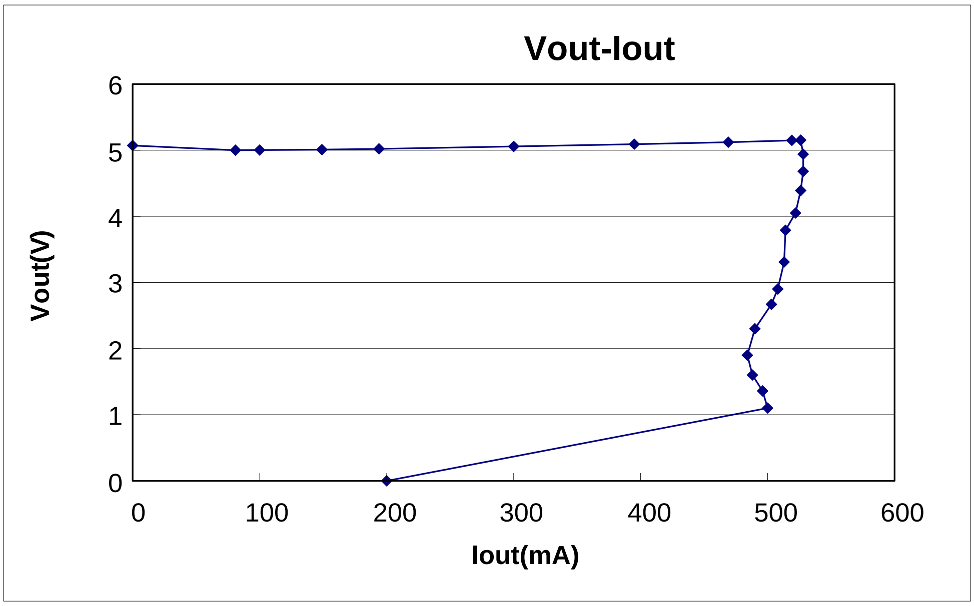


Figure 9 Schematic Of 5V/520mA Led Driver Demo Board

Components list：

NAME	DESCRIPTION	NAME	DESCRIPTION
D1	Diode,Fast,FR107,1A/1000V	C1，C2	E-Cap,4.7uF/400V
D2	Diode,Fast,FR107,1A/1000V	C3	E-Cap,4.7uF/25V
D3	Diode,Schottky,SR160,1A/60V	C4	Capacitor,Ceramic,1nF/1KV
D4-D7	Diode, Rectifier,1N4007	C5	E-Cap,470uF/16V,Low ESR
R1	Resistor,2M,1/4W,±5%	C6	Capacitor,Ceramic,222pF/100V
R2	Resistor,270K,1/2W,±5%	L1	Inductor, Color Ring,1.0mH
R3	Resistor,20K,1/4W,±1%	U1	IC,TP1000
R4	Resistor,2K,1/4W,±1%	Q1	NPN,13003,TO-92
R5	Resistor,47R,1/4W,±5%	T	Transformer EE16, L_M=2.0mH Np:Ns:N_{AUX}=125T:13T:30T
R6	Resistor,1.5K,1/4W,±5%		
R7	Resistor,30R,1/4W,±5%		
Rcs	Resistor,3R,1/2W,±1%		

LOAD CHARACTERISTIC CURVE:

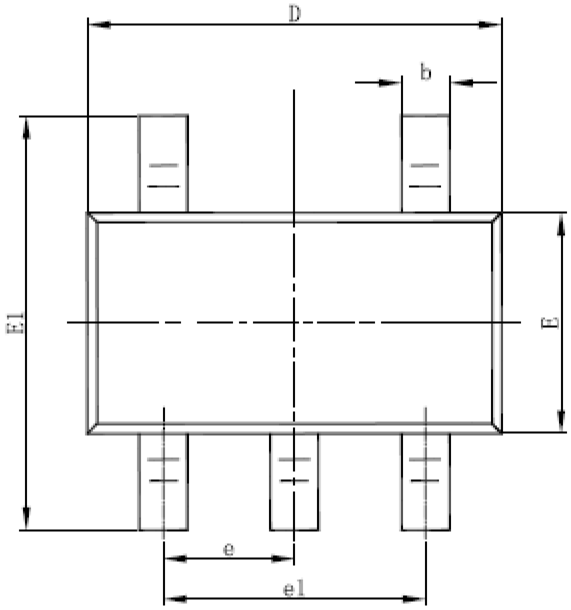


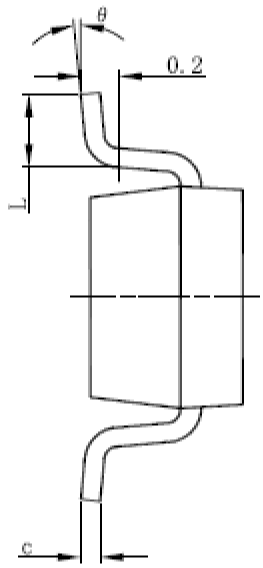
Test Summary:

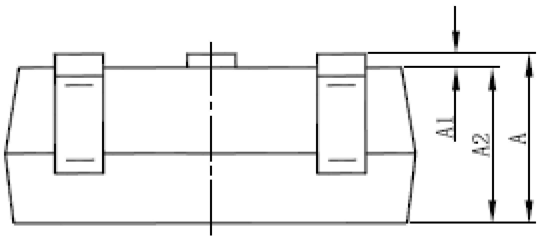
Parameter	Min	Typical	Max	Unit
Input Voltage	85		265	Vac
The No-load Power Consumption			0.15	W
Output Voltage		5.06		V
Output Ripple			0.15	V
Average Efficiency 25%，50%，75% and full load	66			%

PACKAGE DESCRIPTION

SOT23-5L







Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Version History

Date	Version Shows	Version
2013.5.13	Fixed current sampling voltage value	Rev1.2