
**VIPOWER™: the VIPer53-E single output reference board
with 90 to 264 Vac input, 24 W output**

Introduction

The VIPer53-E combines an enhanced current mode PWM controller with a high voltage MDMesh™ Power MOSFET in the same package. The VIPer53-E is available in two different packages, DIP8 and PowerSO-10. The reference board is an offline wide range power supply including the VIPer53-E and is set for secondary regulation by driving the PWM controller through an optocoupler. The switching frequency is 100 kHz and the total output power is 24 W.

Here below the main features:

- Switch mode general purpose power supply
- Current mode control with adjustable limitation
- 75% efficiency
- Output short-circuit and overload protection
- Thermal shutdown protection
- EN55022 Class B EMI specification
- Blue Angel compliant

Table 1. Operating conditions

Parameter	Limits
Input voltage range	From 90 to 264 Vac
Input frequency	100 kHz
Output voltage	V = 12 V
Output power	24 W
Efficiency	75% typical
Line regulation	+/- 0
Load regulation	+/- 0.2%
Output ripple voltage	15 mVpp
EMI	EN55022 Class B

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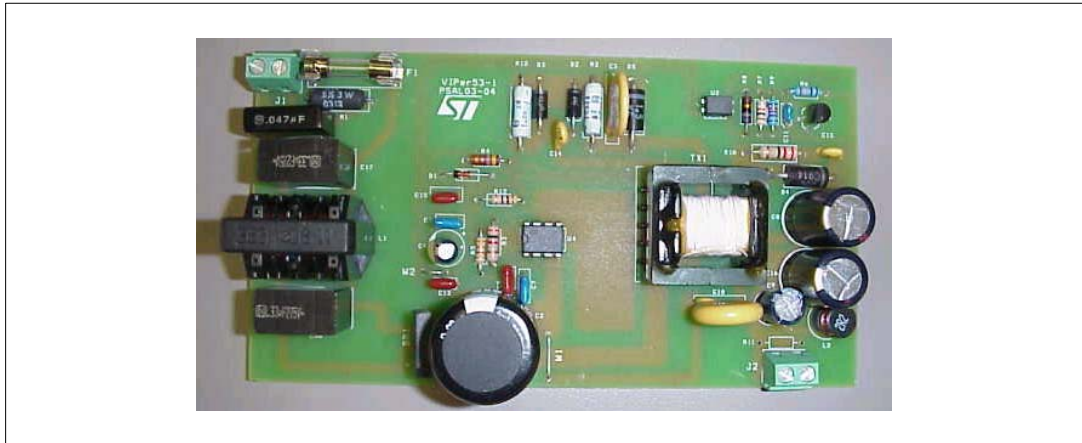
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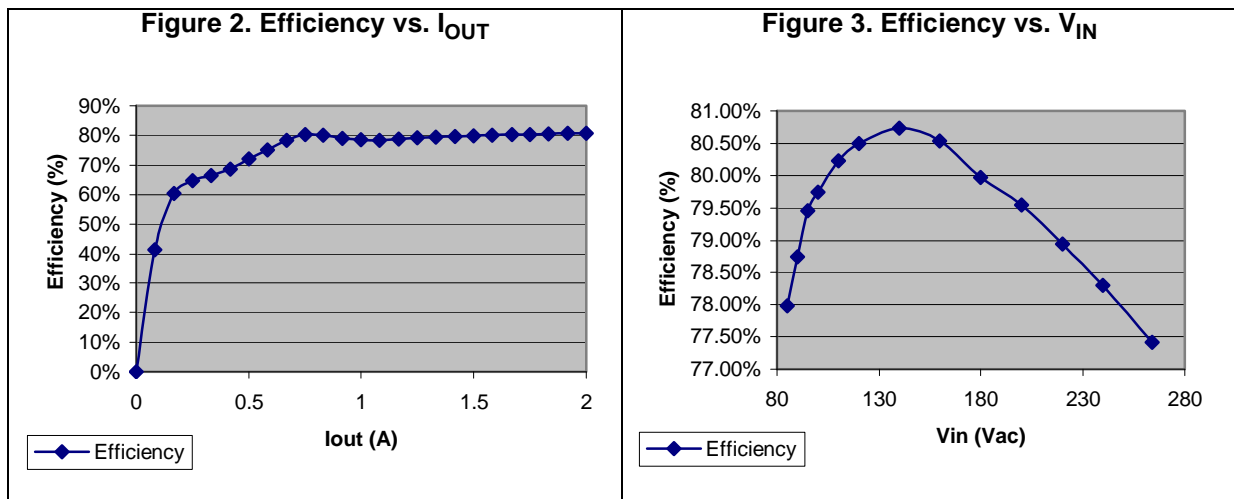
1 PCB layout

Figure 1. Board layout (not in scale)



2 Efficiency

[Figure 2](#) and [Figure 3](#) show the two efficiency curves of the reference board. In [Figure 2](#) the input voltage is 120 Vac while the output load varies from 0 A to the full load 2 A. [Figure 3](#) shows the efficiency where the input voltage varies from 90 to 264 Vac and the output load is fixed at 2 A.

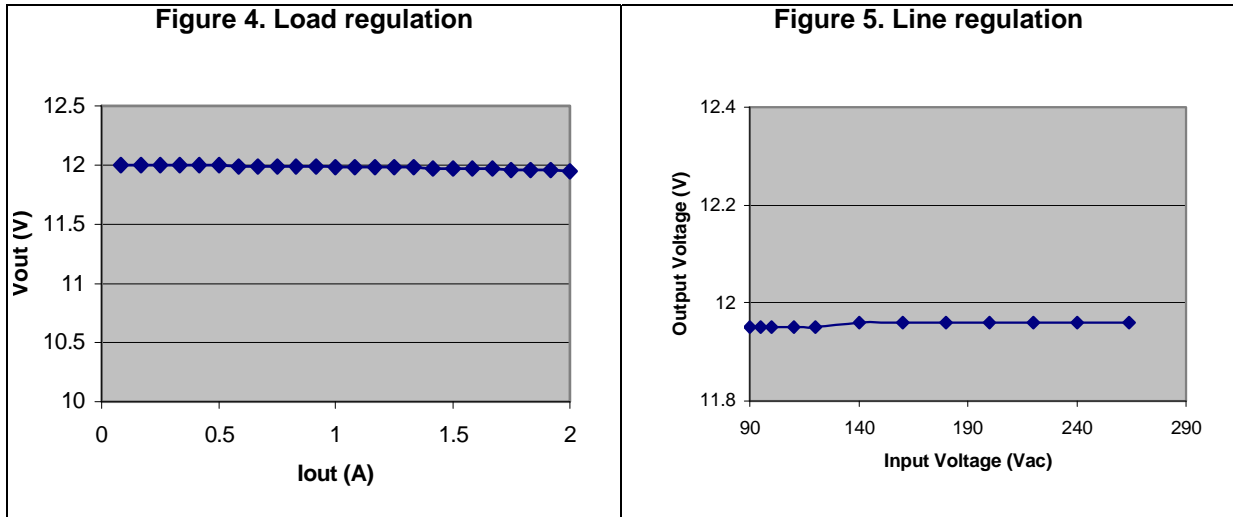


3 Load regulation

V_{OUT} is measured while the output load varies from 0 A to 2 A at the nominal input voltage 120 Vac. [Figure 4](#) shows the load regulation at 0.2%.

4 Line regulation

The line regulation has to be 0%. The output load is at full load 2 A, the input voltage varies from 90 to 264 V and the output voltage for the reference board remains regulated.



5 Transient response

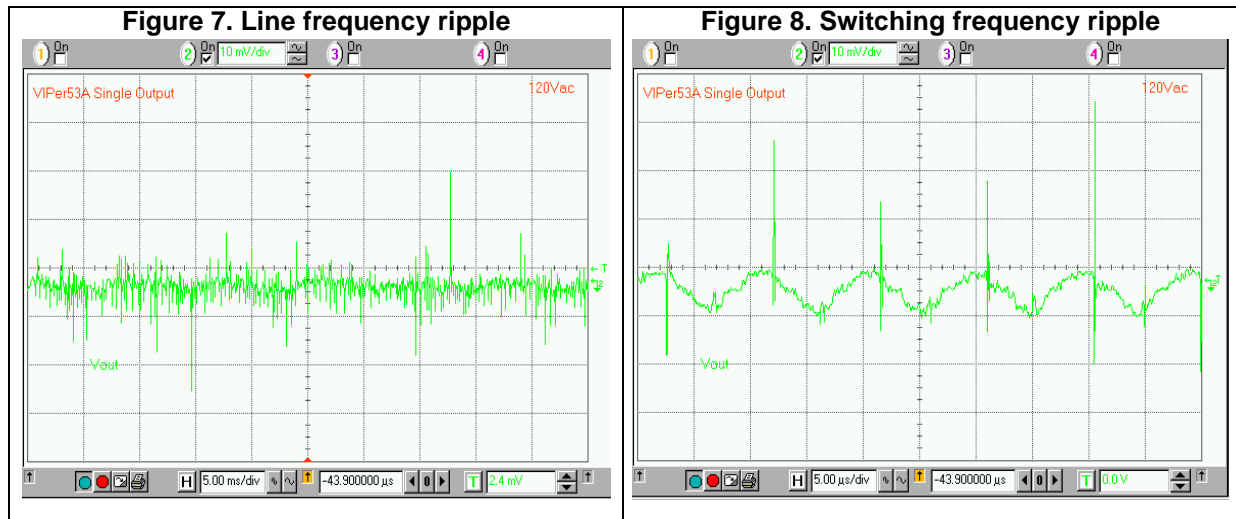
Figure 6. Transient response



Figure 6 shows the transient load response as the output load goes from 1 A to 2 A (50% to 100% load) at the input voltage 120 Vac. The dynamic response is 80 mV or 0.7% while the settling time is 420 μs.

6 Line and switching frequency ripple

Figure 7 and *Figure 8* show the line and switching frequency ripple of the reference board with an input voltage of 120 Vac and the output current is fixed at 2 A.

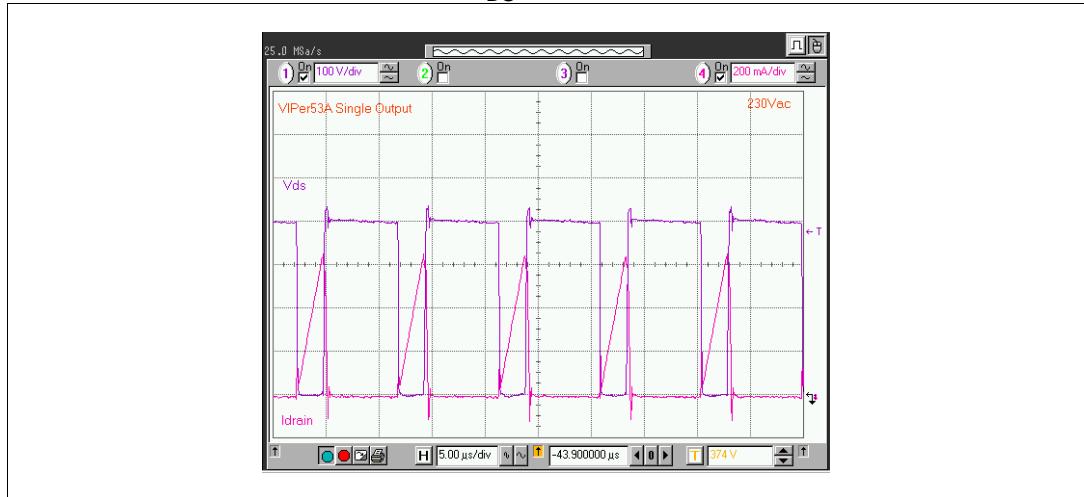


Both waveforms show a line frequency and switching frequency ripple of 10 mVpp each.

7 Waveforms

Figure 9 displays the drain current and V_{DS} at 230 Vac full load. The converter works in discontinuous mode as shown by the waveforms.

Figure 9. V_{DS} and drain current

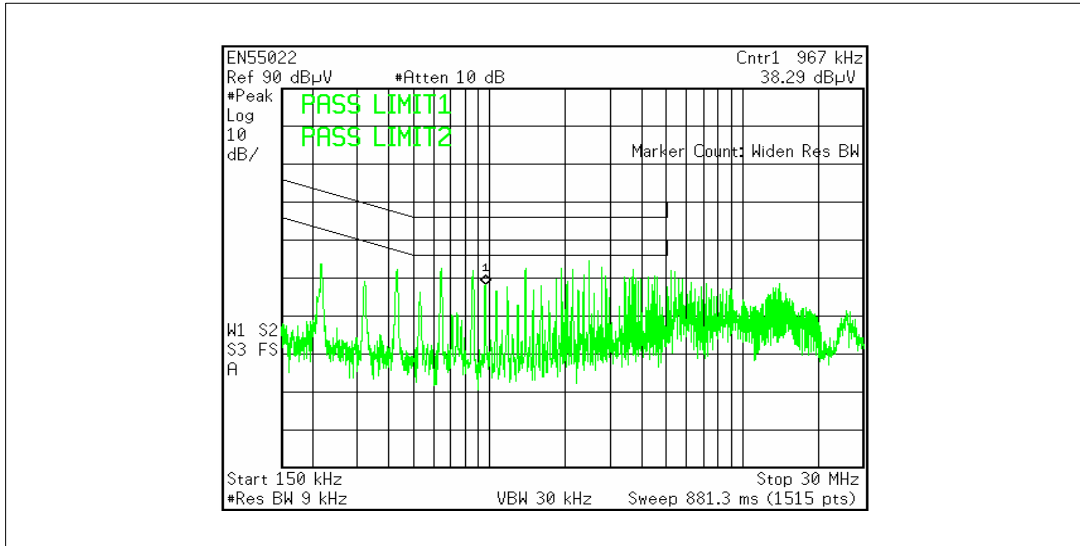


8 Blue Angel

The reference board consumes less than 1 W total when it works in standby burst mode at the input voltage of 120 Vac. The measured input power consumption is 569 mW with zero load on the output. The board meets the Blue Angel certification.

9 EMI results

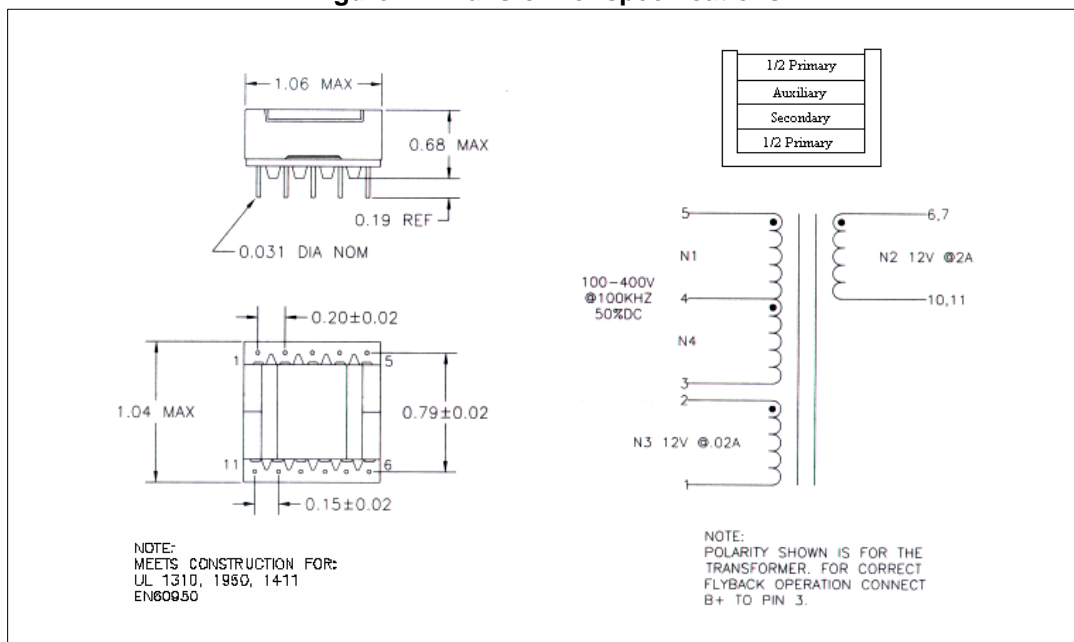
Figure 10. EMI



The reference board passes the EN55022 Class B EMI test as shown in [Figure 10](#).

10 Transformer specifications

Figure 11. Transformer specifications



The transformer is designed and manufactured by Cramer Coil and Transformer Co., Inc. Below the electrical specifications of the transformer:

- Primary inductance 1.10 mH±10%
- Primary leakage inductance 6.4 μH typical
- HIPOT (N1, N3, N4 to N2) 4000 Vac, 1 second
- DCR (N1/N4) 0.905 Ω typical
- DCR (N2) 0.020 Ω typical
- DCR (N3) 0.112 Ω typical
- Turn ratio (N1/N4:N2) 1:0.121±3%
- Turn ratio (N1/N4:N3) 1:0.121±3%

When the VIPer53-E is on, the energy is stored in the primary winding of the transformer (pins from 3 to 5). This energy is transferred to the auxiliary winding (pins 1 and 2), and to the output (6, from 7 to 10, 11) when the VIPer53-E is off. The auxiliary winding provides the bias voltage for the VIPer53-E on pin 7 (V_{DD}).

11 Different 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, as shown in [Table 1](#).

Table 2. Secondary component value to obtain different output voltage and current

V _{OUT} and I _{OUT}	T1	R6	R9	C8, C16	D4
5.0 V 4.8 A	CVP53-003	2.49 kΩ 1%	2.49 kΩ 1%	3300 μF 10 V	STPS1045
12 V 2.0 A	CVP53-001	3.48 kΩ 1%	13.3 kΩ 1%	1000 μF 25 V	BYW98-200
15 V 1.6 A	CVP53-004	2.94 kΩ 1%	14.7 kΩ 1%	1000 μF 35 V	BYW98-200
24 V 1.0 A	CVP53-005	1.50 kΩ 1%	13.0 kΩ 1%	470 μF 50 V	BYW98-200

Figure 12. PC board top legend (not in scale)

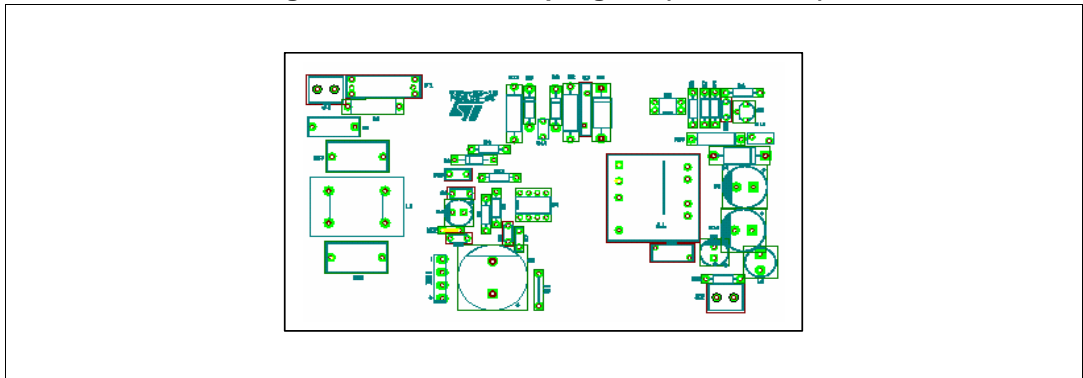


Figure 13. PC board bottom copper (not in scale)

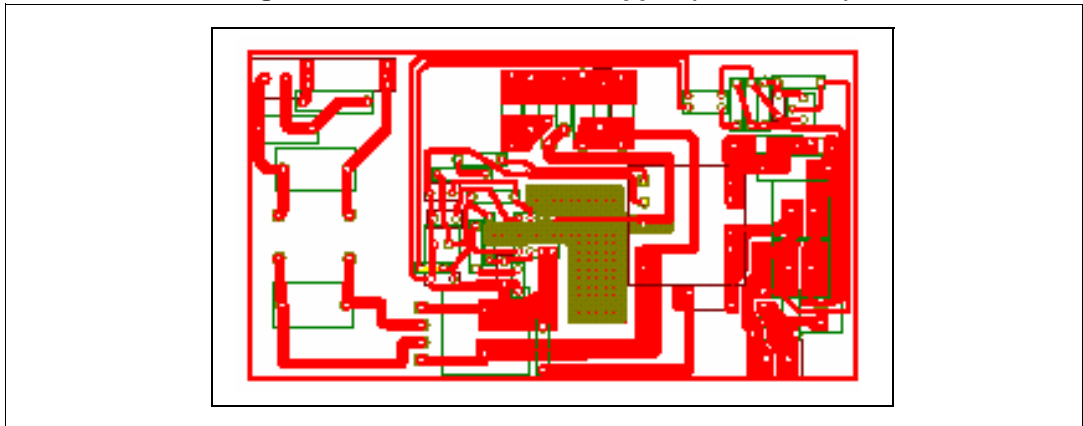


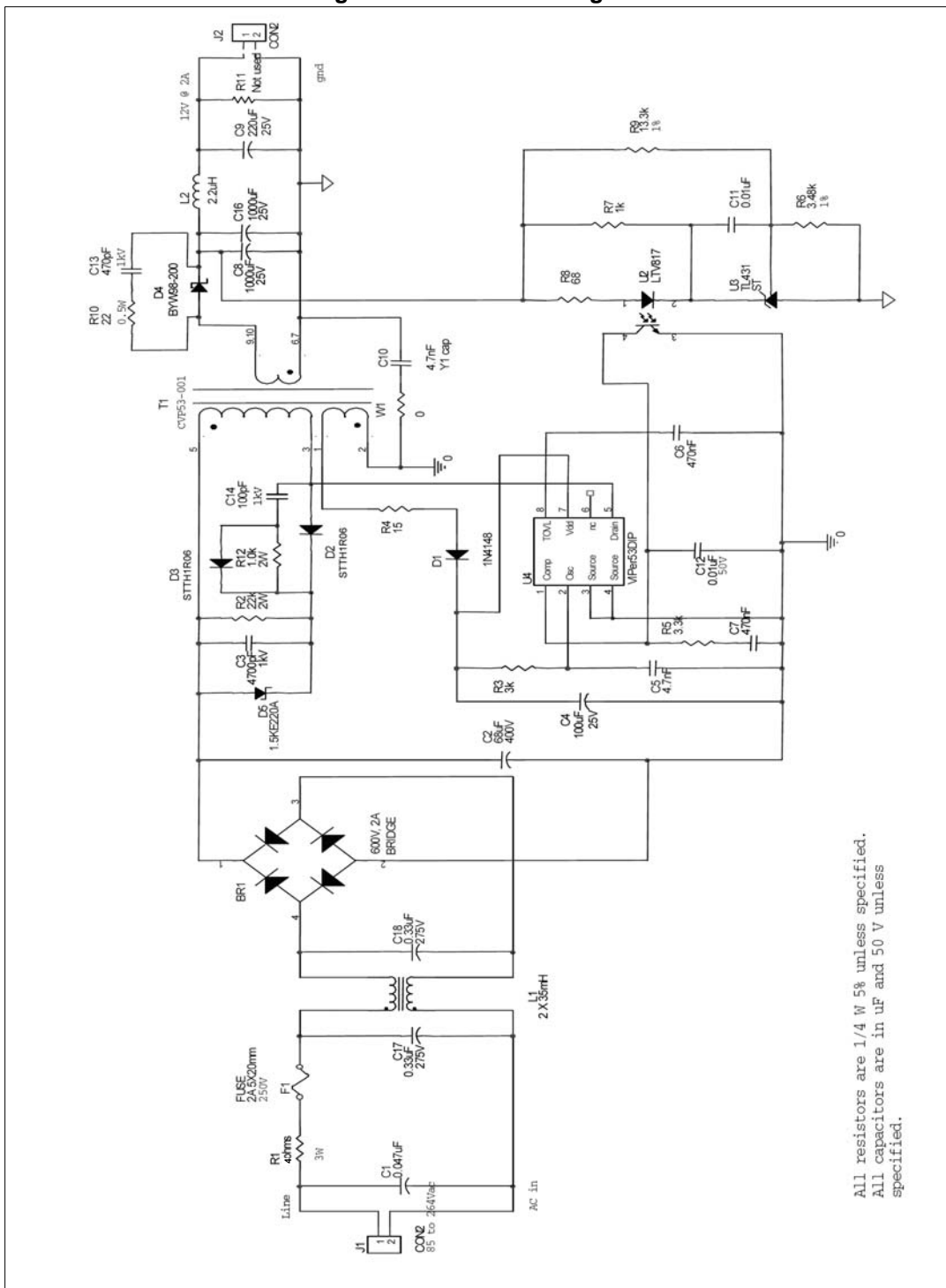
Table 3. Component list

Quantity	Reference	Description
1	BR1	KBP210GDI bridge rectifier
1	C1	0.047 μ F 250 V
1	C2	68 μ F/400 V electrolytic
1	C3	4700 pF 1 k V ceramic
1	C4	100 μ F/25 V electrolytic
1	C5	4.7 nF 50 V polyester
2	C6, C7	470 nF 50 V ceramic
2	C8, C16	1000 μ F/25 V electrolytic
1	C9	220 μ F/25 V electrolytic
1	C10	4.7 nF/250 V Y1 cap
2	C11, C12	0.01 μ F 50 V ceramic
1	C13	470 pF/1 k V ceramic
1	C14	100 pF/1 k V ceramic
1	C15	Not used
2	C17, C18	0.33 μ F/250 V
1	L1	Panasonic 35 mH common-mode line choke
1	L2	Coilcraft 2.2 μ H inductor
1	T1	Cramer Coil CVP53-001
1	R1	4 Ω 5% 3 W wire wound
1	R2	22 k Ω 5% 2 W resistor
1	R3	3 k Ω 5% 0.5 W resistor
1	R4	15 Ω 5% 0.25 W resistor
1	R5	3.3 k Ω 5% 0.25 W resistor
1	R6	3.48 k Ω 1% 0.25 W resistor
1	R7	1 k Ω 5% 0.25 W resistor
1	R8	68 Ω 5% 0.25 W resistor
1	R9	13.3 k Ω 1% 0.25 W resistor
1	R10	22 Ω 5% 0.5 W resistor
1	R12	1 k Ω 5% 2 W resistor
1	R13	Not used
1	D1	1N4148
2	D2, D3	STTH1R06
1	D4	BYW98-200
1	D5	1.5KE220A transil

Table 3. Component list (continued)

Quantity	Reference	Description
1	U2	H11A817A or LTV817A optocoupler
1	U3	TL431
1	U4	VIPer53DIP-E
2	W1, W2	Jumper wire
2	J1, J2	Connectors

Figure 14. Schematic diagram



All resistors are 1/4 W 5% unless specified.
All capacitors are in μF and 50 V unless specified.



12 Revision history

Table 4. Revision history

Date	Revision	Changes
16-Jul-2004	1	First issue
12-Sep-2006	2	- New template - Component list value modified - Schematic diagram modified
12-Nov-2014	3	Updated title in cover page. Content reworked to improve readability, no technical changes.

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