



# AN1347 APPLICATION NOTE

## VIpower: VIPer12 DEMOBOARD, STAND-BY APPLICATION

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### 1. ABSTRACT

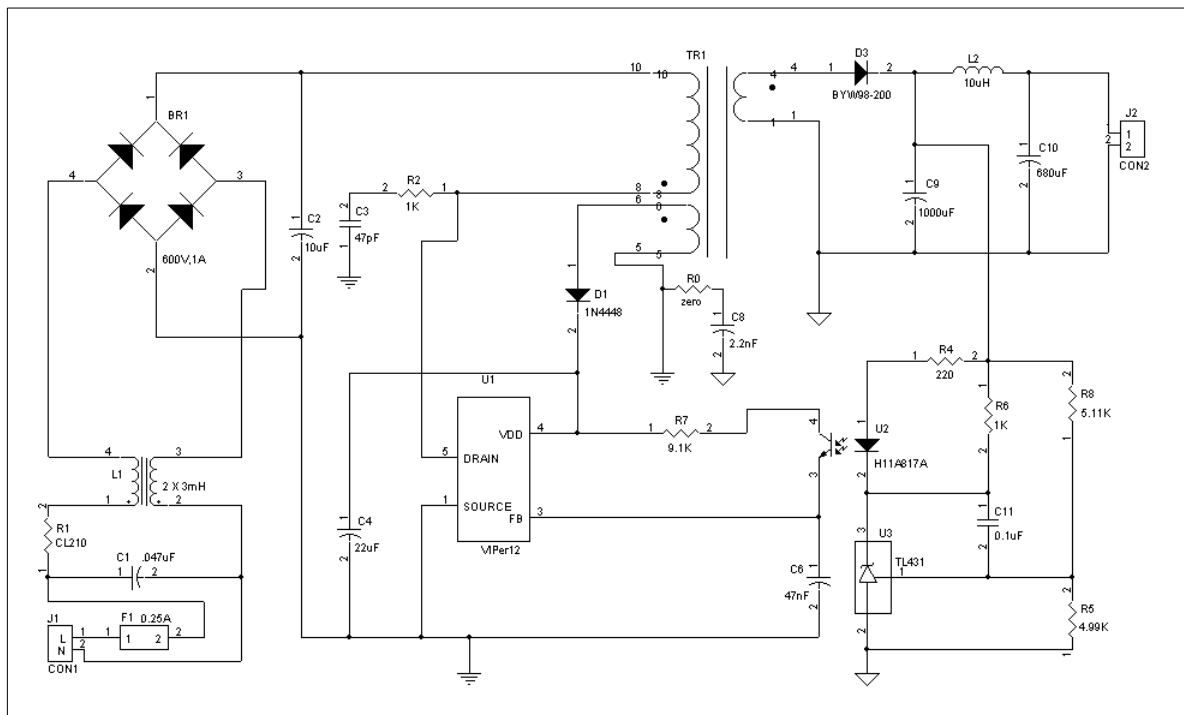
This general circuit can be used in a flyback or forward mode to produce any output voltage in primary or secondary mode regulation and is suitable for a multiple output power supply. This application is for a low input power flyback standby power supply and uses the VIPer12DIP.

### 2. INTRODUCTION

The VIPer12 technology contains a state of the art PWM circuit and a Vertical Power MOSFET, which is avalanche rugged, on the same silicon chip. It is suitable for off line wide range input voltage power supplies of up to 6W (12W for high input voltage range). This solution has the advantage of using few external components compared to a discrete solution, can be used for primary or secondary regulation, has a burst mode in standby for Blue Angel operation, a fixed operating frequency of 50kHz, has current mode control, a built in current limit and contains thermal protection.

It has a very wide range Vdd voltage and is particularly suitable for a battery charger application or a low input power stand-by application.

Figure 1: Stand-by Application Electrical schematic



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The following description is for a standby application with a 5V output voltage, an output power of 5W and a wide range input voltage (see figure 1). The VIPer12 used is an eight pin dip rated for 730V maximum with a maximum peak drain current of 0.36A. In the circuit at maximum load, the device has a maximum voltage of 560V at 264VAC and a maximum peak current of 0.25A at 85VAC. This circuit is operating at 50kHz and is set up for secondary regulation with an optocoupler.

The circuit contains an input fuse (F1), an inrush thermistor (R1), EMI filtering (C1, L1, C8), and a snubber circuit (C3, R2). The output transformer (TR1) is built by Cramer Coil & Transformer Co., Inc. (CVP 11-006).

The PCB assembly does not contain the clamp components (D5, C7 and R9) which are used to lower the spike on the drain to source voltage. Also, the components used for primary regulation D4 and R3 are not assembled.

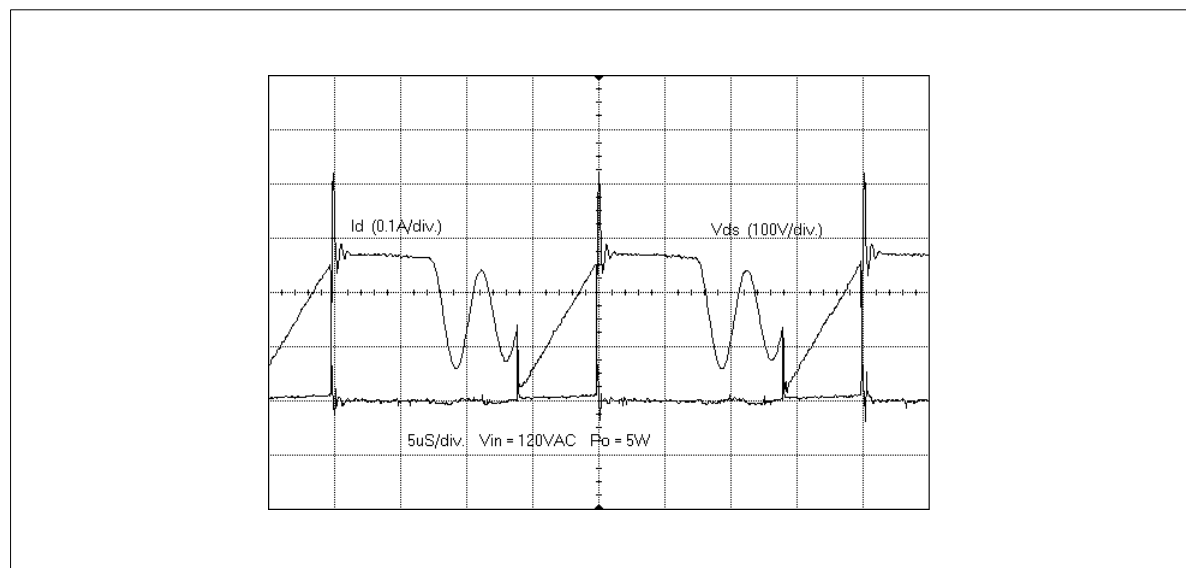
**Table 1:** Operating Conditions

Parameter	Results
Input voltage range	85 to 264 VAC
Input Frequency range	50/60 Hz
Temperature range	10 to 55°C
Output voltage	5V
Output power	Discontinuous
Output power	5 or 10 W
Efficiency	See figure 6, table 3
Output ripple voltage	1% to 3% p-p

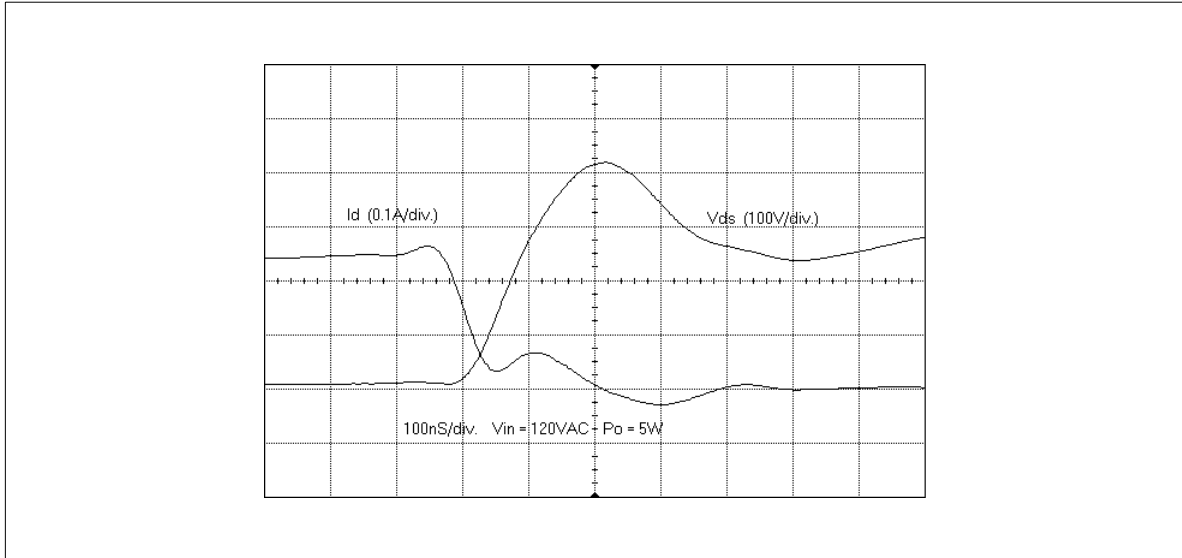
### 3. WAVE FORMS

Figures 2 and 3 show typical wave forms of the drain source voltage and the drain current for an input voltage of 120 VAC and maximum load current.

**Figure 2:** Drain Source Voltage and Drain Current



**Figure 3:** Drain Source Voltage and Drain Current



#### 4. BOARD LEGEND

The components for the major loop (the bulk capacitor C2, the primary on the output transformer TR1 and the VIPer12 U1) are placed in close proximity so that the current loop area is as small as possible. Also, components on the secondary (output rectifier D3, capacitors C9, C10, inductor L2 and transformer output winding TR1) are placed to reduce the current loop area.

Figure 4 and 5 show the VIPer12 Demo Board printed circuit board layout. Note that the width of the current loop area used is as small as possible and still meet the voltage spacing requirements.

Figure 4: PC Board Top Legend (not in scale)

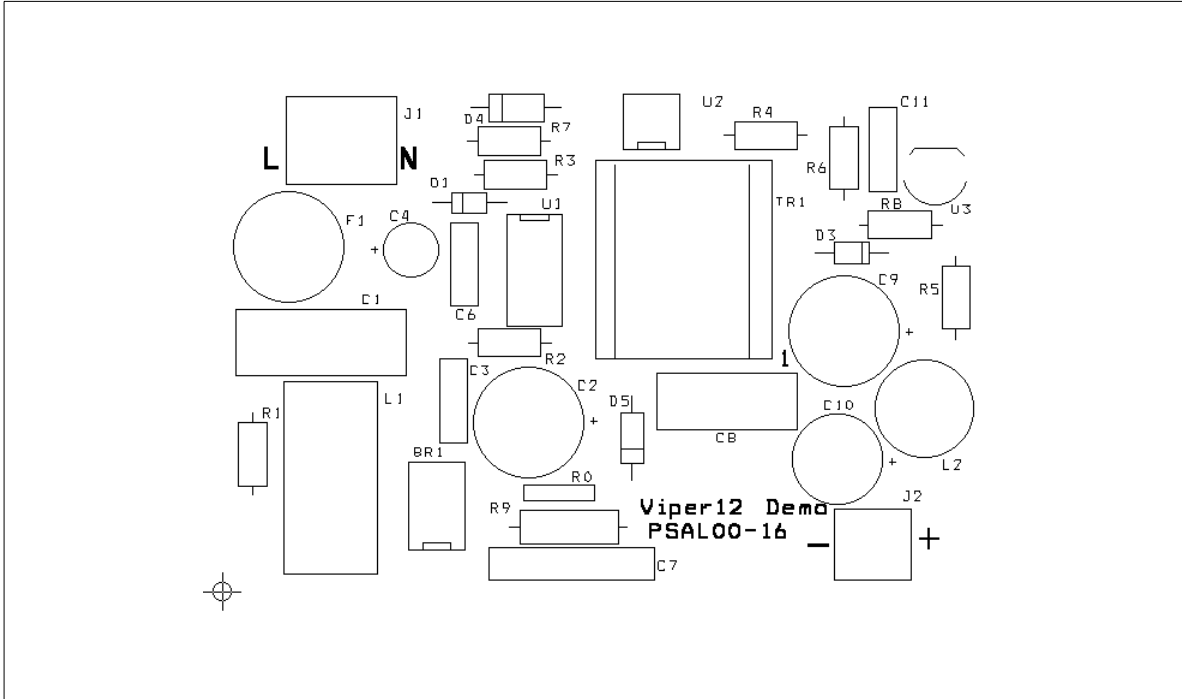
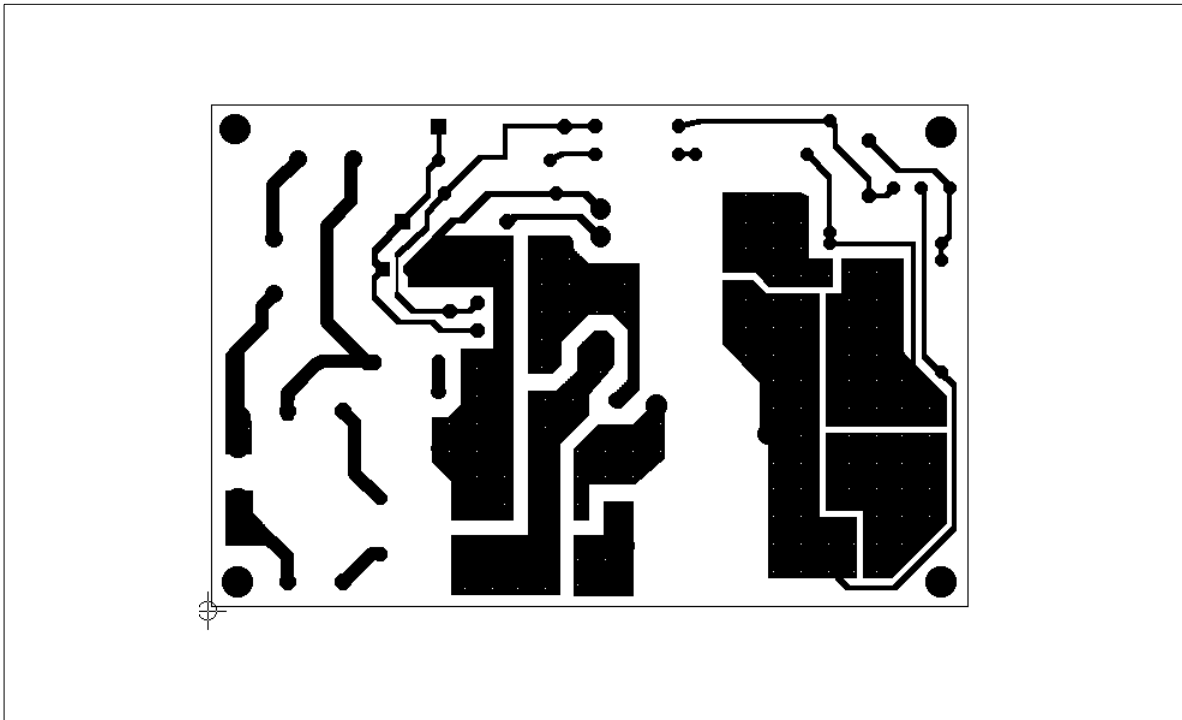


Figure 5: PC Board Bottom Foil (not in scale)



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**Table 2:** Component List

QUANTITY	REFERENCE	VALUE	PART NUMBER
	BR1	600V, 1A	
	C1	0.047 $\mu$ F, 250V	
	C2	10 $\mu$ F, 400V	
	C3	47pF, 1kV	
	C4	22 $\mu$ F, 50V	
	C6	47nF, 50V	
	C7	4700pF, 1kV (not used)	
	C8	2.2nF, "Y", 250V	
	C9	1000 $\mu$ F, 10V	
	C10	680 $\mu$ F, 10V	
	C11	0.1 $\mu$ F, 50V	
	D1	1N4448	<b>STMicroelectronics 1N4448</b>
	D3	BYW98-200	<b>STMicroelectronics BYW98-200</b>
	D4	18V, 0.5W (not used)	
	D5	STTA106 (not used)	
	F1	0.25A, 19372	FUSE
	J1	5mm CON1	Phoenix
	J2	3.5mm CON2	OST
	L1	2x3mH RN202-1/02	Schaffner
	L2	10 $\mu$ H	
	R0	0 $\Omega$	
	R1	CL210 NTC	
	R2	1k $\Omega$ , 1/4W, 5%	
	R3	1k $\Omega$ , 1/4W, 5% (not used)	
	R4	220 $\Omega$ , 1/4W, 5%	
	R5	4.99k $\Omega$ , 1/4W, 1%	
	R6	1k $\Omega$ , 1/4W, 5%	
	R7	9.1k $\Omega$ , 1/4W, 5%	
	R8	5.11k $\Omega$ , 1/4W, 1%	
	R9	47k $\Omega$ , 1W, 5% (not used)	
	TR1	CVP 11-006	CVP 11-006 Cramer Coil & Transf.
	U1	VIPer12DIP	<b>STMicroelectronics VIPer12DIP</b>
	U2	H11A817A	H11A817A
	U3	TL431CLP	<b>STMicroelectronics TL431CLP</b>

## **5A. GENERAL CIRCUIT DESCRIPTION**

The VIPer12 Demo Board is designed as a discontinuous flyback regulator where the energy is stored in the transformer TR1, with primary winding 8-10, when the VIPer12 (U1) is on and delivered to the output, 4-1, and auxiliary winding, 6-5, when the VIPer12 is off. The auxiliary winding provides the bias voltage for the VIPer12 at the Vdd pin 4.

Unlike other VIPer's, the VIPer12 operates by monitoring the current into the feedback pin 3 (FB). When the current into the feedback,  $I_{fb}$ , is zero, the VIPer12 is operating at its full power level. When an  $I_{fb}$  current close to 1mA is reached, the VIPer12 will shut down. Regulation is achieved by controlling the proper amount of current into the feedback pin.

The output voltage is regulated with a TL-431 (U3) via an optocoupler (U2) to the feedback pin. If the output voltage is high, the TL-431 turns on and the current increases in the optocoupler pins 1-2. The current in optocoupler pins 4-3 increases and the current into the VIPer12 FB pin increases. When the FB current increases, the VIPer12 will shorten the on time and lower the output voltage to the proper level.

## **5B. PRIMARY REGULATION ALTERNATIVE**

For primary regulation, the following components are not used: U2, U3, C11, R4, R5, R6, R7, and R8. The components D4 and R3 are used.

D4 provides a somewhat fixed voltage at the auxiliary winding for the Vdd voltage. Regulation depends on good coupling between the auxiliary winding and the output winding. This is an inexpensive solution for an output voltage regulation of about  $\pm 10\%$  with a small change in output current.

## **6. THERMAL CONSIDERATIONS**

The demo board is single sided and utilizes one ounce copper for all of the traces. A wide area of copper is used for a pad, on the demo board, to act as a heat sink for the VIPer12 Dip which will reach a peak  $I_{ds}$  current of 0.25A.

## **7. TRANSFORMER CONSIDERATIONS**

The output transformer has a primary inductance of 3.4mH, a ferrite core EE16 with 7099 material and an AL of 100. It is primary - secondary Hi Pot tested to 3750VAC for 1 second and meets IEC and UL specs. It is wound with a split primary - half on the bottom and half on the top with the auxiliary and output windings in the middle.

## **8. PERFORMANCE CONSIDERATIONS**

A lower leakage inductance transformer will allow a lower power snubber circuit and no clamp circuit to reduce the input power. A larger bulk capacitor or full bridge will reduce the input ripple voltage and allow operation at a lower input line or higher load.

The output filter contains a 10uH inductor (L2) for a typical low output ripple voltage of about 1% p-p at full power. A higher ripple voltage of about 3% p-p can be achieved without inductor L2.

## **9. COST CONSIDERATIONS**

A single rectifier can be used instead of an input bridge. Note that the input ripple voltage will be two times as much compared to the full bridge. Primary mode regulation can be used (with D4 and R3) without secondary regulation for a greater than 5% regulation requirement. Also, primary mode

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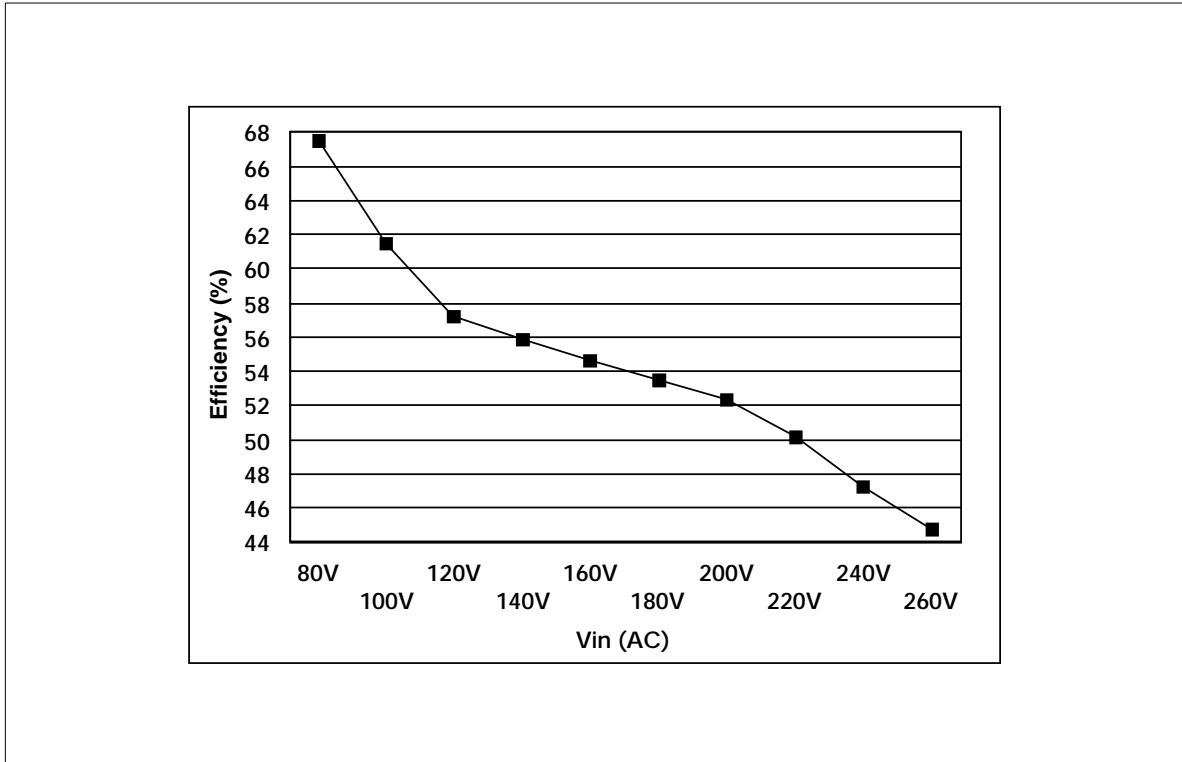
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regulation can be used with a standard three terminal regulator for 5% regulation.

The efficiency, in figure 6, is for the VIPer12 demo board for various input voltages at an input power of one Watt. Also, the efficiency in decimal form is the output power for an input power of 1W.

See table 3 for input power and efficiency (N) at 120VAC, 240VAC, and at various output loads.

**Figure 6:** Efficiency vs. Vin at Pin=1W



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