

Using a VIPer12-based Power Supply to Replace a Wall Transformer

Introduction

This application note describes a power supply that can be used as a wall transformer replacement or as a power module for a small consumer appliance. The design objectives are:

- The outside case dimensions (in inches) are 2L x 2W x 1H, with smaller inside dimensions,
- the Line and Neutral pins (of equal size and 8mm from the end of the assembly) are attached to the case,
- the input voltage ranges are 95V_{AC} to 135V_{AC}; and 190V_{AC} to 270V_{AC},
- the output voltage is 15V (max) at 1mA (min) and is 12V (min) at 500mA (max), with a 50% duty cycle,
- the ambient temperature range is -5°C to 55°C, and
- the Electromagnetic Interference (EMI) is measured for all loads.

The power supply for the wall transformer replacement application consists primarily of a re-packaged VIPer12 Demonstration Board (12V, single output voltage, see Application Note AN1734 for details).

Figure 1. VIPer12-based Power Supply Assembly, Top View



Table of Contents

1	VIPer12-based Power Supply Features and Assembly	4
1.1	Layout and Component Placement	4
1.2	Assembly	5
1.3	Heat Sink Enhancement	7
2	Operation Characteristics	8
3	Transformer Electrical Specifications	10
4	Transformer Mechanical Information	11
	Appendix A. Schematics	12
	Appendix B. KIDDE VIPer12 Demo Board BOM	13
5	Revision History	14

List of Figures

Figure 1.	VIPer12-based Power Supply Assembly, Top View	1
Figure 2.	PCB Layout.	5
Figure 3.	PCB Component Placement.	5
Figure 4.	EMI Measurements (EMI EN5502, Class B).	6
Figure 5.	Heat Sink Configuration	7
Figure 6.	Drain to Source Voltage (V_{ds}) and Drain Current (I_d) Waveforms	8
Figure 7.	Power Supply Efficiency with Line Variation.	8
Figure 8.	Line Regulation: Power Supply Output Voltage vs. Varied Input Line Voltage.	9
Figure 9.	Load Regulation: Power Supply Output Voltage vs. Varied Load	9
Figure 10.	Transformer Winding Schematic	10
Figure 11.	Transformer Mechanical Drawing	11
Figure 12.	VIPer12-based Power Supply Schematics	12

1 VIPer12-based Power Supply Features and Assembly

- Fixed 60kHz Switching Frequency
- Switch mode General Purpose Power Supply
- Burst Mode Operation in Standby for Blue Angel operation
- Current Mode Control
- Typical 75% Efficiency at Full Load
- Auxiliary Undervoltage Lockout with Hysteresis
- Output Short Circuit Protection
- Thermal Shutdown Protection
- Meets EN55022 Class B EMI specification

1.1 Layout and Component Placement

To meet Printed Circuit Board (PCB) space requirements, both sides of the PCB are used for either low or high voltage power supply mains by selecting the appropriate voltage rating for the bulk capacitors and the Metal Oxide Varistor (MOV). Surface-mount components should be used wherever possible to reduce the size of the assembly. The remaining axial lead devices (e.g., resistors, diode, and “pigtail” fuse) are mounted vertically to save PCB space.

The line and neutral pins are molded into the bottom of the case and pass through two holes in the top of the case, and a line cord attachment is on the side opposite the line and neutral pins (see [Figure 2 on page 5](#) and [Figure 3 on page 5](#)). The PCB size is determined by the overall dimensions and the side wall thicknesses of the case (1.78in x 1.78in, with rectangular mounting slots in each side). A 0.118in mounting hole is provided. Additional support using 0.75in PCB standoffs is recommended, with the component leads trimmed to 0.65in (max).

See [Appendix A. Schematics on page 12](#) and [Appendix B. KIDDE VIPer12 Demo Board BOM on page 13](#) for details.

1.2 Assembly

The initial PCBs and power supply assemblies were routed, built, and tested in the lab. An assembly fits into the case with the attached output wire cable that is connected from the flange to the end. If a Pollution Degree 1 rating is desired, the assembly should be in a sealed case, since the cable runs from the secondary (across the transformer) to the primary. Additionally, the transformer can be smaller if the case is sealed. If a sealed case is not used, then thicker insulation or triple-insulated wire may be required.

Assembly EMI (EN5502, Class B) measurements are shown in [Figure 4 on page 6](#).

Figure 2. PCB Layout

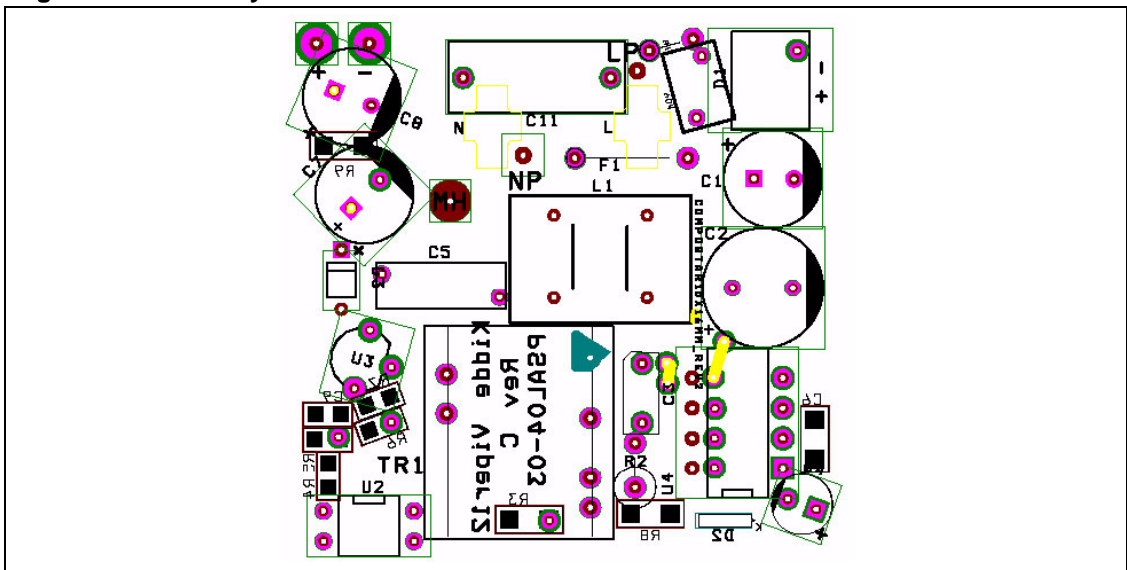


Figure 3. PCB Component Placement

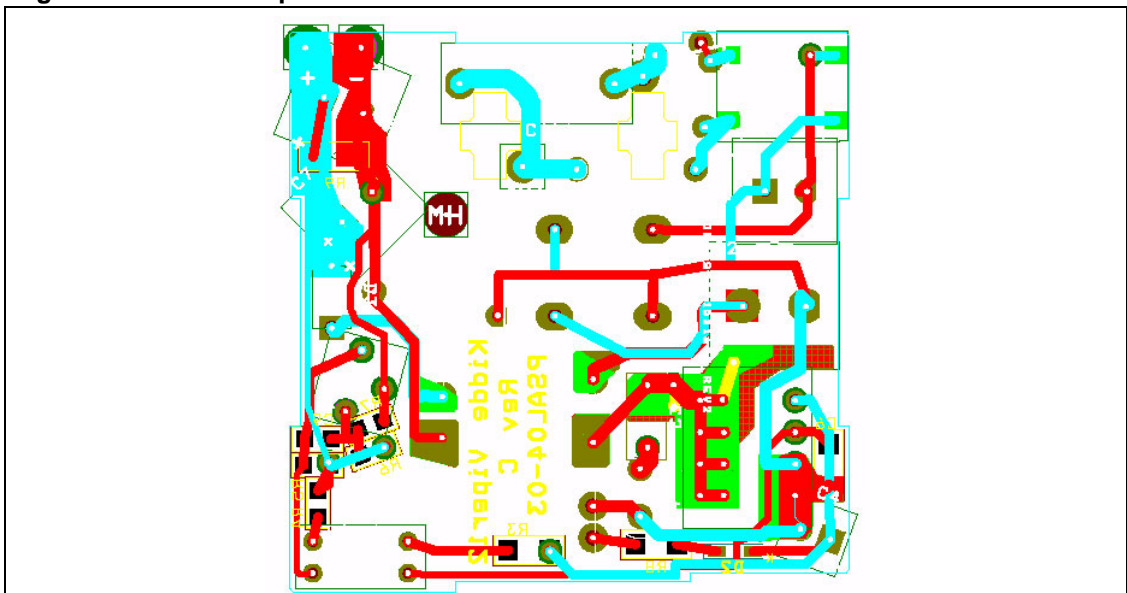
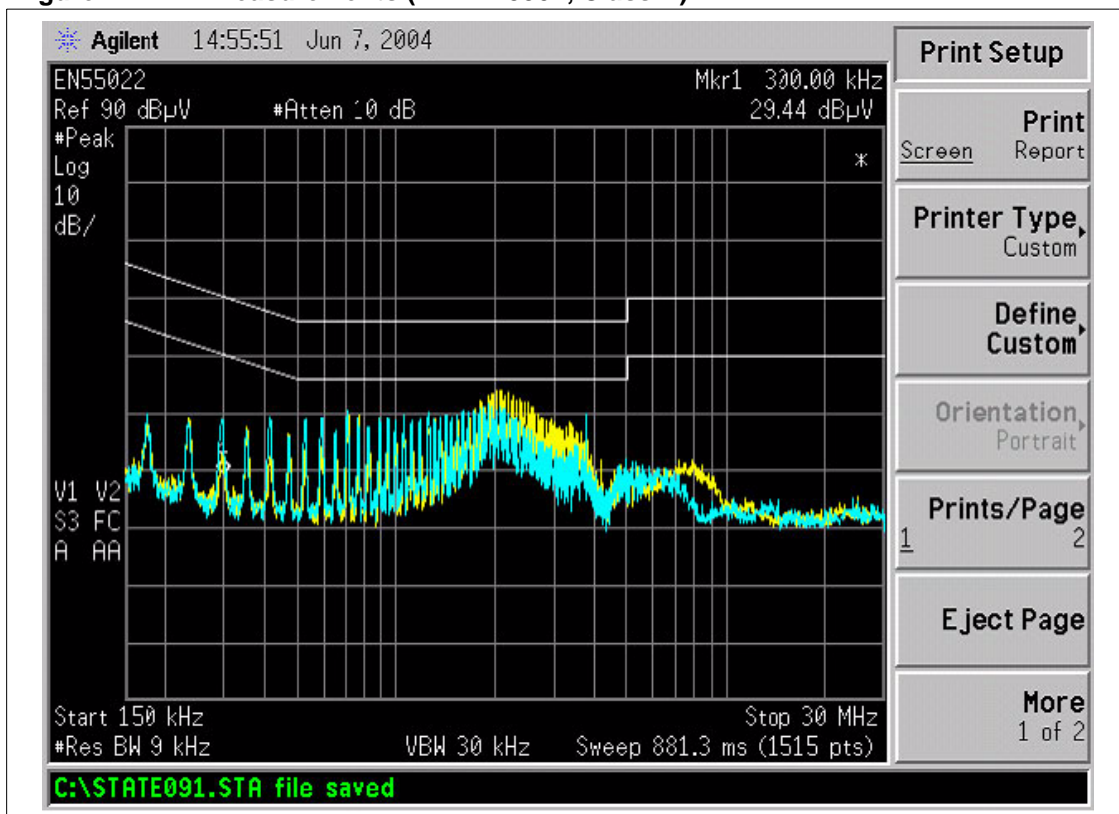


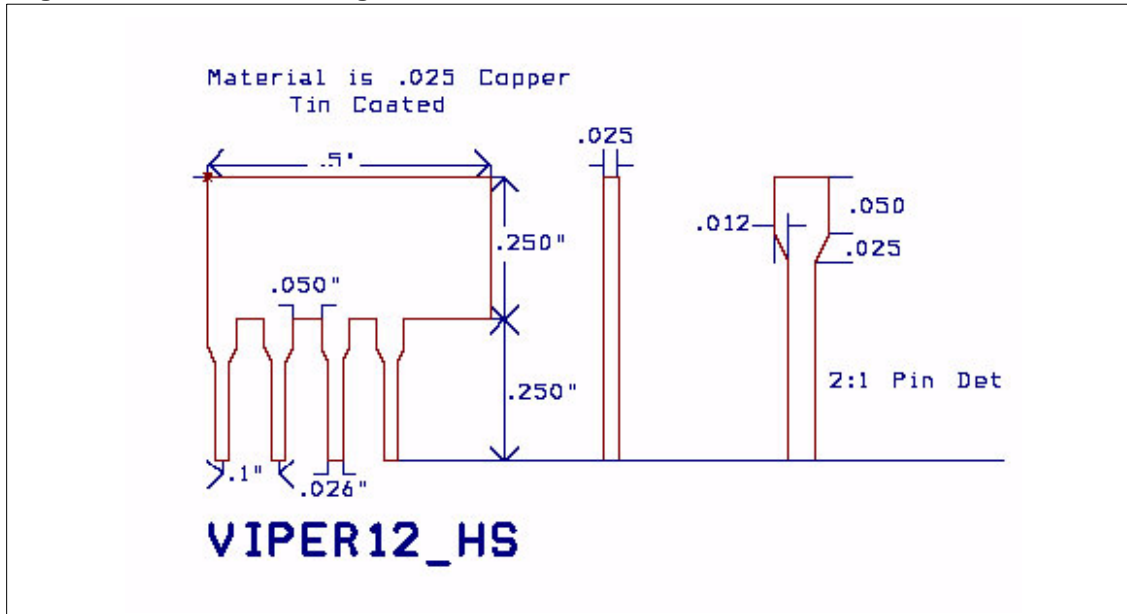
Figure 4. EMI Measurements (EMI EN5502, Class B)



1.3 Heat Sink Enhancement

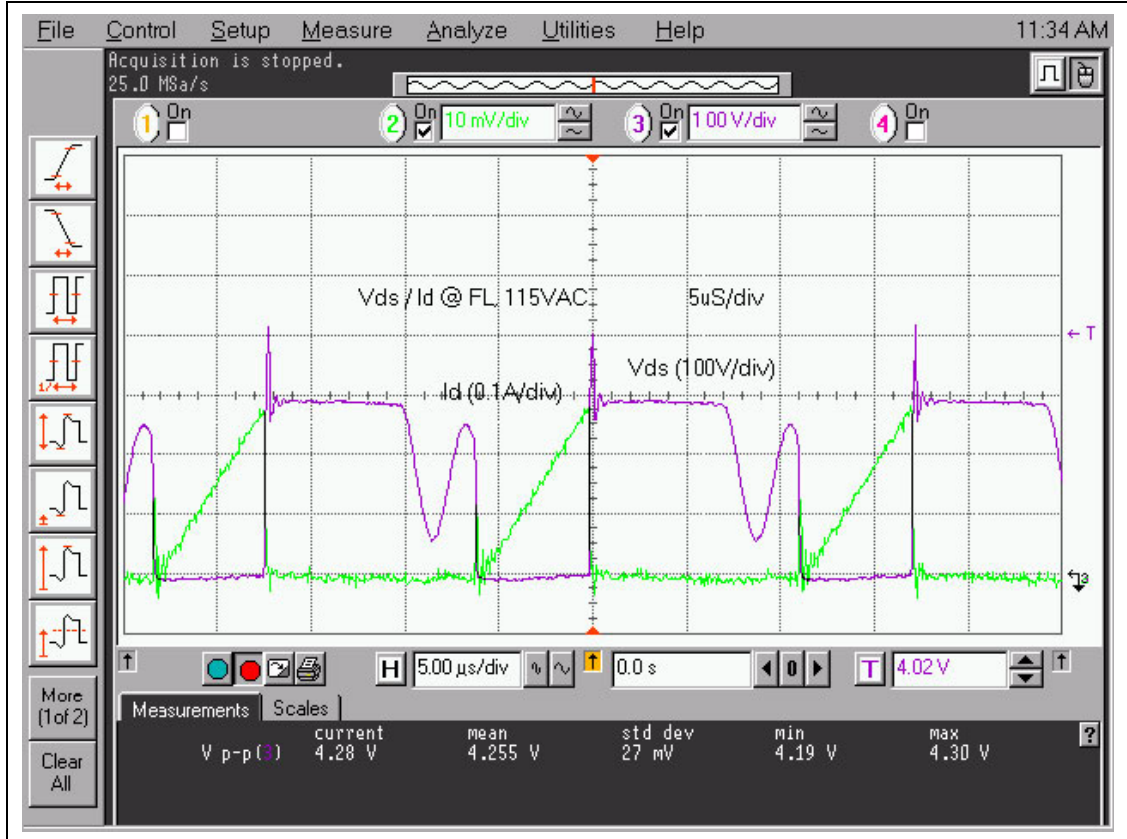
The smaller layout, though useful for PCB space savings, is also prone to heat sink area reduction. To enhance the cooling capacity for the VIPer12, mounting a small heat sink directly in the holes with the 4 DRAIN pins in the VIPer12's DIP package is recommended (see [Figure 5](#)).

Figure 5. Heat Sink Configuration



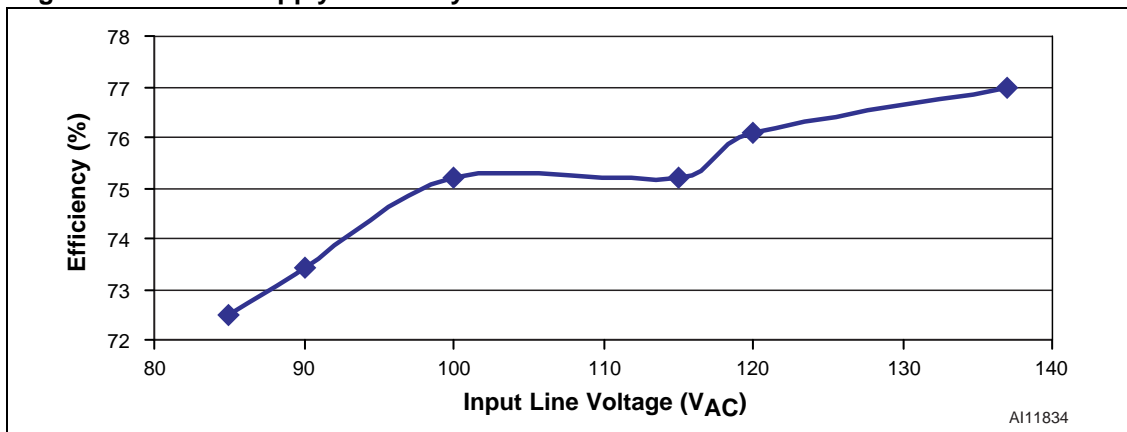
2 Operation Characteristics

Figure 6. Drain to Source Voltage (V_{ds}) and Drain Current (I_d) Waveforms



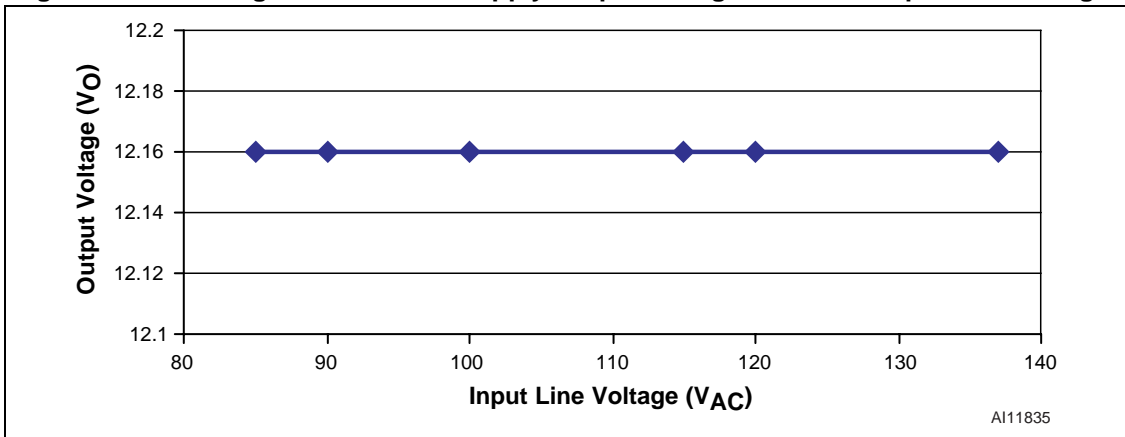
Note: Measured during normal operation with an input line of 115V_{AC} and the output at full load.

Figure 7. Power Supply Efficiency with Line Variation



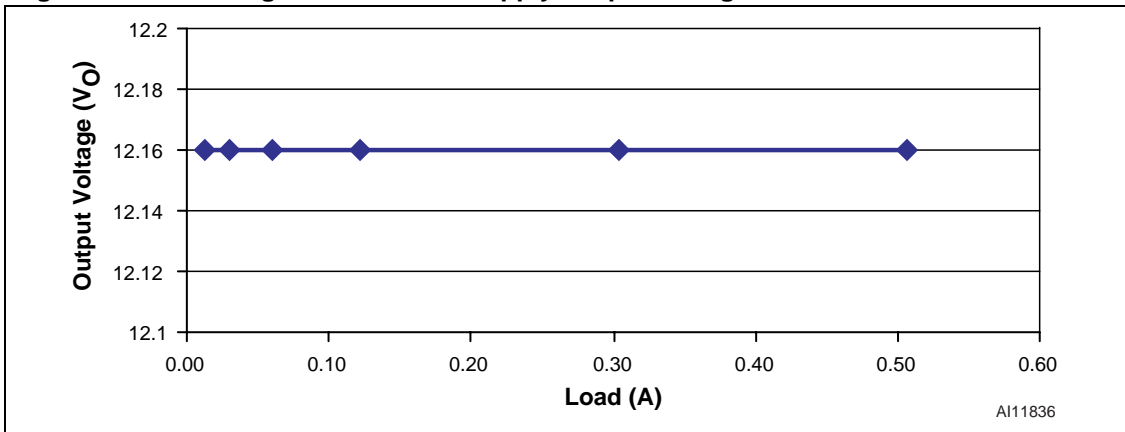
Note: Measured at full load, when the line is varied from 85V_{AC} to 137V_{AC}.

Figure 8. Line Regulation: Power Supply Output Voltage vs. Varied Input Line Voltage



Note: Power supply output voltage is monitored while running at full load, and the line is varied from 85V_{AC} to 134V_{AC}.

Figure 9. Load Regulation: Power Supply Output Voltage vs. Varied Load



Note: Power supply output voltage is monitored while running at 115V_{AC}, and the load is varied from 0.01A to 0.51A.

3 Transformer Electrical Specifications

When the VIPer12A (U4) is ON, energy is stored in the primary winding of transformer (10-8), TR1. This energy is transferred to the auxiliary winding (5-6), and to the output (1-2) when the VIPer12A is OFF. The auxiliary winding provides the bias voltage for the VIPer12A at pin 4 (V_{DD}).

Figure 10. Transformer Winding Schematic

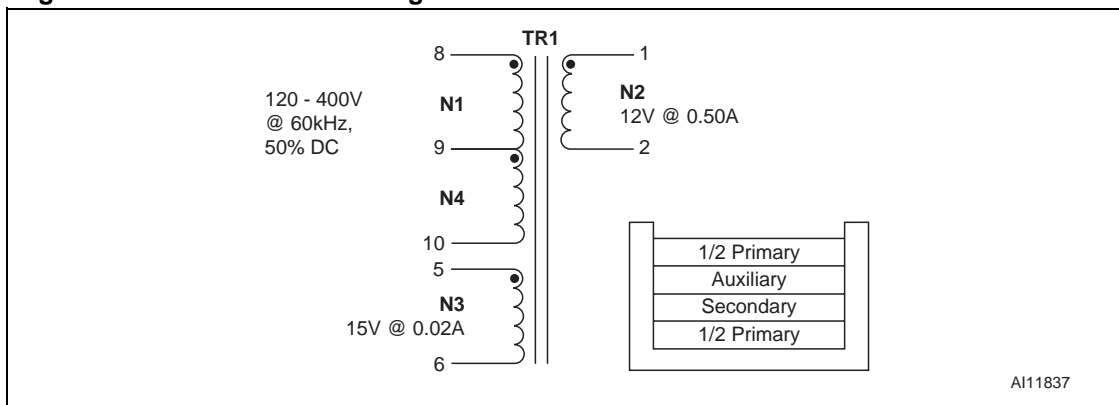
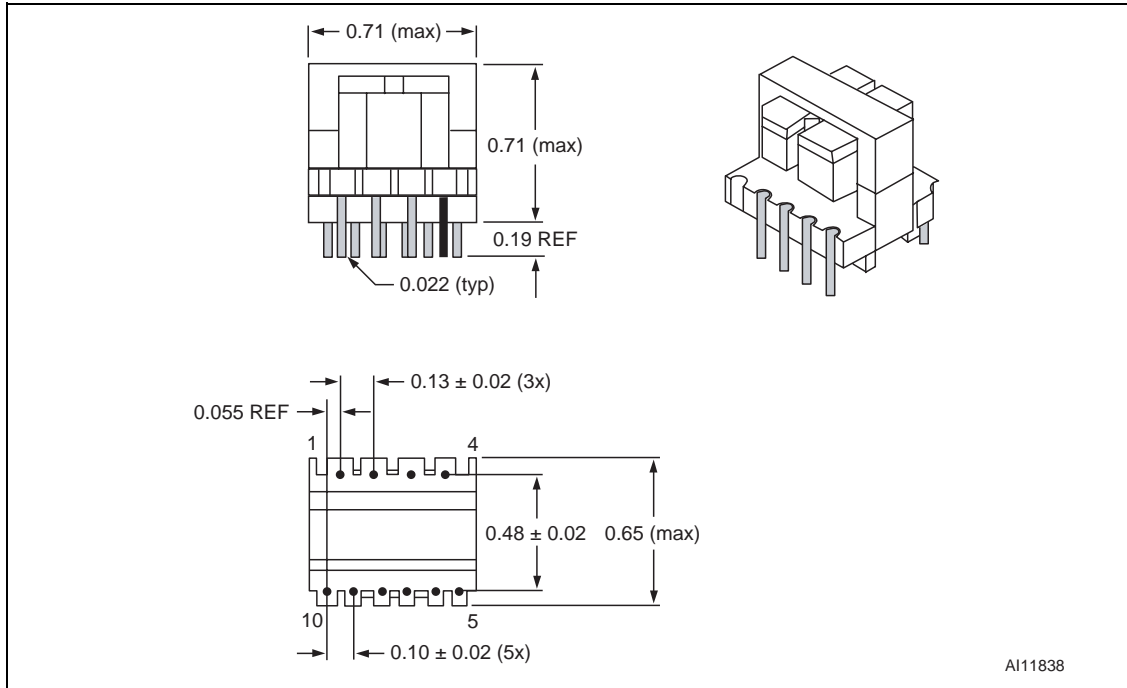


Table 1. Winding Inductance Ratings

Parameter	Value	Units
Primary Inductance (L_p)	3.25 ± 10%	mH
Primary Leakage Inductance (L_{lp})	34 (typ)	μH

4 Transformer Mechanical Information

Figure 11. Transformer Mechanical Drawing



Appendix B. KIDDE VIPer12 Demo Board BOM

Table 2. Domestic Bill of Materials

Qty	Reference	Part Description	Manufacturer	Manufacturer Part Number
1	BR1	SM Bridge 600V 1.5A	Diodes, Inc.	DF1506S-T
1	C1	4.7uF/250V Electro	Panasonic	ECA-2EHG4R7
1	C2	10uF/250V Electro	Panasonic	ECA-2EHG100
1	C3	47pF 1kV Ceramic	Panasonic	ECC-D3A470JGE
1	C4	22uF/25V Electro	Panasonic	ECA-1EM220
1	C5	3.3nF 250V Y1	Panasonic	ECK-ATS332ME
1	C6	47nF SMD 1206		
2	C7, C8	330uF/25V Electro	Panasonic	EEU-FC1E331L
1	C9	0.01uF 0805	Panasonic	ECJ-2VB1H103K
1	C11	0.047uF 250V Box	Panasonic	ECQ-U2A473ML
1	D2	200V .2A	Micro Commercial	BAV20WS-TP
1	D3	200V 1A	STMicroelectronics	STTH102
1	F1	5.1 Ohm Fusable Resistor		
1	L1	Common Mode	Hua Jung Comp.	HJC0308Q
1	R1	JUMPER		
1	R2	2K 5% 1/2W		
1	R3	9.1K 5% 1206		
1	R4	220 5% 805		
1	R5	1K 5% 0805		
1	R6	13.3K 1% SMD 0805	Panasonic	ERJ-6ENF1332V
1	R7	3.40K 1% SMD 0805	Panasonic	ERJ-6ENF3401V
1	R8	4.7 5% 1206		
1	R9	3.3K 5% 1206		
1	TR1	Output transformer	Cramer Coil	CVP11-021
1	U2	H11A817A	Fairchild	H11A817A
1	U3	TL431	STMicroelectronics	TL431AIZ
1	U4	VIPer12A Dip	STMicroelectronic	VIPer12ADIP
1	MOV	220V Varistor		
1	HS	U4 Heat Sink		
2		AC Wires		
1		Output cable assembly		

5 Revision History

Date	Revision	Changes
11-November-2005	1.0	First edition

Information furnished is believed to be accurate and reliable. However, STMicroelectronics assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of STMicroelectronics. Specifications mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. STMicroelectronics products are not authorized for use as critical components in life support devices or systems without express written approval of STMicroelectronics.

The ST logo is a registered trademark of STMicroelectronics.
All other names are the property of their respective owners

© 2005 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan -
Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com

