AN1736
Application note

VIPower: VIPer22A dual output reference board 90 to 264 VAC input, 10W output

Introduction

This is an off-line wide range VIPer22A dual outputs power supply at a switching frequency of 60kHz and is set up for secondary regulation with an optocoupler. One output delivers 5V at 1A and while a second output delivers12V at 0.42A, making up the total output power of 10W.

- Switch mode general purpose power supply
- Single-sided board
- 75% efficiency
- Output short circuit protection
- Thermal shutdown protection
- Meets EN55022 class B EMI specification
- Meets Blue Angel

Operating conditions

Parameter	Limits
Input voltage range	90 to 264Vac
Input Frequency Range	50/60 Hz
Output voltages	V1= 5V; V2=12V
Output current	I=0.84A
Output power	10W
Efficiency	75% typical
Line regulation	+/- 0% for 5V output
Load regulation	+/- 0.3% for 5V output
Output ripple voltage	20mVpp
EMI	EN55022 Class B

Contents

List of figures

List of tables

1 PCB lay-out

Figure 1. Board lay-out

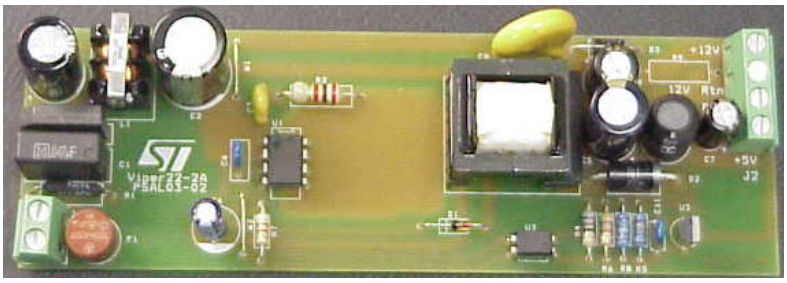


Figure 2. **Board top legend (not in scale)**

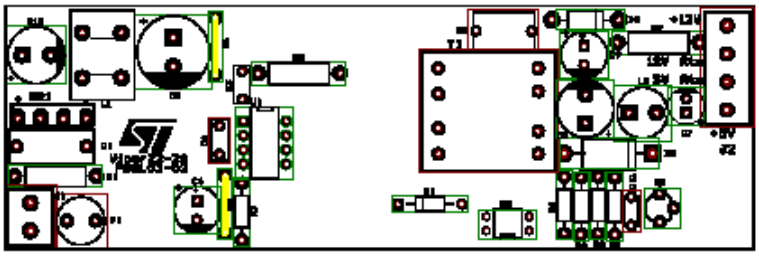
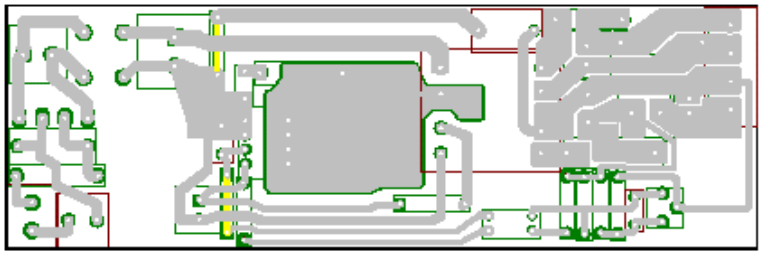


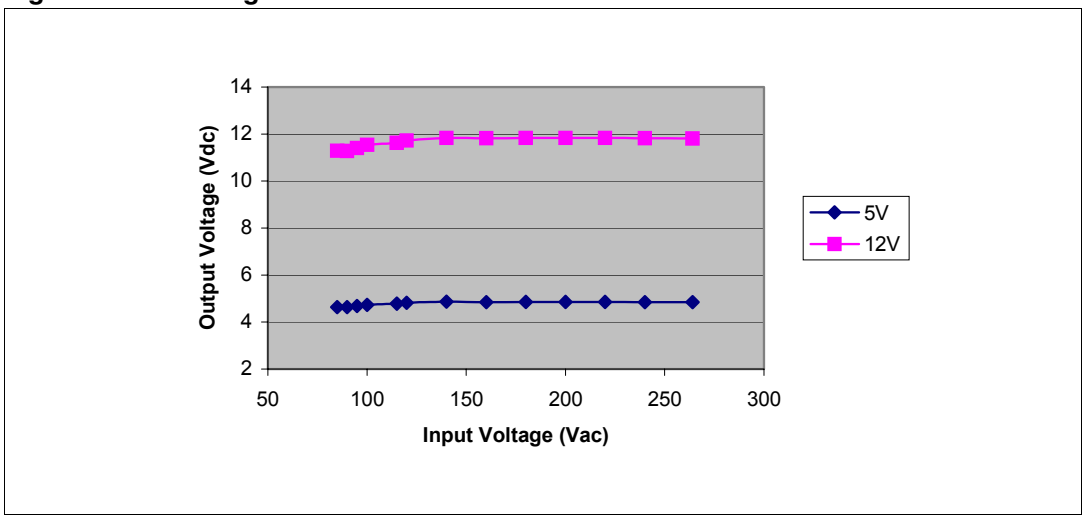
Figure 3. **Board bottom foil (not in scale)**



2 Line regulation

Figure 4. shows the line regulation of both the +5V and the +12V output. The output voltages are measured for the input voltage range of 85 to 264VAC at the maximum output power of 10W. The +5V output shows a 0% line regulation while the +12V output has a line regulation of 0.25%.

Figure 4. Line regulation



3 Load regulation

The load regulation measurements are taken at the input voltage of 120Vac. Here, the load regulation measured for the +5V output is ±0.3% while the +12V output shows a load regulation of ±0.46%. See *Figure 5.* and *Figure 6.*

Figure 5. Load regulation for 5V output

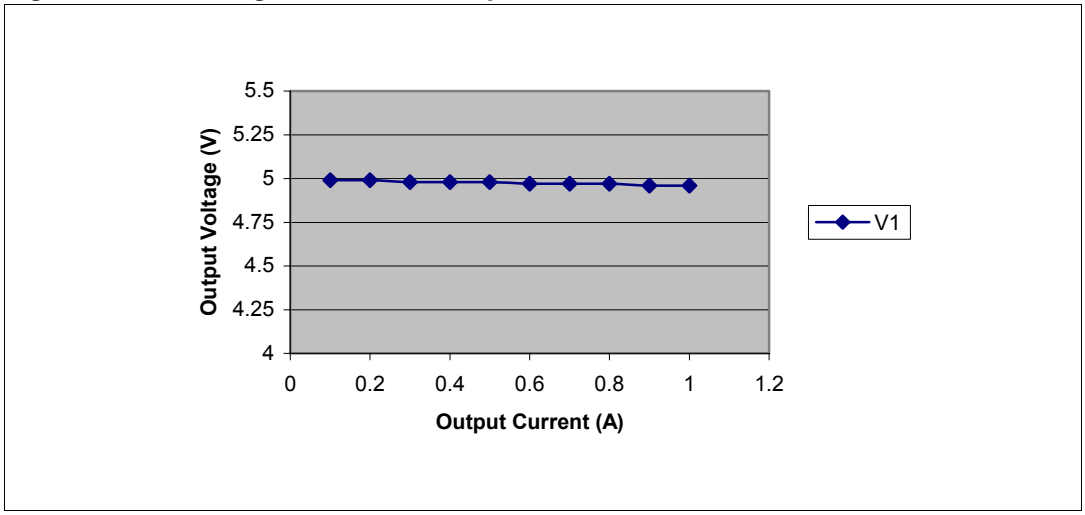
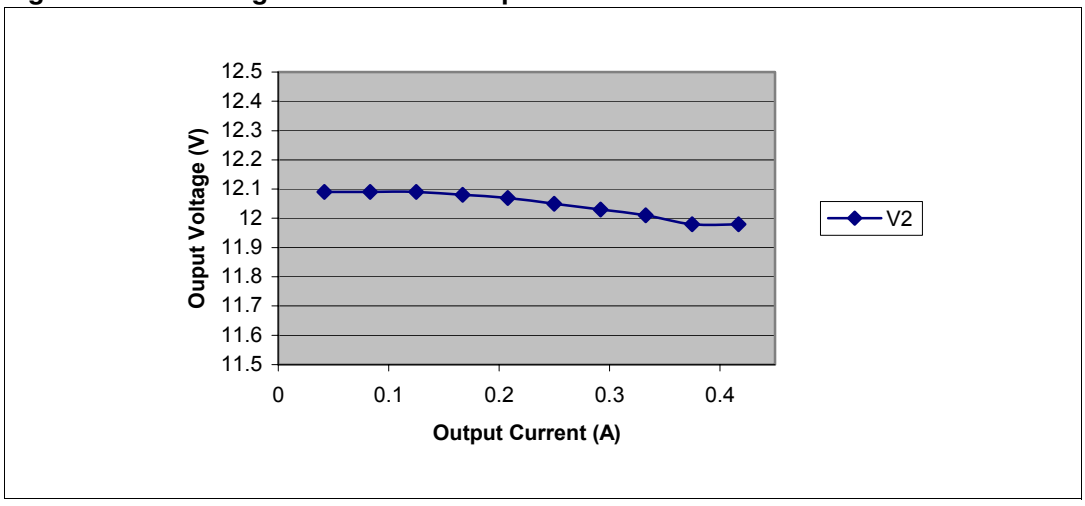


Figure 6. Load regulation for 12V output



4 Efficiency

Figure 7. shows the efficiency curve of the reference board when the input voltage is varied from 90 to 264Vac at the maximum output power of 10W. Here, the typical efficiency value is measured to be 75%.

Meanwhile, *Figure 8.* shows the efficiency measurement taken at 120Vac while the output power is varied from 1W to the maximum 10W. The typical efficiency measured is also around 75%.

Figure 7. Efficiency vs. input voltage

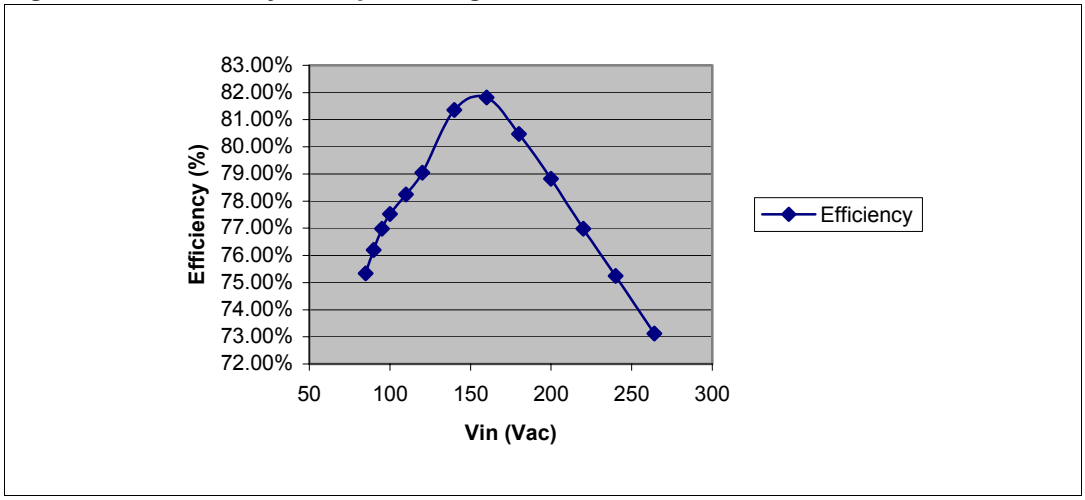
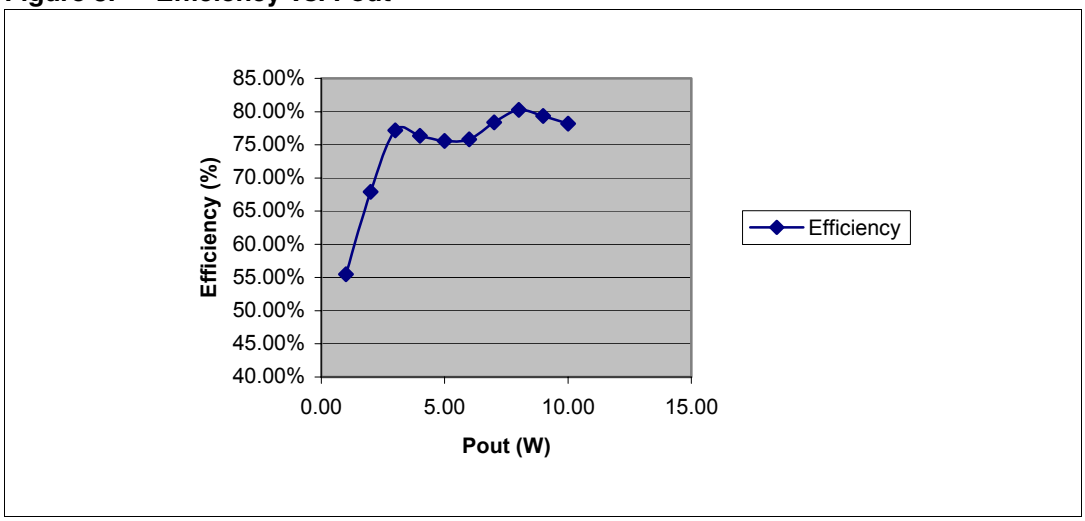


Figure 8. Efficiency vs. Pout



5 Line frequency ripple

Figure 9. Line ripple for 5V output

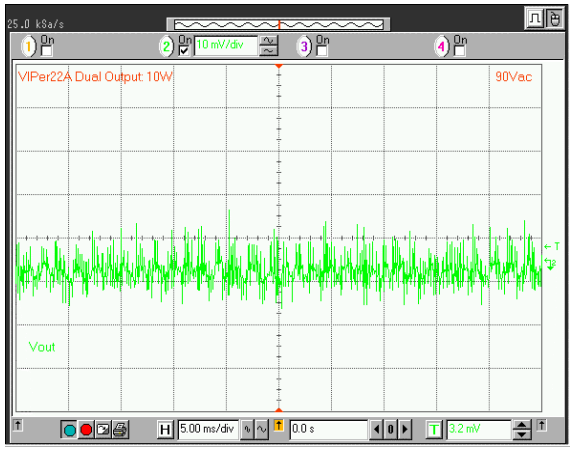


Figure 10. Line ripple for 12V output

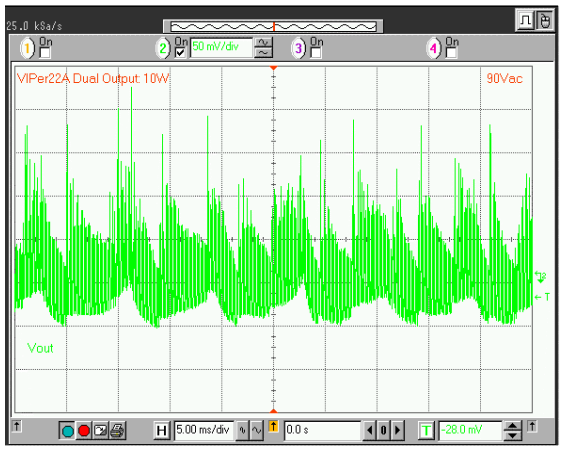


Figure 9. and *Figure 10.* show the line frequency ripple waveforms of the +5V and +12V output respectively taken at 90Vac input. The line frequency ripple for +5V is 10mVpp while for the +12V output; it is 50mVpp.

6 Switching frequency ripple

Figure 11. Switching ripple for 5V output

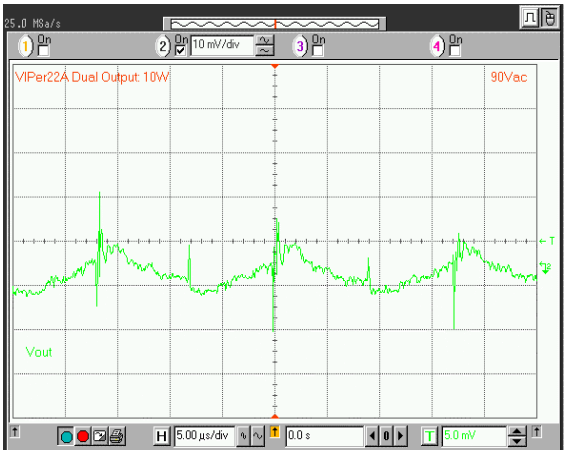
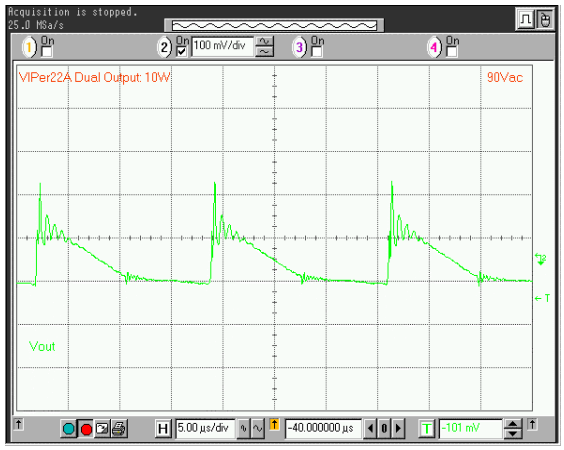


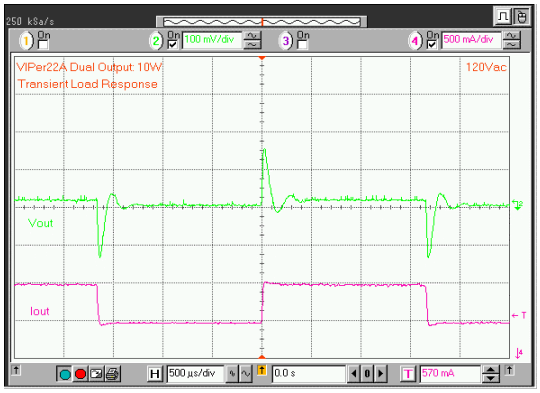
Figure 12. Switching ripple for 12V output



The switching ripple for the +5V output measured is 12mVpp while this ripple measured for the +12V output is 200mVpp. The low ripple for the +5V output is obtained using the low pass LC (PI) filter configuration of L2 and C10. The waveforms are taken at the input voltage of 90Vac.

7 Transient load response

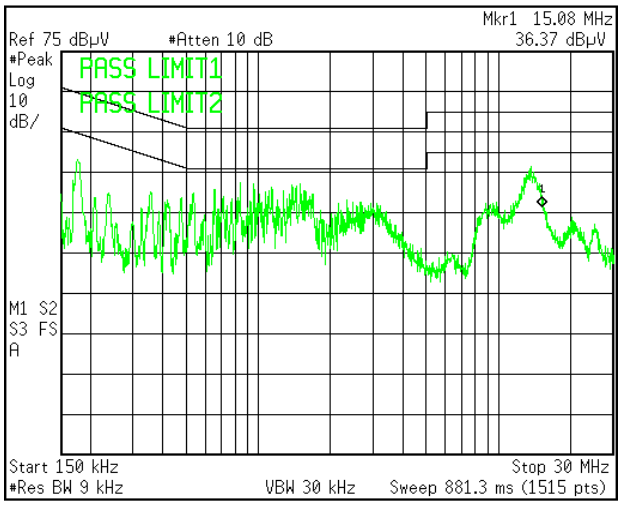
Figure 13. Transient load response



The transient load response is measured at the input voltage of 90Vac where the +5V output load is varied from 50% load (0.5A) to 100% load (1A) while the +12V is kept at the nominal load value of 0.21A. The dynamic response measured is 140mV or 2.8% while the settling time is 500ms. See *Figure 13.*

8 EMI results

Figure 14. EMI



The unit passes the European Norm, EN55022 Class B EMI.

9 Blue Angel

The reference board meets the Blue Angel Norm, consuming less than 1W total when working in stand-by mode. The board operates in burst mode when both the output loads are reduced to zero and the output voltages still remain regulated.

9.1 Stand-by input power

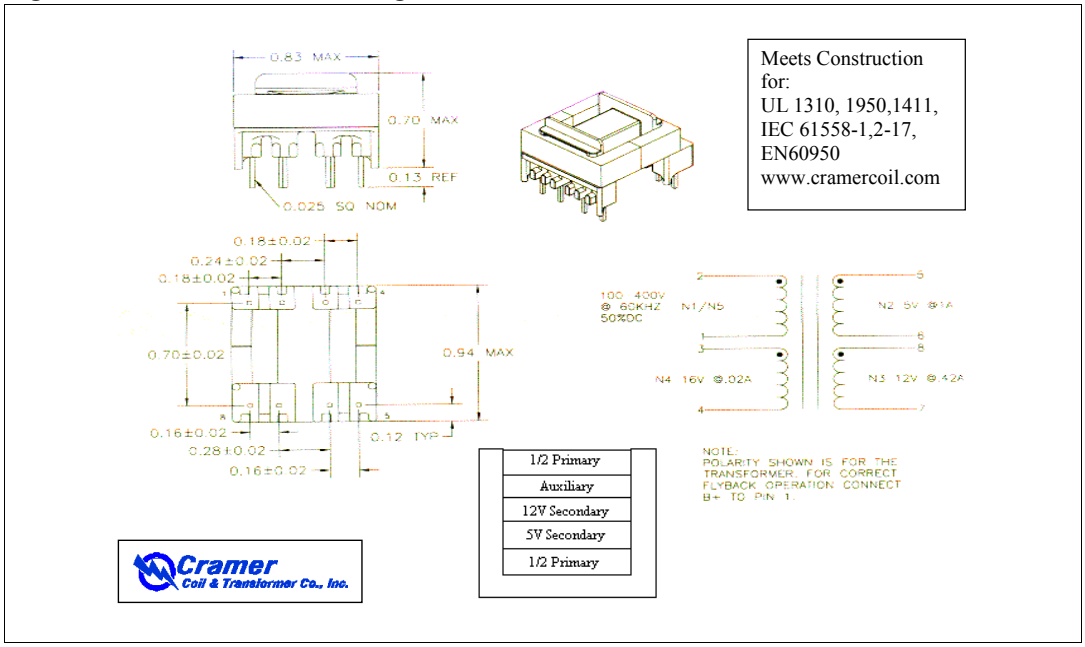
Table 1. Input power in no load condition at different input voltage

Input Voltage	Input Wattage at No Load
115Vac	210.38mW
230Vac	331.85mW

At the input voltage of 120Vac, a minimum load of 100mA is needed to keep the total input power consumption to be less than 1W.

10 Transformer specification

Figure 15. Mechanical drawings of the transformer



When the VIPer22A (U1) is on, energy is stored in the primary winding of transformer (1-2), TX1. This energy is transferred to the auxiliary winding (3-4), and to the output (5-6) when the VIPer22A is off. The auxiliary winding provides the bias voltage for the VIPer22A at pin 4 (Vdd).

The electrical specifications of the transformer are as follow:

- Primary Inductance 2.25mH±15%
- Primary Leakage Inductance 22µH typical
- Turns Ratio (N1/N5:N2) 1:0.053
- Turns Ratio (N1/N5:N3) 1:0.127
- Turns Ratio (N1/N5:N4) 1:0.167

The transformer is designed and manufactured by Cramer Coil and Transformer.

11 Output current and voltage capability

The standard voltage and current values for the reference board can be changed to deliver a different voltage and current value, with changes to the following components as detailed in *Table 2.*

Table 2. Change in output voltage and current

Output Voltages	T1	C9
5 and 12V	CVP32-002	220µF/25V
5 and 15V	CVP32-003	220µF/35V
5 and 24V	CVP32-004	220µF/50V

12 Thermal considerations

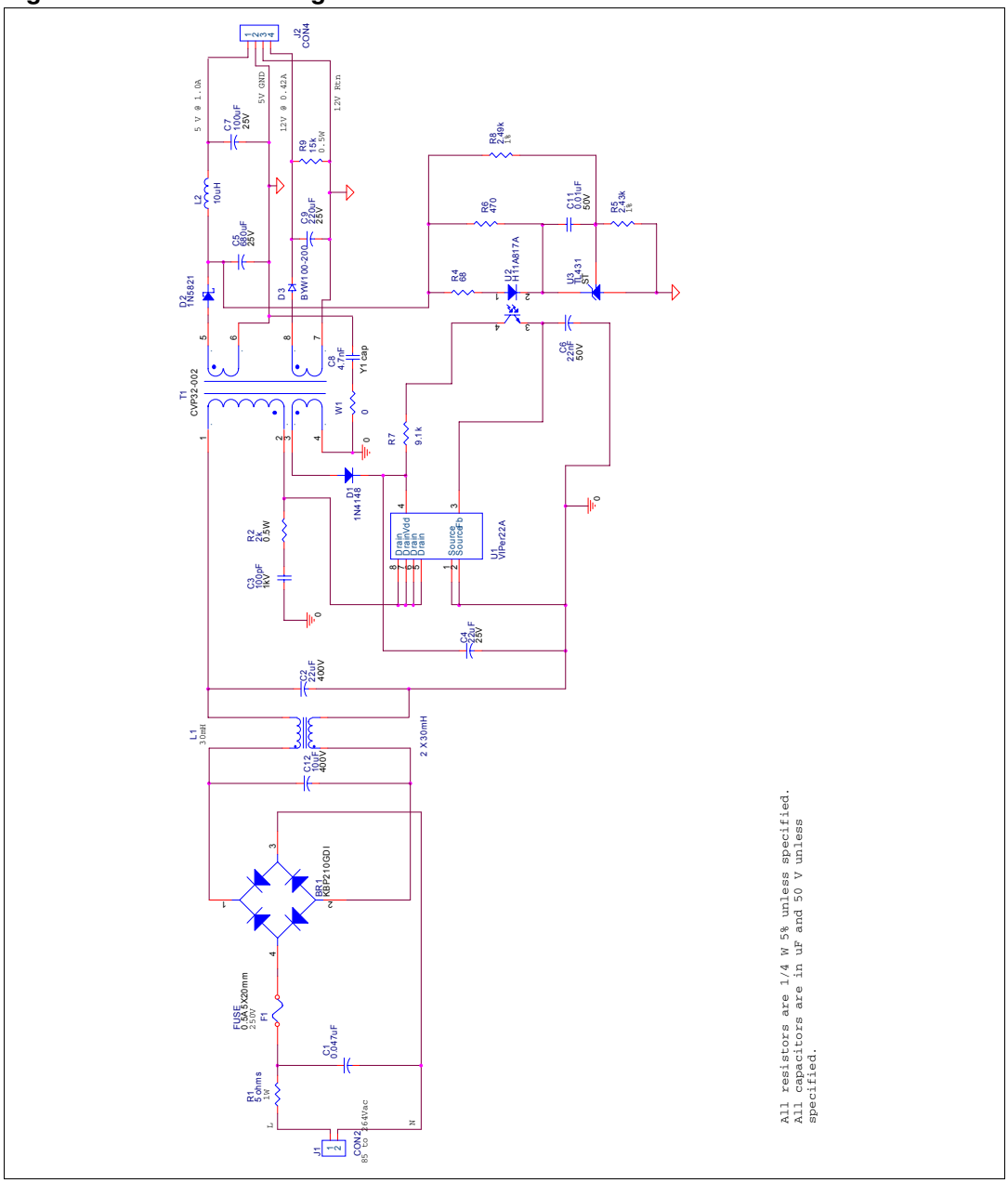
The reference board is single-sided and utilizes a wide area of two ounces copper pad to act as a heat sink for the VIPer22ADIP. All other traces utilize one-ounce copper.

13 Component list

Table 3. Bill of material

Quantity	Reference	Description
1	BR1	KBP210GDI
1	C1	0.047µF/250V boxcap
1	C2	22µF/400V electrolytic
1	C3	100pF 1kV ceramic
1	C4	22µF/25V electrolytic
1	C5	680µF/25V electrolytic
1	C6	22nF/50V ceramic
1	C7	100µF/25V electrolytic
1	C8	4.7nF/250V Y cap
1	C9	210µF/25V electrolytic
1	C11	0.01µF/50V ceramic
1	C12	10µF/400V electrolytic
1	D1	1N4148
1	D2	1N5821
1	D3	STMicroelectronics BYW100-200
1	F1	0.5A 250V Fuse
2	J1, J2	Connectors
1	L1	Compostar 2x30mH common-mode line choke
1	L2	Coilcraft 10µH inductor
1	R1	5Ω 5% 1W Wire wound
1	R2	2KΩ 5% 1/2W
1	R4	68Ω 5% 1/4W
1	R5	2.438KΩ 1% 1/4W
1	R6	470Ω 5% 1/4W
1	R7	9.1kΩ 5% 1/4W
1	R8	2.49KΩ 1% 1/4W
1	R9	15KΩ 5% 1/2W
1	T1	Cramer coil transformer CVP32-002
1	U1	STMicroelectronics VIPer22ADIP
1	U2	H11A817A or LTV817 optocoupler
1	U3	STMicroelectronics TL431
2	W1, W2	Jumper wire

Figure 16. Schematic diagram



14 Revision history

Table 4. Revision history

Date	Revision	Changes
16-Jul-2003	1	First issue
13-Jun-2005	2	- Schematic changed - Component list table modified
09-Sep-2005	3	Schematic modified
31-Jul-2006	4	- New template - Component list value modified