APPLICATION NOTE

Title	**5W Charger with 100mW Standby Power Using PT2203**
Applications	**Cell Phone Charger**
Specification	**AC Input Range: 90-264Vac** **DC Output: 5V/1A (CV & CC)**
Model No.	**PT2203_EPS_01**
Doc. No.	**PT2203_AN01**
Revision	**0.2**

FEATURES

- CC and CV Control Without Secondary Feedback(No Opto-coupler needed)
- Meet “100mW” No-Load Standby Power Consumption Requirement
- Meet EPA2.0 for Average Efficiency with lots of margin
- Output short circuit and open-loop protection
- Fully Compliance to EN55015 and CISPR-22 Class B EMI

Table of Contents

1 INTRODUCTION

This application notes describes an isolated, primary-side constant voltage/constant current (CV/CC) Charger designed with 5V constant voltage and 1A constant current from an input voltage range from 90 VAC to 264 VAC based on PT2203.

This application notes contains the Adapter specification, schematic, PCB layout, bill of materials, magnetic components spec and test data. Please refer to datasheet for the details of PT2203

2 SPECIFICATION

DESCRIPTION	CONDITION	MIN	TYP	MAX	UNITS
INPUT CHARATERISTIC					
Input Voltage Range		90	115/ 230	264	VAC
Rated Voltage Range		100	115/ 230	240	VAC
Input Current	Vin=90V~264Vac			0.1	A
Frequency		47	50/60	63	Hz
Standby Power	Vin=230Vac			100	mW
Average Efficiency	Vin=110/230Vac, 25%, 50%, 75%, 100% full load	70			%
OUTPUT CHARATERISTIC					
Rated Output Voltage	CV Operation Mode	4.75	5	5.25	V
Vout Range at CC	CC Operation Mode	2.5		5	V
CC Range	CC Operation Mode	0.9	1	1.1	A
Turn-on Delay Time	Vin=100V/240Vac, Full load			2	S
Hold up Time	Vin=100V/240Vac, Full load	8			mS
PROTECTION					
Short Circuit Protection	Vin=100V/240Vac	Auto Recovery			
Open loop Protection	Vin=100V/240Vac	Auto Recovery			
Over Temperature Protection	Vin=100V/240Vac, Full load	Auto Recovery			
ENVIRONMENTAL					
EMI	Vin=110V/220Vac, Full load	Meets CISPR22B / EN55022B			

3 DEMO BOARD PHOTO

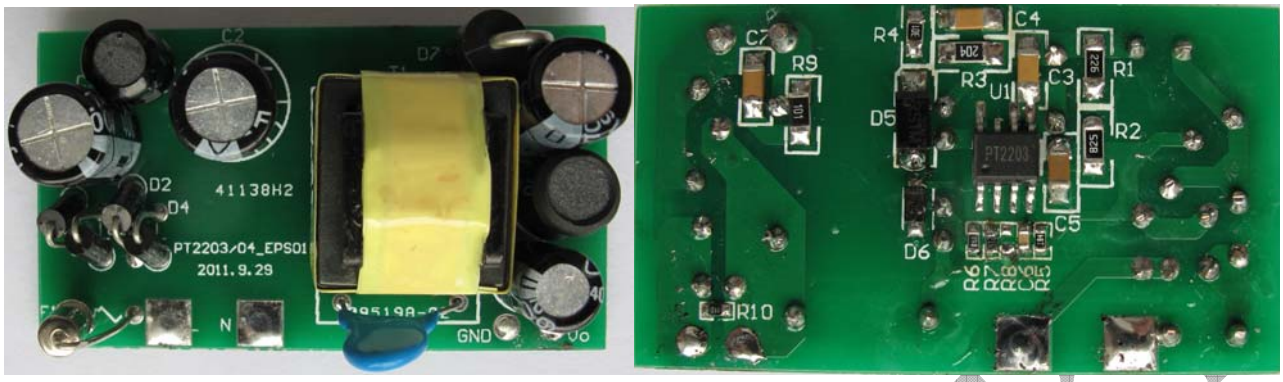


FIGURE 1 TOP AND BOTTOM VIEW

4 SCHEMATIC

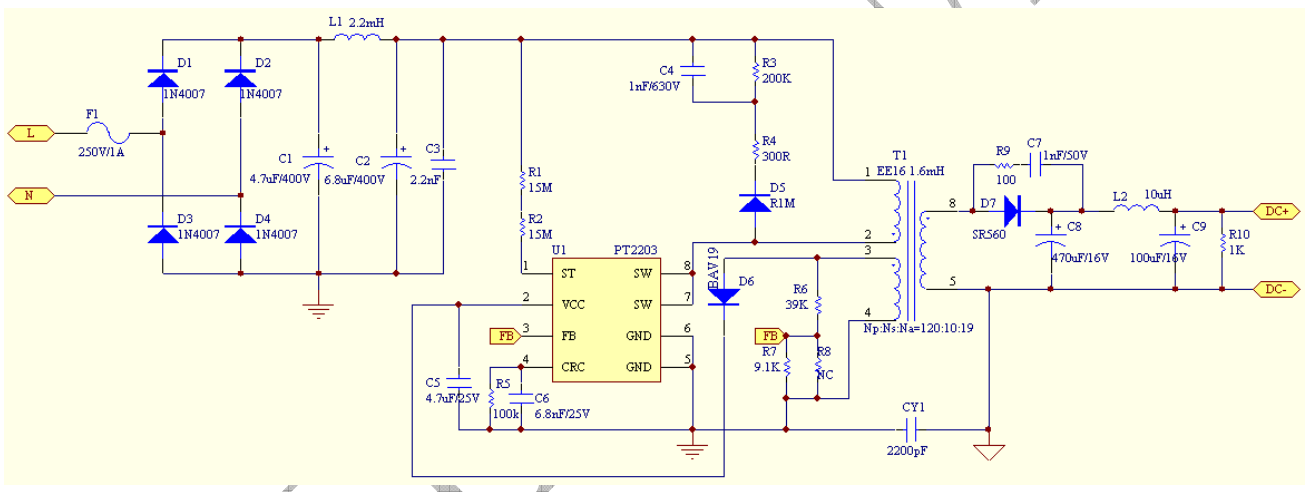


FIGURE 2 SCHEMATIC

5 PCB LAYOUT

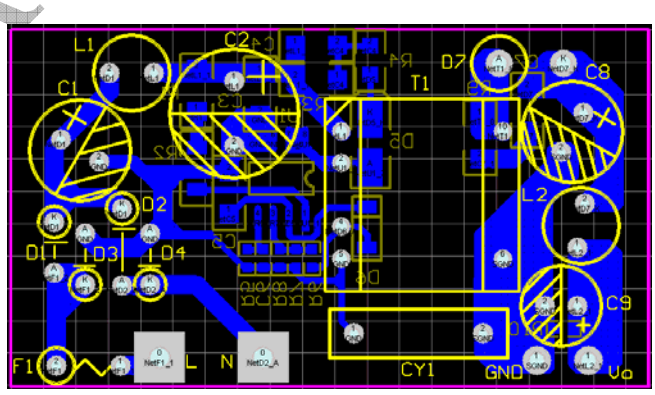


FIGURE 3 PCB LAYOUT (50MM*28MM)

6 BILL OF MATERIALS

Item	Reference	Value	Description	Manufacture
1	C1	4.7uF	CAP AL 400V 4.7U M 8*11.5	NICHICON
2	C2	6.8uF	CAP AL 400V 6.8U M 10*12	NICHICON
3	C3	2200pF	CAP SMD 630V 2200pF K X7R 1206	MURATA
4	C4	1000pF	CAP SMD 630V 1000pF K X7R 1206	MURATA
5	C5	4.7uF	CAP SMD 25V 4.7uF K X7R 1206	MURATA
6	C6	6.8nF	CAP SMD 25V 6.8nF K X7R 0603	MURATA
7	C7	1nF	CAP SMD 50V 1nF K X7R 0805	MURATA
8	C8	470uF	CAP AL 16V 470U M 8*11.5	NICHICON
9	C9	100uF	CAP SMD 16V 100uF M 6.3*11.5	NICHICON
10	CY1	2200pF	CAP Y CD 250VAC 470pF P10	MURATA
11	D1	1N4007	DIO SI 1A 1000V DO-41	VISHAY
12	D2	1N4007	DIO SI 1A 1000V DO-41	VISHAY
13	D3	1N4007	DIO SI 1A 1000V DO-41	VISHAY
14	D4	1N4007	DIO SI 1A 1000V DO-41	VISHAY
15	D5	S1M	DIO Glass 1A 1000V SMA	VISHAY
16	D6	BAV19W	DIO SW 0.2A 100V SOD-123	VISHAY
17	D7	SB560	DIO SBD 5A 60V DO-201AD	VISHAY
18	F1	1A	FUSE 1A 250V	Littlefuse
19	L1	2.2mH	INDUCTOR 2.2mH 6*10	Coilcraft
20	L2	10uH	INDUCTOR 10uH 1.5A 6*10	Coilcraft
21	R1	15M	RES SMD 1/4W 15Mohm J 1206	YAGEO
22	R2	15M	RES SMD 1/4W 15Mohm J 1206	YAGEO
23	R3	200k	RES SMD 1/4W 200kohm J 1206	YAGEO
24	R4	300R	RES SMD 1/8W 300ohm J 0805	YAGEO
25	R5	100k	RES SMD 1/8W 100kohm J 0603	YAGEO
26	R6	39k	RES SMD 1/10W 39kohm J 0603	YAGEO
27	R7	9.1k	RES SMD 1/10W 9.1kohm J 0603	YAGEO
28	R8	NC	RES SMD 1/10W 200kohm J 0603	YAGEO
29	R9	100R	RES SMD 1/10W 100ohm J 0603	YAGEO
30	R10	1k	RES SMD 1/10W 1kohm J 0603	YAGEO
31	T1	1.6mH	TRANSFORMER EE16 1.6mH +/-10%	KANGSHUN
32	U1	PT2203	IC POWTECH PT2203 SOP8	POWTECH

7 TRANSFORMER SPECIFICATION

7.1 Physical Dimension

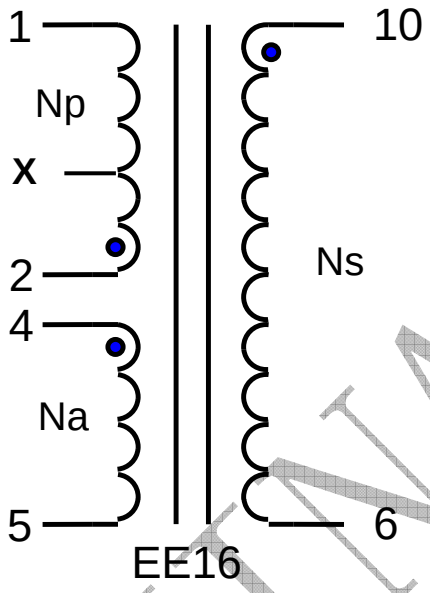


FIGURE 4 TRANSFORMER ELECTRICAL DIAGRAM

7.2 Winding Table

Winding	Terminal		Turns	Method	Wire		Insulation	
	Start	Finish			Type	Size*QTY	T/W	Layer
Np1	2	X	60	Distribute Center	2UEW	0.23*1	0.025*8.5	2
Na2	5	NC	20	Distribute Center	2UEW	0.15*1	0.025*8.5	2
Na1	4	5	19	Distribute Center	2UEW	0.19*1	0.025*8.5	2
Ns	10	6	10	Distribute Center	TIW-3	0.5*1	0.025*8.5	2
Np2	X	1	60	Distribute Center	2UEW	0.23*1	0.025*8.5	2

7.3 Electrical Specifications

Item	Description	Condition	Limits
1	Electrical Strength	60 seconds, 50Hz, 2mA, from Primary to Secondary	3000VAC
2	Primary Inductance	Pin 1 to Pin2, all other winds open, measured at 40KHz, 1Vrms	1.6mH±10%
3	Primary Leakage Inductance	Pin 1 to Pin2, with Pins 6 and 10 shorted, measured at 40KHz, 1Vrms	50uH(Max)

8 PERFORMANCE EVALUATION

All data were measured at TA=25°C and with 1.8m 24# output cable unless specified otherwise. The EUT were pre-heated for 0.5hrs before test.

8.1 Standby Power

VIN(VAC)	90	115	230	265
Pin(mW) at 0%Po	44.4	45	52.2	57.6

8.2 Average Efficiency

VIN(VAC)	25%Po	50%Po	75%Po	100%Po	Avg.Eff	EPA2.0
	0.25A	0.5A	0.75A	1A	(%)	(%)
115	73.82	72.56	70.86	69.94	71.79	68.17
230	70.50	71.52	70.70	69.98	70.68	

8.3 Line and Load Regulation

Output Voltage is measured at the end of the PCB, using CC-Mode of an Electronics Load.

Vo(V)	0	0.25	0.5	0.75	1	LoadReg(%)
90	5.168	4.995	4.935	4.941	4.934	4.53%
115	5.151	4.987	4.927	4.928	4.921	4.47%
132	5.142	4.980	4.921	4.923	4.914	4.43%
180	5.092	4.968	4.917	4.918	4.911	3.55%
230	5.014	5.034	4.909	4.916	4.907	2.52%
264	5.015	5.012	4.909	4.913	4.903	2.23%
LineReg(%)	2.98%	1.31%	0.53%	0.57%	0.63%	

8.4 Current Limit and Constant Current

Measured the constant current in the CV-Mode of an Electronics Load.

Io(A)	4.5	4	3.5	3	2.5	LoadReg(%)
90	1.048	1.062	1.066	1.083	1.095	4.29%
110	1.080	1.073	1.096	1.096	1.108	3.16%
132	1.071	1.094	1.089	1.110	1.117	4.12%
180	1.096	1.085	1.104	1.102	1.112	2.43%
230	1.081	1.098	1.099	1.113	1.119	3.40%
264	1.090	1.109	1.103	1.120	1.126	3.20%
LineReg(%)	4.38%	4.24%	3.44%	3.30%	2.75%	

8.5 U-I Curve

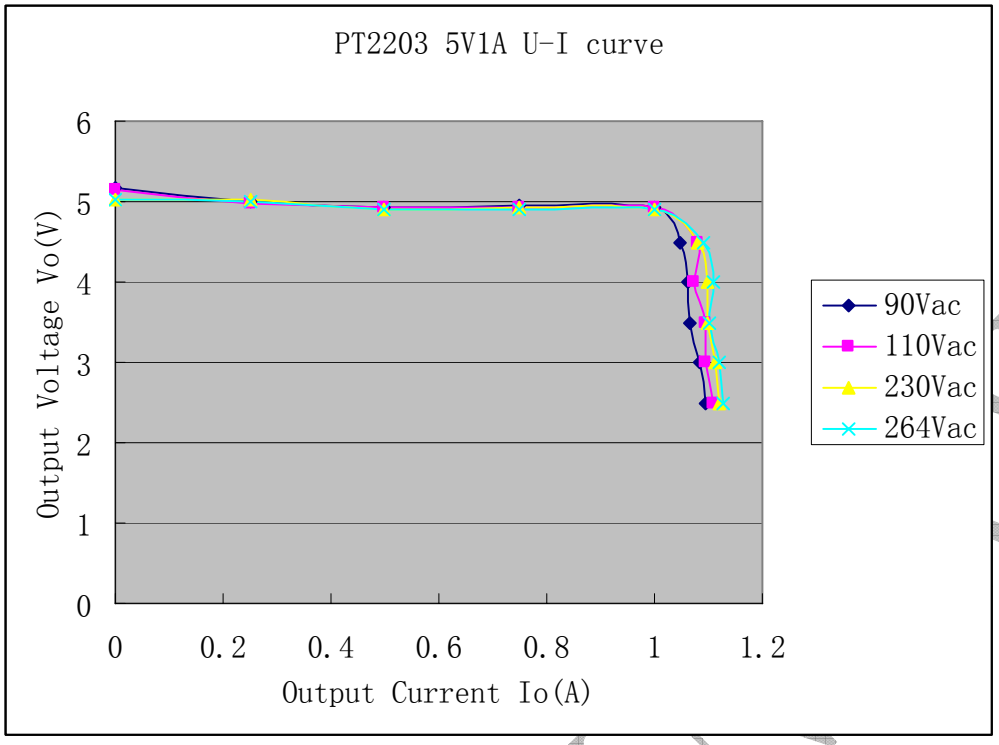


FIGURE 5　U-I CURVE

8.6　Output Ripple Voltage and Current

Test Condition: Vin=230VAC, 5V1A（CV）and 4.5V 1A（CC）

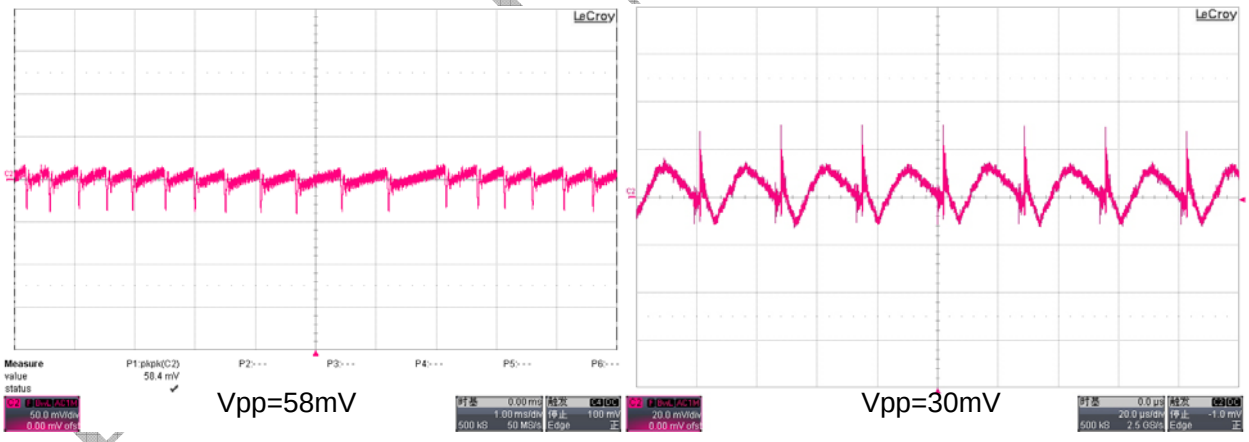
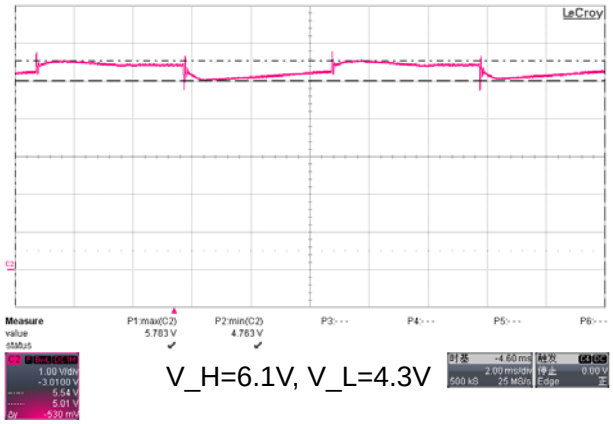


FIGURE 6　RIPPLE VOLTAGE AT CV AND CC MODE

8.7　Output Dynamic Response

Test Condition: 0.08A Load ~1A Load 5Hz; 2.55A/uS; 230Vac/ 50Hz



8.8 Turn-on Delay Time

Test Condition: Turn on 110Vac; Full Load;

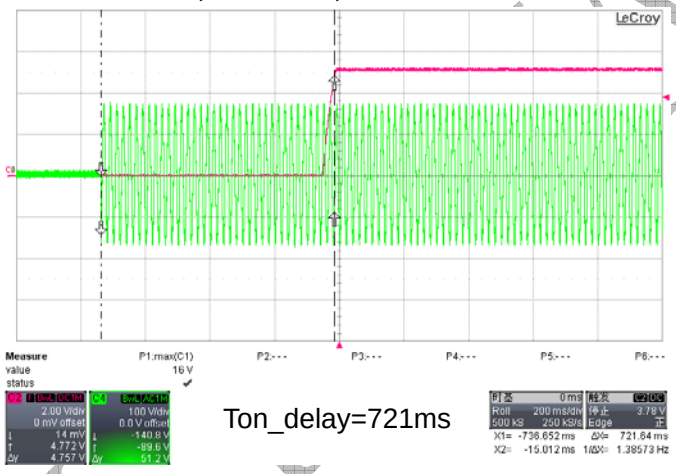


FIGURE 7 TURN-ON DELAY TIME

8.9 Conducted EMI

Test Condition: Vin=230VAC, 5V1A

EMI TEST REPORT

parameter

Organization:	POWTECH	Operator:	AE	EUT:	PT2203
Place:	Powtech LAB	Time:	2011/10/28/16:41		
Detector:	PK+AV	Test-time(ms):	10		
Limit:	EN55022B	Transductor:	10		
Remark:					

freq, step

Start(MHz)	End(MHz)	Step(MHz)
0.150	0.500	0.005
0.500	1.000	0.005
1.000	5.000	0.005
5.000	10.000	0.010
10.000	30.000	0.030

scan result

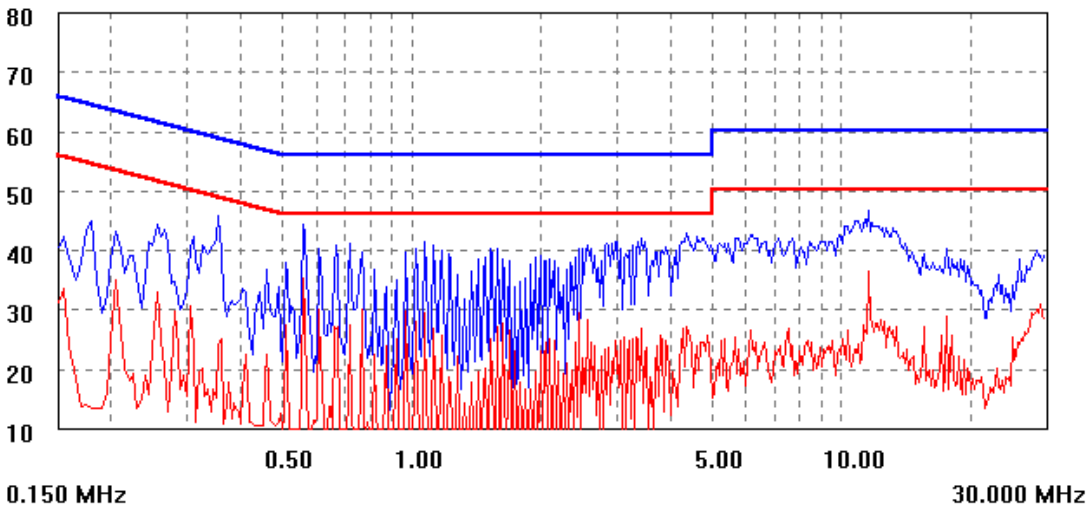


FIGURE 8 EMI CURVE

9 KEY DESIGN POINTS

9.1 Transformer Design

输入：90V～264Vac，输出：Vo＝5.2V，Io＝1.1A。

1）激磁电感Lp

$$Lp＝2Po/（Ip2*Fsw*Effi）$$

其中Ip为原边峰值电流，Fsw为开关工作频率，Effi为EUT转换效率，代入：Po＝5.72W，Ip＝0.39A，fsw设为55kHz，设η＝85%，则Lp＝1.609mH，实际取1.6mH.

2）变压器匝比

轻载条件下，芯片内部通过调节原边电流采样基准，从而控制变压器传输功率，Ip_lightload＝0.4*Ip_fullload，设输出整流二极管导通时间为Toff，则变压器匝比为：

$$n＝0.4*Lp*Ip/(Toff\_min*Vo)$$

代入：Lp＝1.6mH， Ip＝0.39A，Toff_min≧3us（由电压反馈采样时刻决定），Vo=5.2V，则n＝14，一般选择60≦nVo≦80V，本Demo取n＝12.

3）初次级匝数

根据5W输出功率，选择EE16磁芯，磁芯有效截面积Ae＝19mm^2.

$$Np＝Lp*Ip/（Bmax*Ae）$$

代入：Lp＝1.6mH.，Ip＝0.39A，取Bmax＝0.27T，Ae＝19mm2，则:

初级匝数：Np＝120Ts，

次级匝数：Ns＝Np/n=10Ts;

辅组绕组匝数：Na＝Vcc_noload/(Vo+Vd)*Ns

Na需要满足空载时Vcc电压超过Vcc_off,一般留40%左右裕量，Vcc_off可参考芯片datasheet，最大值为7.5V，取Vcc_noload=10.5V，则Na＝10.5/(5.2+0.3)*10=19Ts。

9.2 Feedback Resistance design

反馈上拉电阻由开关频率Fsw，激磁电感Lp以及原边辅组绕组匝比Npa决定。开关频率由Ifb，Ton和Vfb决定，查询datasheet，当Vfb=VREF，IFB×Ton=2.5mA*uS时，Fsw＝55kHz。其中

$$Ifb＝Vbus/（Npa*Rfbup）$$

$$Ton＝Lp*Ip/Vbus$$

代入以上两个公式，可得：

$$Lp*Ip/(Npa*Rfbup)=2.5(mA*uS)$$

推出：$$Rfbup=Lp*Ip/(Npa*2.5)$$

代入：Lp＝1.6mH，Ip＝0.39A，Npa＝120/19＝6.3，则Rfbup＝39.62k，实际取39k。

反馈下拉电阻需要满足在变压器反激时间，Vfb＝2V，即：

$$Vfb=Rfbdn*Nas*(Vo+Vd)/(Rfbup+Rfbdn)=2(V)$$

推出：$$Rfbdn=2*Rfbup/[Nas*(Vo+Vd)-2]$$

代入Rfbup＝39k，Nas＝19/10，得到：Rfbdn＝9.23k，实际取9.1k。

注：不同变压器副边及辅组绕组匝比需严格按照理论计算匝数绕制，若有偏差，将直接影响到输出电压设定。

10 REVISION HISTORY

Date	Author	Revision	Description & changes
2011.9.26	Jin Gaoxian	Ver0.1	Initial Release
2011.11.01	Li Liang	Ver0.2	Updated Evaluation data