



## Design Example Report

<b>Title</b>	<i>0.7W Power Supply using LNK353P</i>
<b>Specification</b>	Input: 195 – 265 VAC Output: 7V / 0.1A
<b>Application</b>	TV Back Channel Power Supply
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### Summary and Features

- Low cost, low part count solution (only 18 components)
- <150 mW no-load input power
- Meets EN550022 and CISPR-22 Class B EMI with no Y1 safety capacitor
- Optimized switching speed yields excellent radiated EMI performance
- Small EE13 core size

The products and applications illustrated herein (including circuits external to the products and transformer construction) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations' patents may be found at [www.powerint.com](http://www.powerint.com).

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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 isolated source to provide power 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.



## 1 Introduction

This document is an engineering report describing a single input, 0.7W output power supply utilizing a **LinkSwitch-HF** LNK353P device.

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



Figure 1 – Populated Circuit Board Photograph

## 2 Power Supply Specification

Description	Symbol	Min	Typ	Max	Units	Comment
<b>Input</b> Voltage Frequency No-load Input Power (230 VAC)	$V_{IN}$ $f_{LINE}$	195 47		265 64	VAC Hz W	2 Wire – no P.E.
<b>Output</b> Output Voltage Output Ripple Voltage Output Current	$V_{OUT1}$ $V_{RIPPLE1}$ $I_{OUT1}$		7 50 0.1		V mV A	$\pm 10\%$ 20 MHz bandwidth
<b>Total Output Power</b> Continuous Output Power	$P_{OUT}$		0.7		W	
<b>Efficiency</b>	$\eta$		60		%	Measured at $P_{OUT}$ (0.7 W), 25 °C
<b>Environmental</b> Conducted EMI Safety						Meets CISPR22B / EN55022B Designed to meet IEC950, UL1950 Class II  >5 dB margin
External Ambient Temperature	$T_{AMB}$	0		50	°C	Free convection, sea level



### 3 Schematic

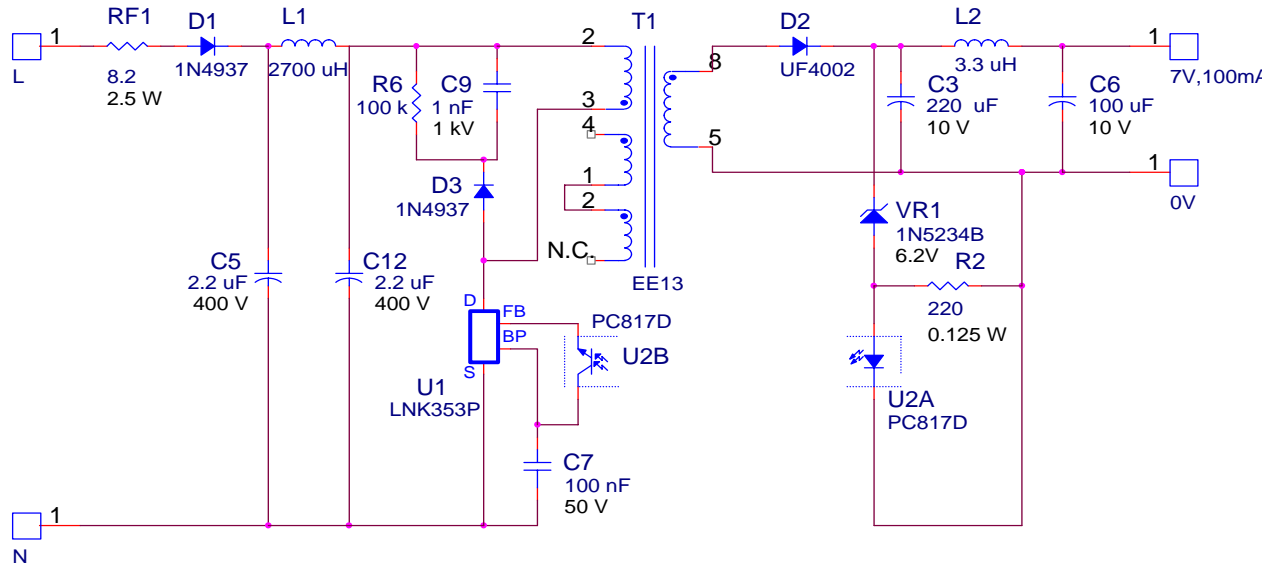


Figure 2 – Schematic

### 4 Circuit Description

A simple, low cost, 0.7 W power supply is achieved with minimum parts count - made possible by the *LinkSwitch* power device. The integrated 700 V switching MOSFET and On/Off control function achieve high efficiency operation without a bias winding.

The EE13 transformer uses a bobbin with extended creepage to meet safety spacing requirements. The transformer operating flux density is low (1250 Gauss, 125 mT) to reduce audio emissions, due to On/Off control, to acceptable levels. This combined with standard dip varnishing of the transformer virtually eliminates audible noise.

#### 4.1 Input and EMI Filtering

AC input differential filtering is accomplished with a filter formed by C5/C12 and L1. The inductor L1 is sleeved to also allow it to function as a fuse.

An additional diode may be added to the Neutral phase in applications where lower EMI margins and/or an increased input surge withstand is required.

#### 4.2 Output Rectification and Filtering

Output rectification and filtering is achieved with output rectifier D2 and filter capacitor C3.



## 5 PCB Layout

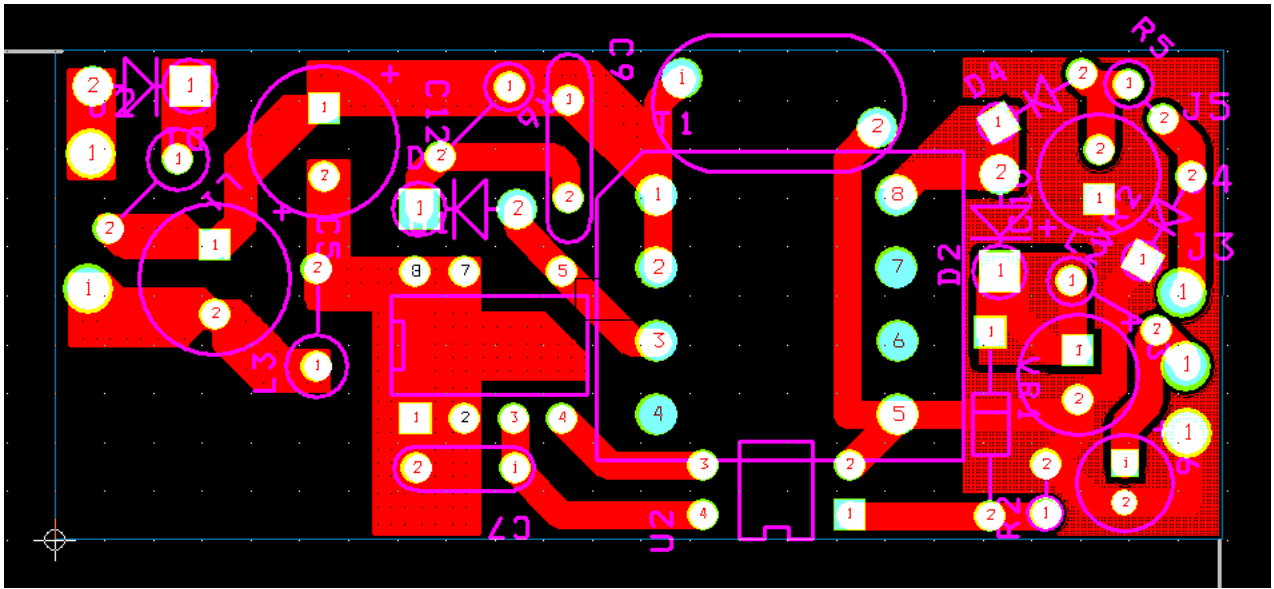


Figure 3 – Printed Circuit Layout. (Not all parts are fitted due to Spec. change.)

## 6 Bill Of Materials

Item	Qty	Value	Description	Part Reference	Mfg	Mfg Part Number
1	1	220 uF	220 uF, 10 V, Electrolytic, Low ESR, (6.3 x 11)	C3	Rubycon	10YXG220M6.3X11
2	2	2.2 uF	2.2 uF, 400 V, Electrolytic, (8 x 11.5)	C5 C12	United Chemi-Con	SMG400VB2R2M8X11LL
3	1	100 uF	100 uF, 10 V, Electrolytic, Gen. Purpose, (5 x 11)	C6	United Chemi-Con	KME10VB101M5X11LL
4	1	100 nF	100 nF, 50 V, Ceramic, X7R	C7	Panasonic	ECU-S1H104KBB
5	1	1 nF	1 nF, 1 kV, Disc Ceramic	C9	Panasonic	ECK-D3A102KBP
6	2	1N4937	600 V, 1 A, Fast Recovery Diode, 200 ns, DO-41	D1 D3	Vishay	1N4937
7	1	UF4002	100 V, 1 A, Ultrafast Recovery, 50 ns, DO-41	D2	Vishay	UF4002
8	1	2700 uH	2700 uH, 80 mA, 40 Ohm, Axial Ferrite Inductor	L1	Epcos	B78148-S1275-J
9	1	3.3 uH	3.3 uH, 0.285 A, Iron Core	L2	API Delevan	1025-32K
10	1	8.2	8.2 Ohm Fusible Resistor, 2.5W	RF1		
11	1	220	220 R, 5%, 1/8 W, Carbon Film	R2	Yageo	CFR-12JB-220R
12	1	100 k	100 k, 5%, 1/4 W, Carbon Film	R6	Yageo	CFR-25JB-100K
13	1	EE13	Bobbin, EE13, Horizontal, 8 pins	T1	Hical Magnetics	
14	1	LNK353P	LinkSwitch-HF, LNK353P, DIP-8B	U1	Power Integrations	LNK353P
15	1	PC817D	Opto coupler, 35 V, CTR 300-600%, 4-DIP	U2	Isocom, Sharp	ISP817D, PC817X4
16	1	1N5234B	6.2 V, 5%, 500 mW, DO-35	VR1	Microsemi	1N5234B



## 7 Transformer Specification

### 7.1 Electrical Diagram

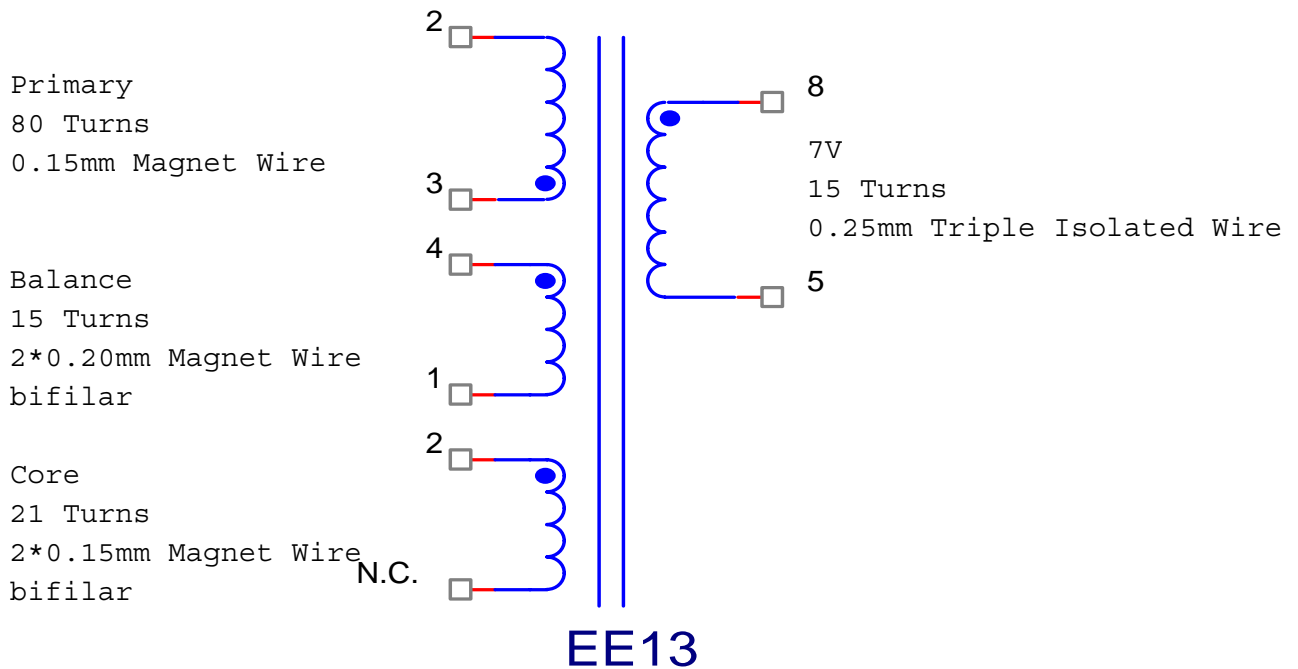


Figure 4 – Transformer Electrical Diagram

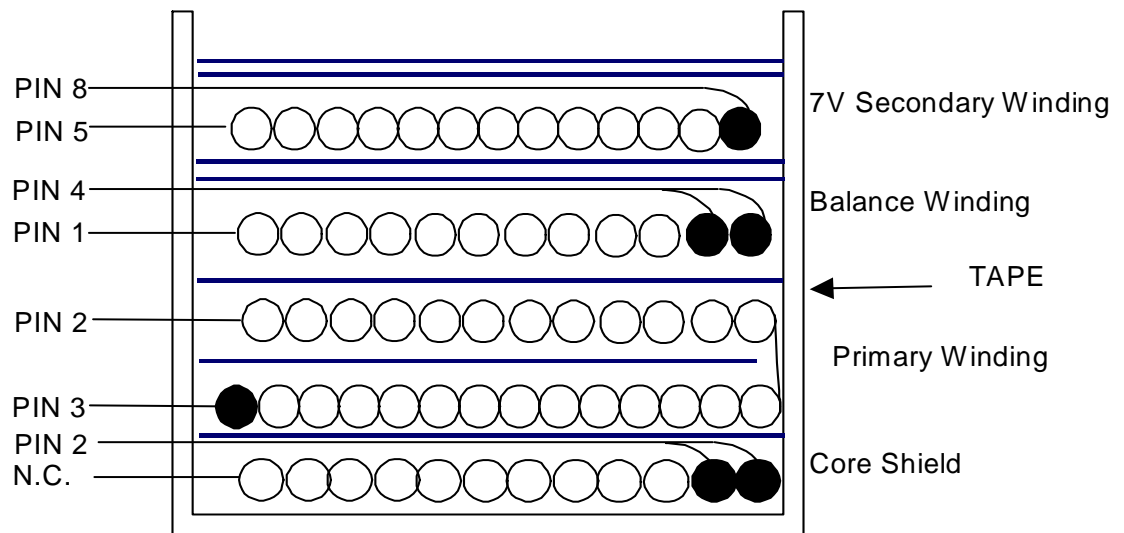
### 7.2 Electrical Specifications

<b>Electrical Strength</b>	60 Hz 1 min, from Pins 2-3 to Pins 5-8	3000 VAC
<b>Primary Inductance</b>	From pins 3-2, all other windings open	650 $\mu$ H, $\pm$ 12%
<b>Primary Leakage Inductance</b>	From pins 3-2 with and 5-8 shorted	30 $\mu$ H (Max.)

### 7.3 Materials

Item	Description
[1]	Core: EE13, PC40EE13, TDK – ALG 102 nH/T <sup>2</sup>
[2]	Bobbin: Horizontal 8 pin
[3]	Magnet Wire: 0.15mm
[4]	Magnet Wire: 0.2mm
[5]	Triple Insulated Wire: 0.25mm
[6]	Tape: 3M 1298 Polyester Film (white) 7.9mm wide by 2.2 mils thick
[7]	Varnish (dip)

**7.4 Transformer Build Diagram**



**Figure 5 – Transformer Build Diagram**





## 8 Performance Data

All measurements performed at room temperature, 50 Hz input frequency.

### 8.1 Load and Line Regulation

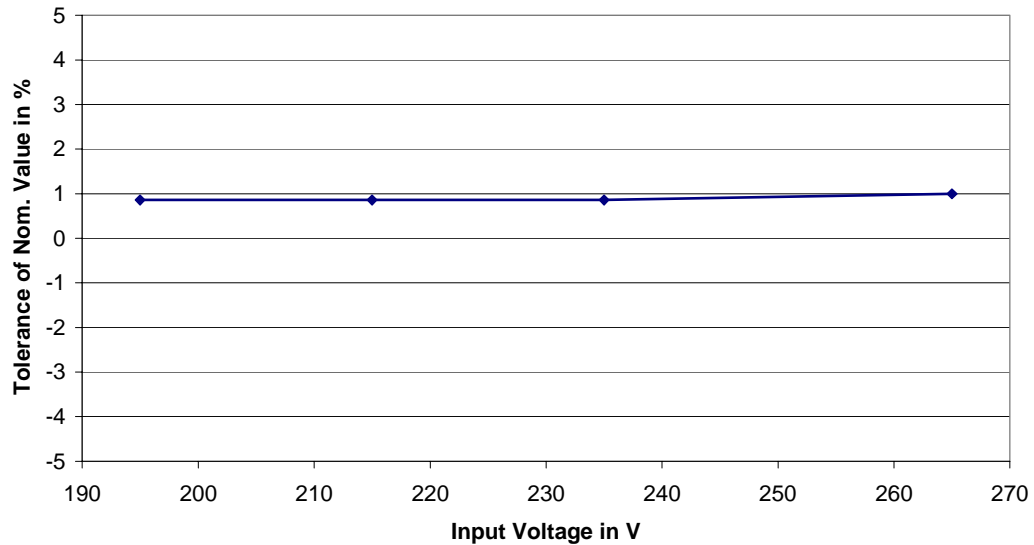


Figure 6 – Line Regulation, Room Temperature

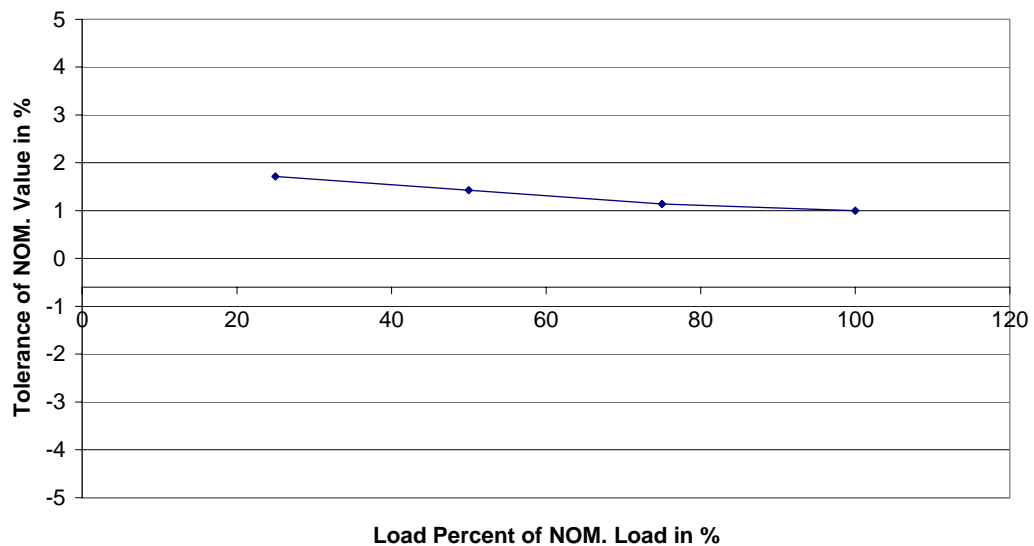


Figure 7 – Load Regulation, Room Temperature



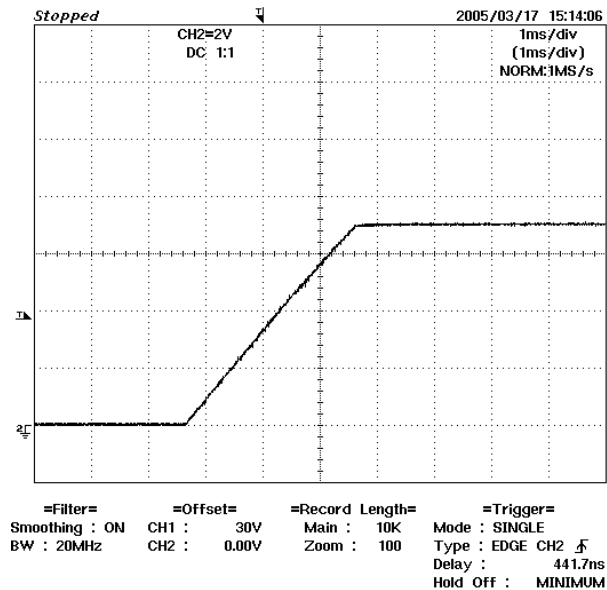
## 9 Thermal Performance

(Measured with Testo Infrared Thermometer)

Temperature (°C)		
Item	195 VAC	265 VAC
Ambient	25	25
Transformer (T1)	33.5	32.5
LinkSwitch (U1)	32	39
Resistor (R6)	31	34.5
Rectifier (D2)	35	37

## 10 Waveforms

### 10.1 Output Voltage Start-up Profile



**Figure 8** – Start-up Profile, 230 VAC  
 $V_{OUT}$ , 2 V & 1 ms / div.



## 10.2 Output Ripple Measurements

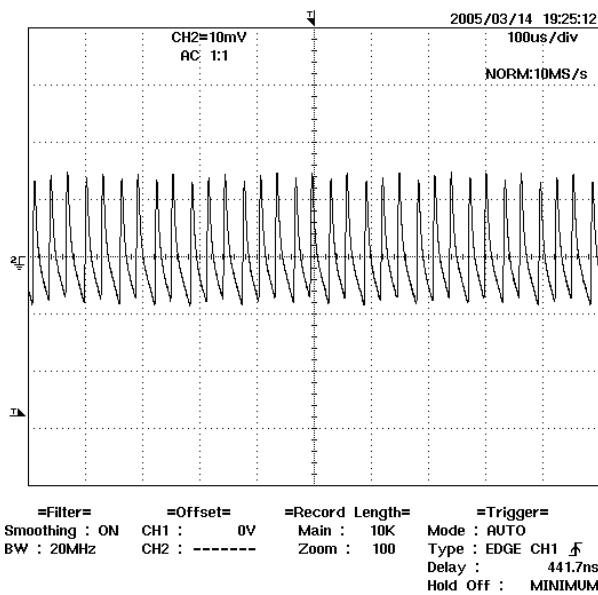
### 10.2.1 Ripple Measurement Technique

A ripple probe, which included 1.0  $\mu\text{F}$  Aluminum electrolytic capacitor in parallel with 0.1 $\mu\text{F}$  ceramic capacitor, was used for all ripple measurements. The probe was located at the end of the DC output cable assembly.

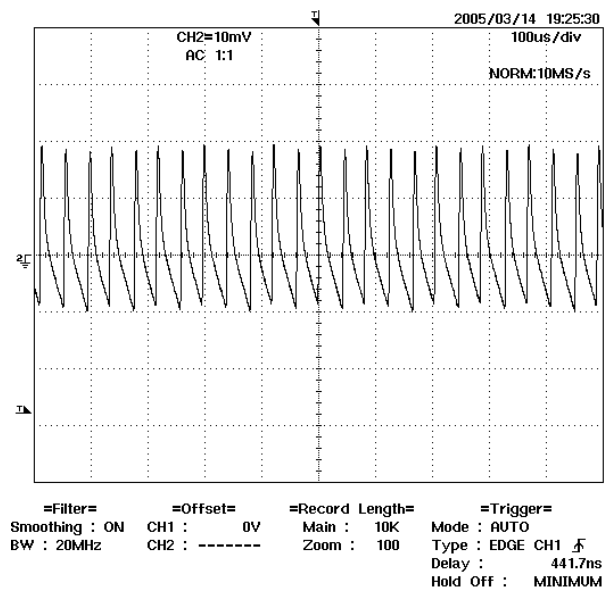


**Figure 9** – Oscilloscope Probe with Probe Master 5125BA BNC Adapter. (Modified with wires for probe ground for ripple measurement, and two parallel decoupling capacitors added.)

### 10.2.2 Measurement Results



**Figure 10** – Ripple, 195 VAC, Full Load.  
100us, 10 mV / div



**Figure 11** – Ripple, 265 VAC, Full Load.  
100us, 10 mV / div



## 11 Conducted EMI

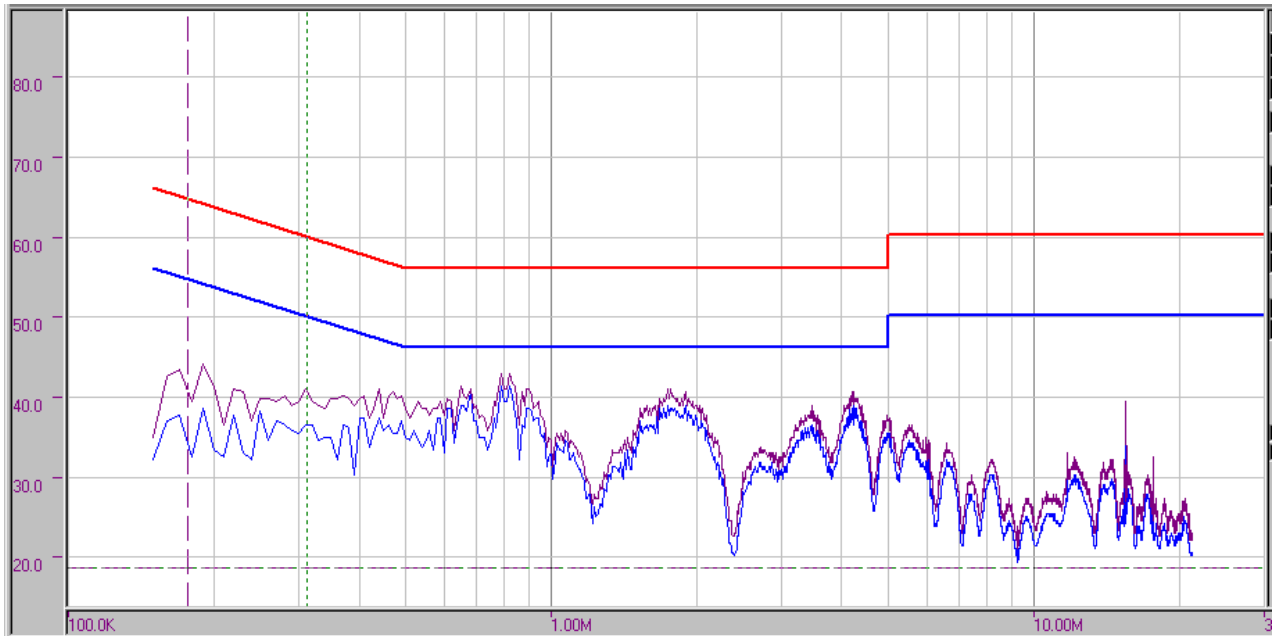


Figure 12 – Conducted Emissions without Artificial Hand QP/AVG: 230 VAC, Full load, Neutral

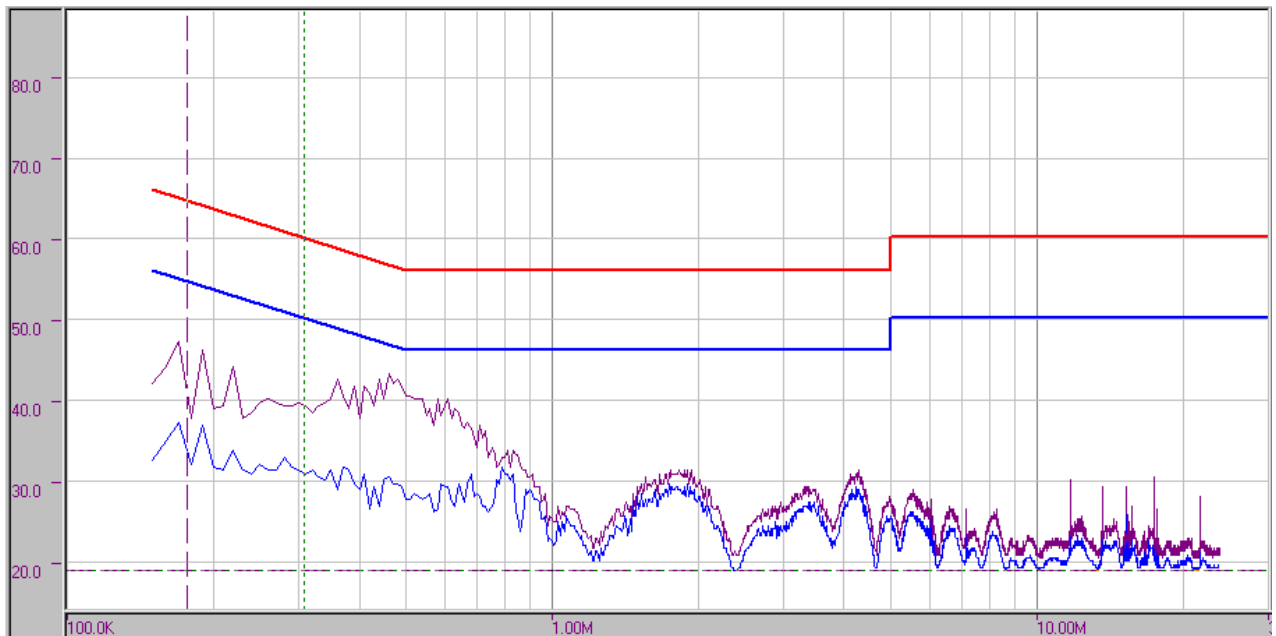


Figure 13 – Conducted Emissions without Artificial Hand QP/AVG: 230 VAC, Full load, Line



**Revision History**

<b>Date</b>	<b>Author</b>	<b>Revision</b>	<b>Description &amp; changes</b>	<b>Reviewed</b>
10-26-05	HM	1.0	Initial Release	KM/JC/VC



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