Design Example Report

Title	***1.5W power supply using LNK500P***
Specification	Input: 85 – 264VAC Output: 5.0V / 300mA
Application	Adapter
Author	Power Integrations Applications Department
Document Number	DER-14
Date	February 4, 2004
Revision	1.0

Summary and Features

- Very low cost to replace linear type solution
- No Y cap
- meets EMI CISPR-22
- Low parts count
- Very low AC leakage current

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Important Notes:
Although this board is designed to satisfy safety isolation requirements, the engineering prototype has not been agency approved. Therefore, all testing should be performed using an isolation transformer to provide the AC input to the prototype board.

Design Reports contain a power supply design specification, schematic, bill of materials, and transformer documentation. Performance data and typical operation characteristics are included. Typically only a single prototype has been built.

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1 Introduction

This is a design example report showing performance of a 5.0 V, 300 mA hand phone adapter. This design uses LinkSwitch – an integrated IC comprising a high voltage MOSFET, PWM controller, to replace linear solutions.

This document contains the power supply specification, schematic, bill of materials, transformer documentation, printed circuit layout, and performance data.

2 Power Supply Specification

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	85		264	V_{AC}	2 wire, no protective earth
Frequency	f_{LINE}	47	50/60	64	Hz	
Output						
Output Voltage	V_{OUT}	4.5	5.0	5.5	V	* see section 7.4 for VI curve
Output Ripple Voltage	V_{RIPPLE}				mV	20 MHz Bandwidth
Output Current	I_{OUT}		0.3		A	
Total Output Power						
Continuous Output Power	P_{OUT}		1.5		W	
Efficiency	η		65		%	Measured at Full Load 25 ^{o}C
Environmental						
Conducted EMI						CISPR 55022 B
Safety						Designed to meet IEC950, UL1950 Class II
Ambient Temperature	T_{AMB}	0		40	^{o}C	Free convection, Sea level

Table 1 - Power Supply Specification

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3 Schematic

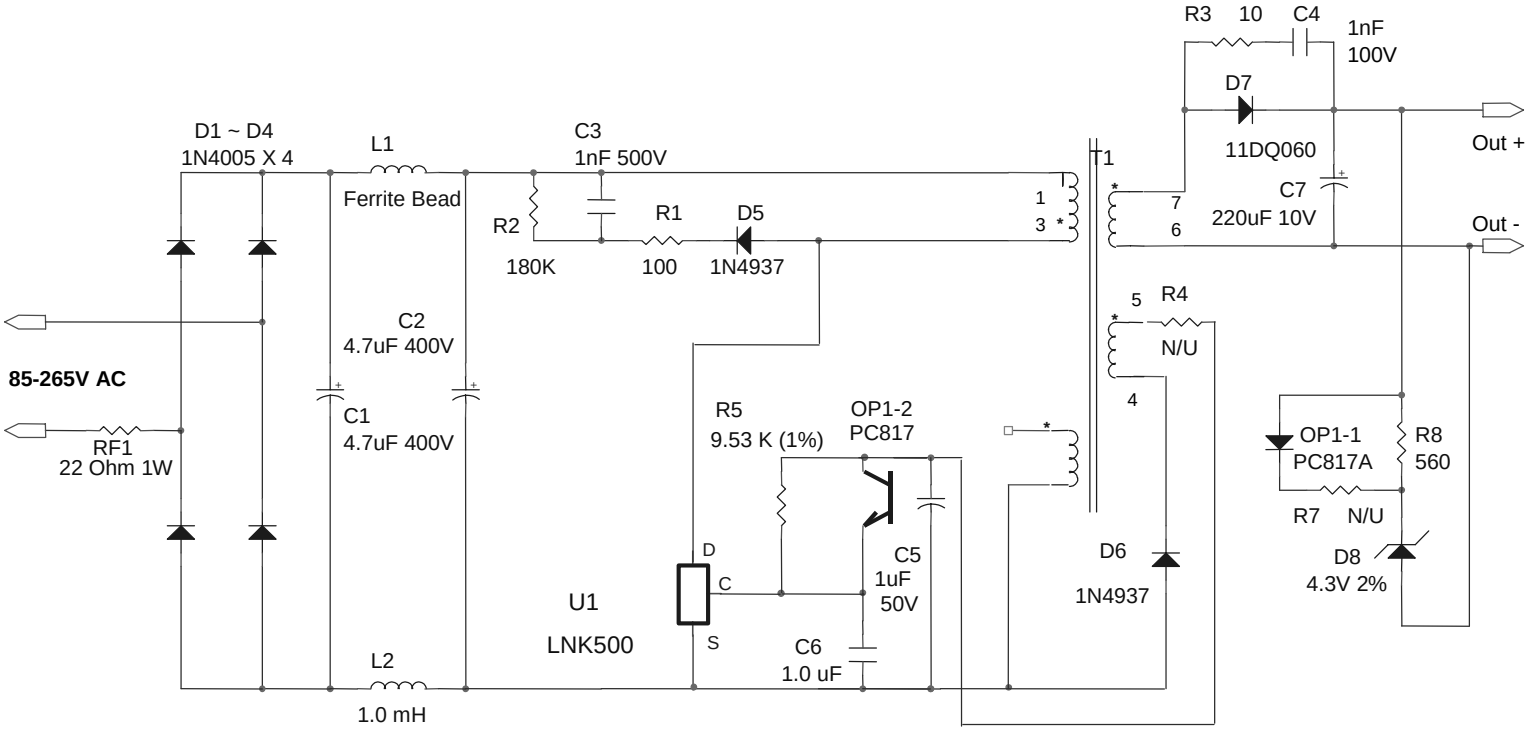

Figure 1 – Schematic

4 PCB Layout

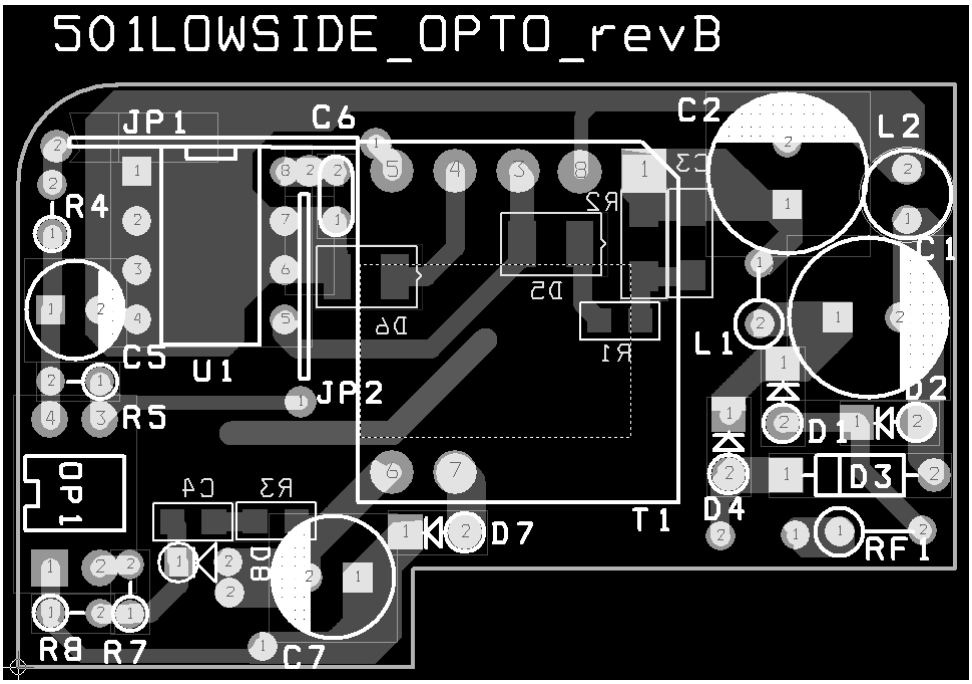

Figure 2 – Printed Circuit Layout

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5 Bill Of Materials

Item	Quantity	Reference	Parts
1	2	C1, C2	4.7uF 400V, electrolytic capacitor
2	1	C3	1.0nF, 500V, ceramic
3	1	C4	1.0nF, 100V
4	1	C5	1.0uF, 50V, electrolytic capacitor
5	1	C6	1.0uF 50V, ceramic
6	1	C7	220uF, 10V, low ESR electrolytic capacitor
7	4	D1, D2, D3, D4	1N4005, 1A 600V
8	2	D5, D6	1N4937, 1A 600V fast recovery
9	1	D7	11DQ06, 1.1A, 60V schottky diode
10	1	D8	4.3V, 2% BZX79B4V3, Zener diode
11	1	L1	Ferrite Bead
12	1	L2	1.0 mH
13	1	RF1	22 Ω, 1.0 W fusible resistor
14	1	R1	100, 1/8W
15	1	R2	180 KΩ, 1/4W
16	1	R3	10 Ω, 1/8W
17	1	R4	N/U
18	1	R5	9.53 K, 1/8W, 1%
19	1	R7	N/U
20	1	R8	560Ω, 1/8W
20	1	T1	Transformer
21	1	U1	LNK 500P
22	1	OP1	Opto-coupler PC817D

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6 Transformer

6.1 Transformer Diagram

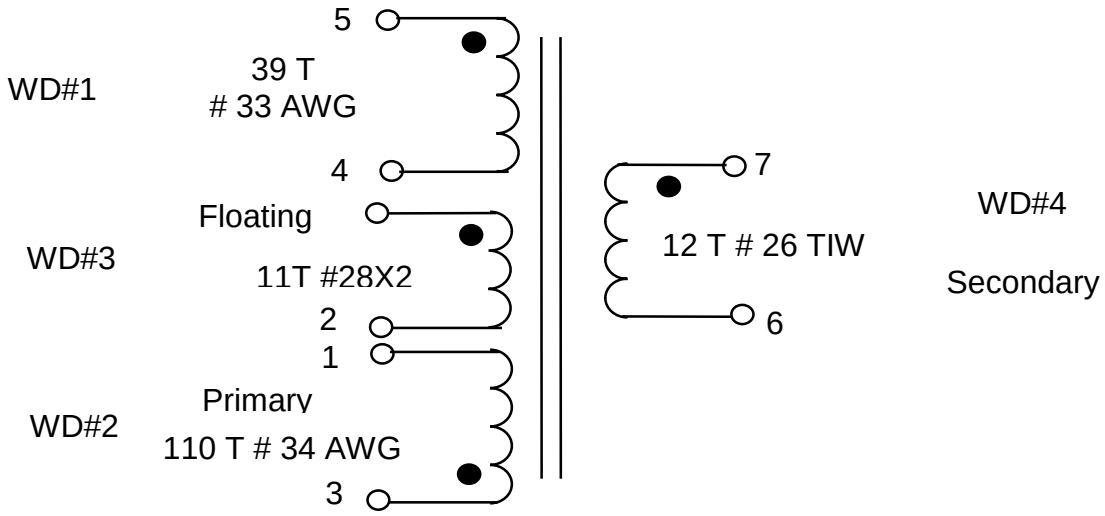

Figure 3 – Transformer Schematic.

6.2 Electrical Specifications

Electrical Strength	60Hz 1minute, from Pins 1-4 to Pins 6-7	3000 V ac
Primary Inductance (Pin 1 to Pin 3)	All windings open	2.73 mH +/- 5% at 42KHz
Resonant Frequency	All windings open	300 kHz (Min.)
Primary Leakage Inductance	Pins 6-7 shorted	60 uH Max.

6.3 Materials

Item	Description
[1]	Core: EE16, TDK Gapped for AL of 225.6 nH/T^2
[2]	Bobbin: Horizontal 10 pin.
[3]	Magnet Wire: #33 AWG
[4]	Magnet Wire: #34 AWG
[5]	Magnet Wire: #28 AWG
[6]	Triple Insulated Wire: #26 AWG.
[7]	Tape: 3M 1298 Polyester Film, 2.0 mils thick, 8.4 mm wide
[8]	Tinned bus wire 33 AWG
[9]	Varnish

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6.4 Transformer Construction

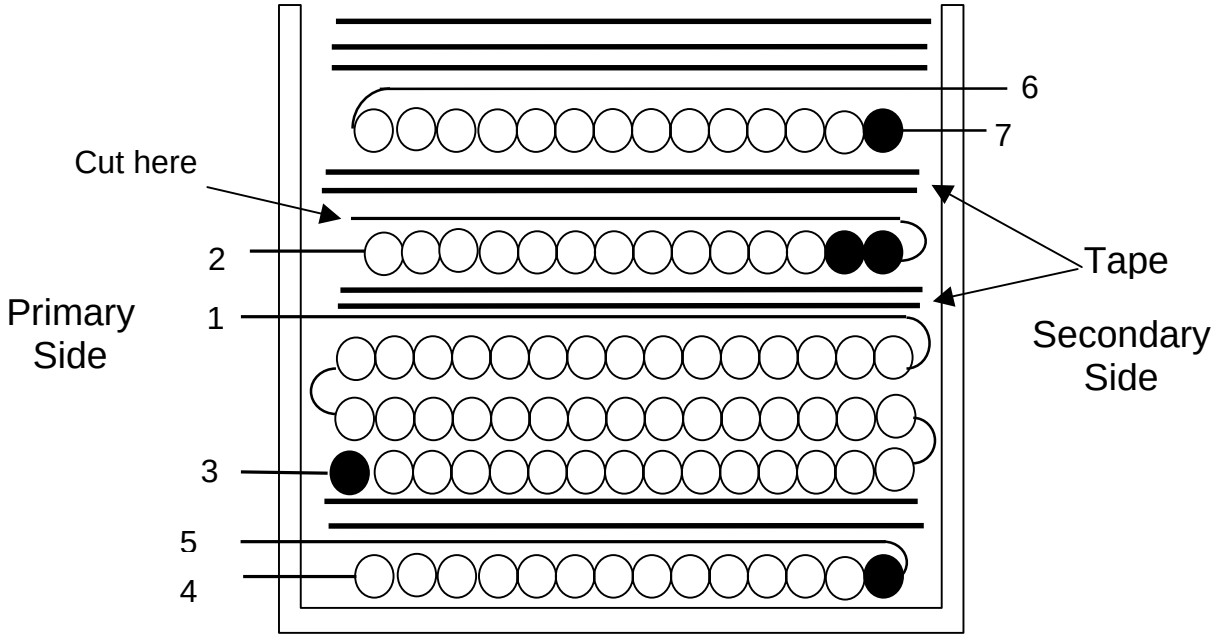

Figure 4 – Transformer Winding Diagram

6.5 Winding Instructions

WD1 Bias winding	Primary pin side of the bobbin oriented to left hand side. Start at Pin 8 temporarily. Wind 39 turns of item [3] from right to left. Wind with tight tension across entire bobbin evenly. Finish on Pin 4.
WD1	Change the start pin from pin 8 to pin 5.
Insulation	2 Layers of tape [7] for insulation.
WD#2 Primary winding	Start at pin 3 wind 110 turns of item [4] in three layers. Wind with tight tension across entire bobbin evenly Finish at pin 1
Insulation	2 Layers of tape [7] for insulation.
WD #3 Shield Winding	Start at Pin 8 temporarily, wind 11 bifilar turns of item [5], with from right to left with tight tension. Wind uniformly, in a single layer across entire width of bobbin. Finish on Pin 2.
WD #3	Flip the start end to left hand side, cut the lead of the starting end.
Insulation	2 Layers of tape [6] for insulation.
WD #4 Secondary Winding	Start at pin 7, wind 12 turns of item [6] from right to left. Wind uniformly, in a single layer across entire bobbin evenly. Finish on pin 6.
Outer Insulation	3 Layers of tape [6] for insulation.
Core Assembly	Assemble and secure core halves.
Core Grounding	Start at Pin 2, wind 2 turns of [8], close primary side. Finish at pin2. Wind it tight making the wire tough the core
Varnish	Varnish

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7 Performance Data

All measurements performed at room temperature, 60 Hz input frequency unless otherwise specified. The electronic load was used to measure efficiency. All output voltages are measured at the end of the power supply output cable. The resistance of the output cable is approximately 0.2 Ω.

7.1 Efficiency

Efficiency was measured at 300 mA with E-load.

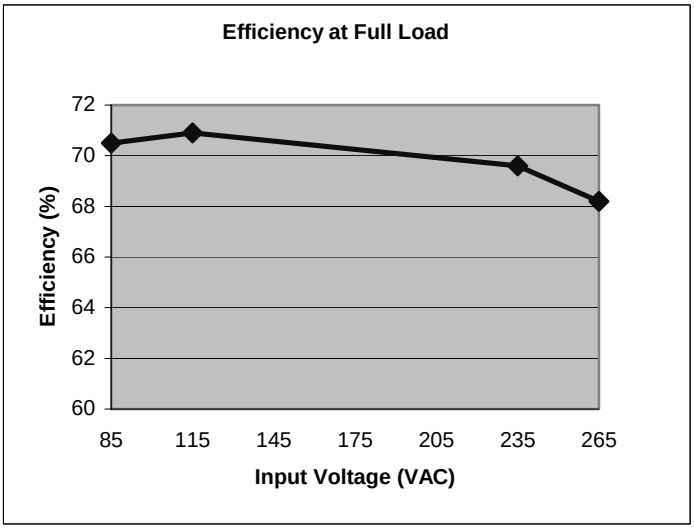

Figure 5 - Efficiency vs. input voltage at 300 mA load.

7.2 No-load Input Power

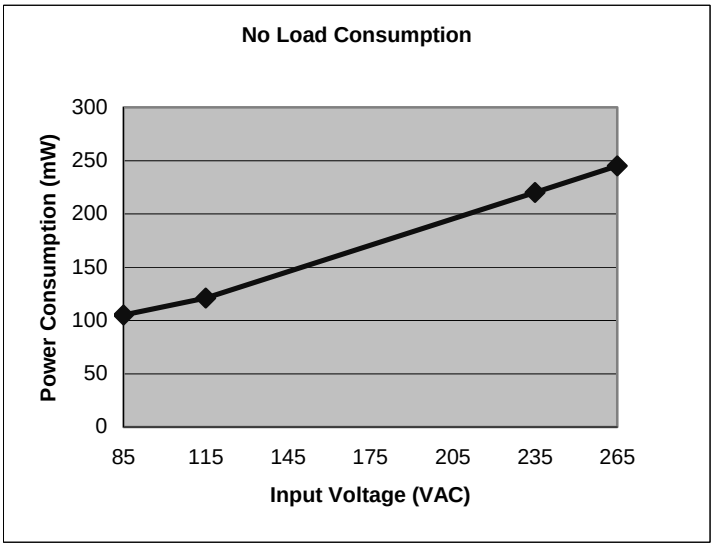

Figure 6 - Zero load input power vs. input line voltage.

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7.3 Load Regulation

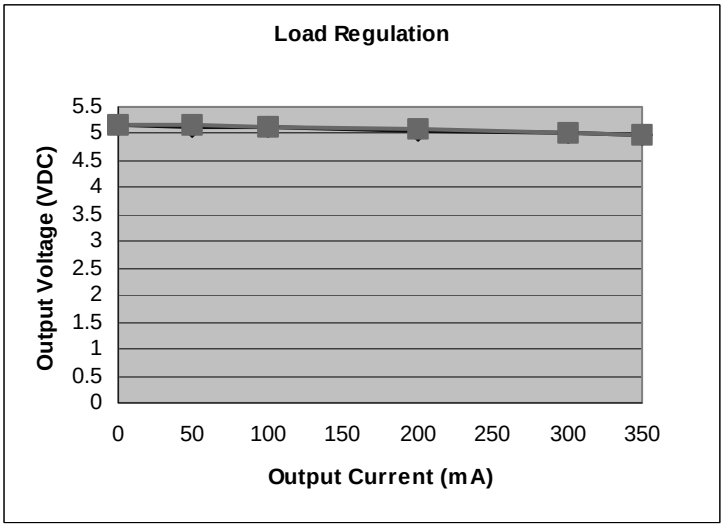

Figure 7 Load regulation

7.4 Line Regulation

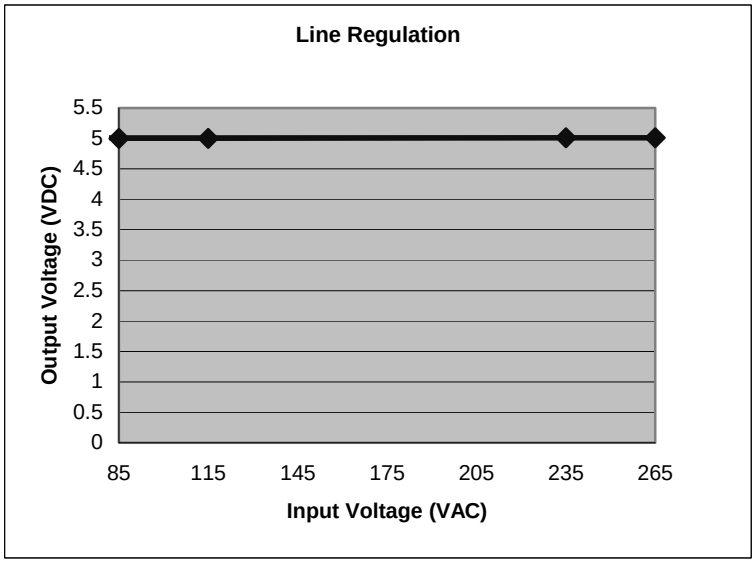

Figure 8 Line regulation

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7.5 Output Ripple & Noise

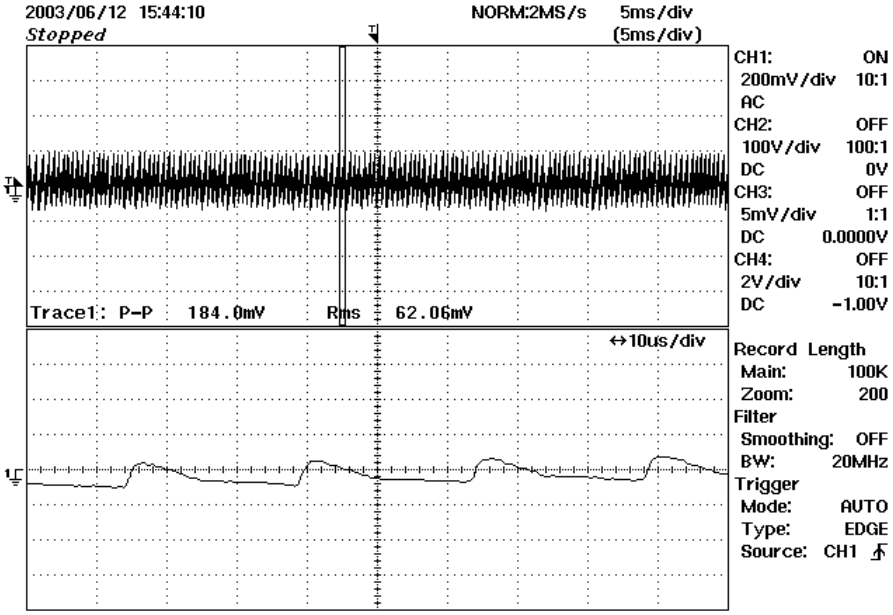

Figure 9 Output Ripple & Noise at 300 mA E-Load, 115 VAC input

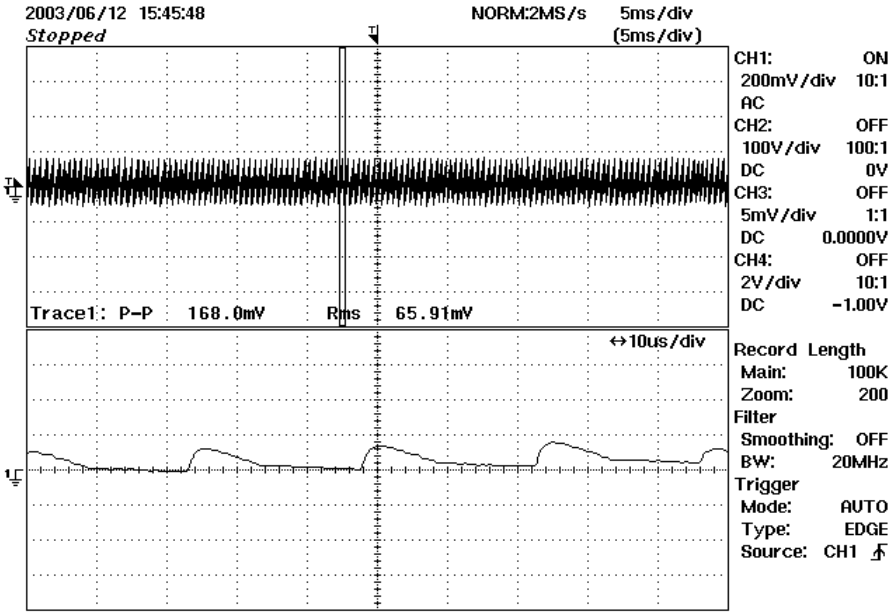

Figure 10 Output Ripple & Noise at 300 mA E-load, 230VAC input

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8 Conducted EMI

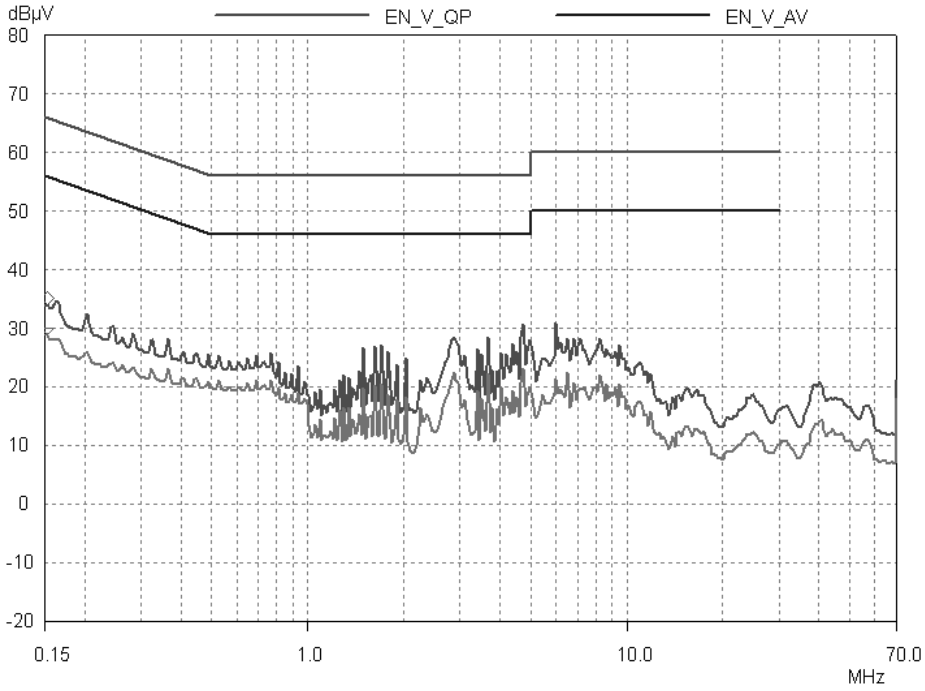

Figure 11 EMI at 230 VAC, 300mA Resistive Load, Line, No Artificial Hand

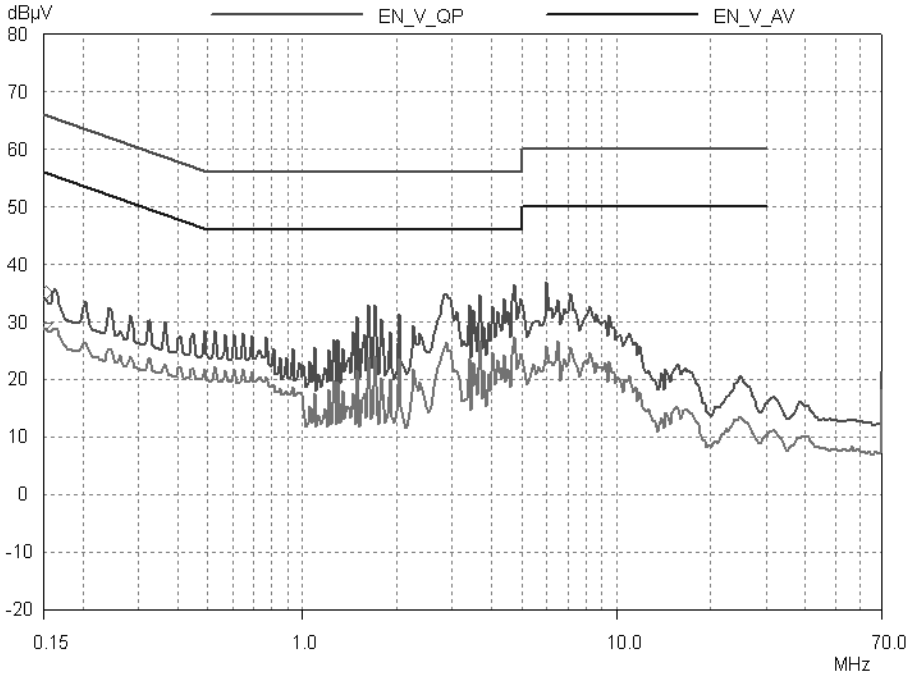

Figure 12 EMI at 230 VAC, 300mA Resistive Load, Line, With Artificial Hand

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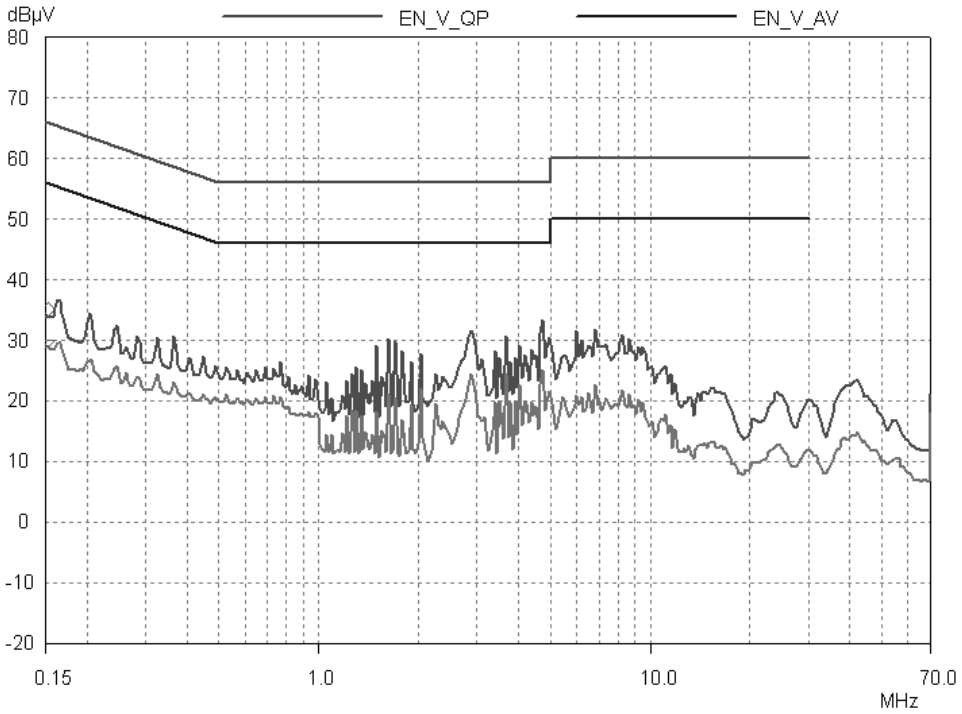

Figure 13 EMI at 230 VAC, 300mA Resistive Load, Neutral, No Artificial Hand

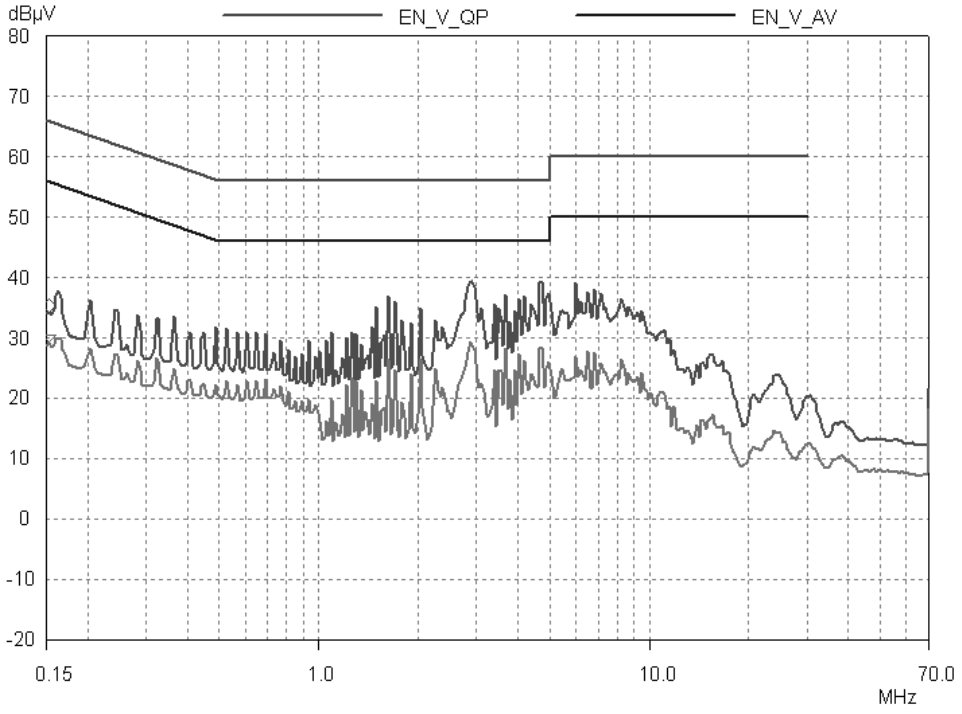

Figure 14 EMI at 230 VAC, 300mA Resistive Load, Neutral, With Artificial Hand

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9 Revision History

Date	Author	Revision	Description & changes	Reviewed
February 4, 2004	YG	1.0	First Release	AM/VC

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