Design Example Report

Title	***16W Power Supply using TOP243P***
Specification	Input: 195Vac - 265Vac Output: 1.8V/600mA, 3.3V/750mA, 5V/520mA, 12V/0.8A
Application	Set Top Box
Author	Power Integrations Applications Department
Date	April 20, 2005
Document Number	DER-51
Revision	1.0

Summary and Features

- Low cost flyback platform power supply
- Direct generation of 1V8, 3V3, 5V and 12V rails from transformer requires no linear post regulation.
- >60ms hold up time

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Important Note:
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 document is a prototype engineering report describing a 16W power supply utilizing a TOP243P.

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

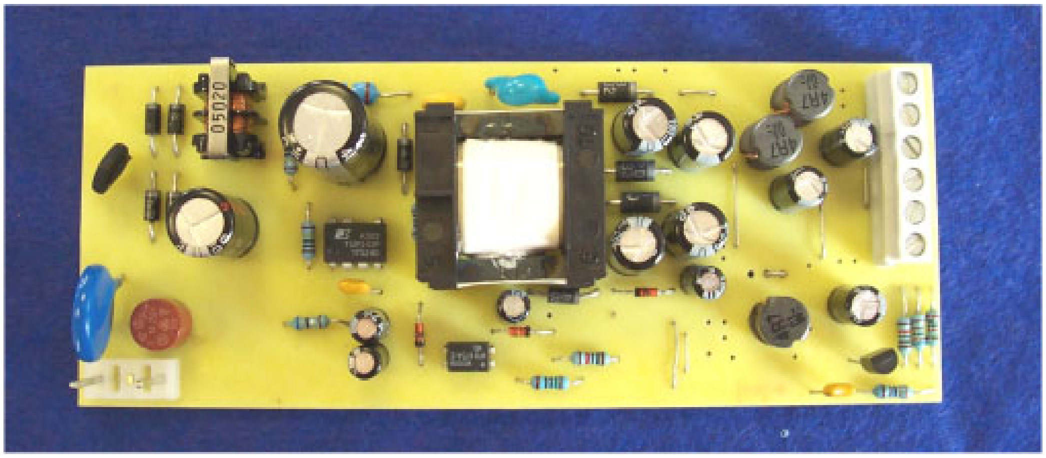

Figure 1 – Populated Circuit Board Photograph

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2 Power Supply Specification

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	85		265	VAC	2 Wire – no P.E.
Frequency	f_{LINE}	47	50/60	64	Hz	
No-load Input Power (230 VAC)				0.3	W	
Output						
Output Voltage 1	V_{OUT1}		1.8		V	± 5%
Output Ripple Voltage 1	$V_{RIPPLE1}$			18	mV	20 MHz bandwidth
Output Current 1	I_{OUT1}	0.3		0.6	A	
Output Voltage 2	V_{OUT2}		3.3		V	± 5%
Output Ripple Voltage 2	$V_{RIPPLE2}$			33	mV	20 MHz bandwidth
Output Current 2	I_{OUT2}	0.4		0.75	A	
Output Voltage 3	V_{OUT3}		5		V	± 5%
Output Ripple Voltage 3	$V_{RIPPLE3}$			50	mV	20 MHz bandwidth
Output Current 3	I_{OUT3}	0.2		0.52	A	
Output Voltage 4	V_{OUT4}		12		V	± 5%
Output Ripple Voltage 4	$V_{RIPPLE4}$			120	mV	20 MHz bandwidth
Output Current 4	I_{OUT4}	0.01		0.8	A	
Output Voltage 5	V_{OUT5}		-5		V	± 5%
Output Ripple Voltage 5	$V_{RIPPLE5}$				mV	20 MHz bandwidth
Output Current 5	I_{OUT5}	10		10	mA	
Total Output Power						
Continuous Output Power	P_{OUT}			16W	W	
Efficiency	η	77			%	Measured at P_{OUT} (16 W), 25 °C
Environmental						
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Surge		4			kV	1.2/50 µs surge, IEC 1000-4-5, Series Impedance: Differential Mode: 2 Ω Common Mode: 12 Ω
Surge		3			kV	100 kHz ring wave, 500 A short circuit current, differential and common mode
Ambient Temperature	T_{AMB}	0		50	°C	Free convection, sea level

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3 Schematic

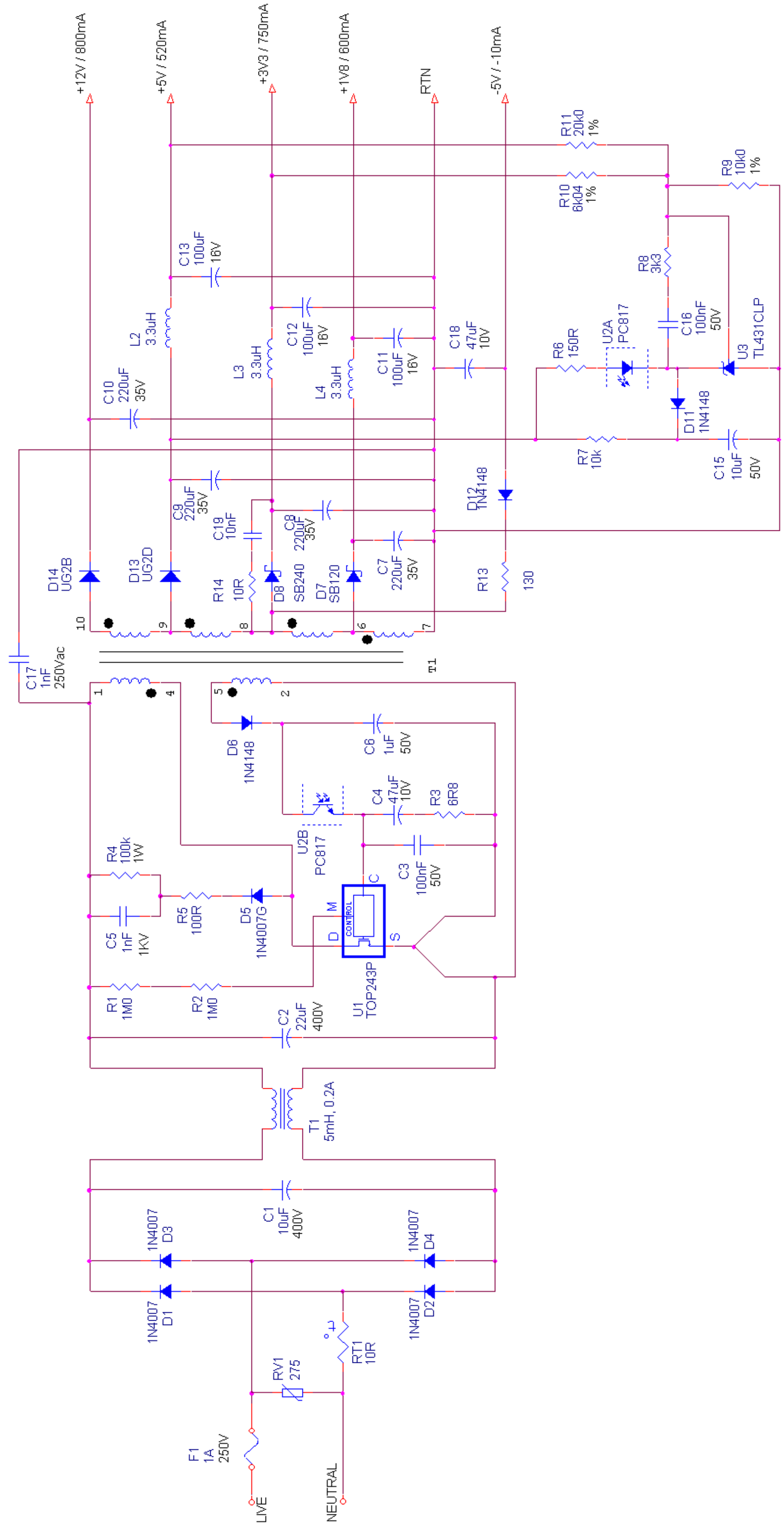

Figure 2 – Schematic

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4 Circuit Description

This power supply is based on a flyback converter using TOP243P.

4.1 Input EMI Filtering

Input differential mode EMI filtering is provided by the two bulk capacitors (C1 and C2) in combination with the leakage inductance of the common-mode choke, T1. Shield winding techniques have been used in the transformer to reduce common-mode noise and this has resulted in the power supply requiring only a small 5mH, 0.2A CM-Choke and 1nF Y1 capacitor.

4.2 TOPSwitch Primary

The TOP243P has been configured to give over-voltage and under-voltage shutdown protection by using the M-pin functionality. A slow 1N4007GP diode has been used in the primary side leakage clamp since it has a specified reverse recovery of about 2uS. This allows some of the clamp energy to be recycled and increases overall efficiency. A small 100R resistor is placed in series with this diode to limit the pull-out current to a safe level.

The input bulk storage capacitors have been oversized to provide the required 60ms hold-up time.

4.3 Transformer details

Full transformer construction details are given in section 7. Shield windings have been used to minimize core voltage potential and to minimize primary to secondary common-mode current flow. In order to generate the 1V8, 3V3, 5V and 12V rails accurately, 3 turns are used for the 1V8, 2 extra for the 3V3, 3 extra for the 5V and 6 extra for the 12V rail.

4.4 Output Feedback

Feedback is derived from the 3V3 and 5V rails with approximately 50/50 influence split. A TL431 and opto-isolator is used to feedback to the primary.

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5 PCB Layout

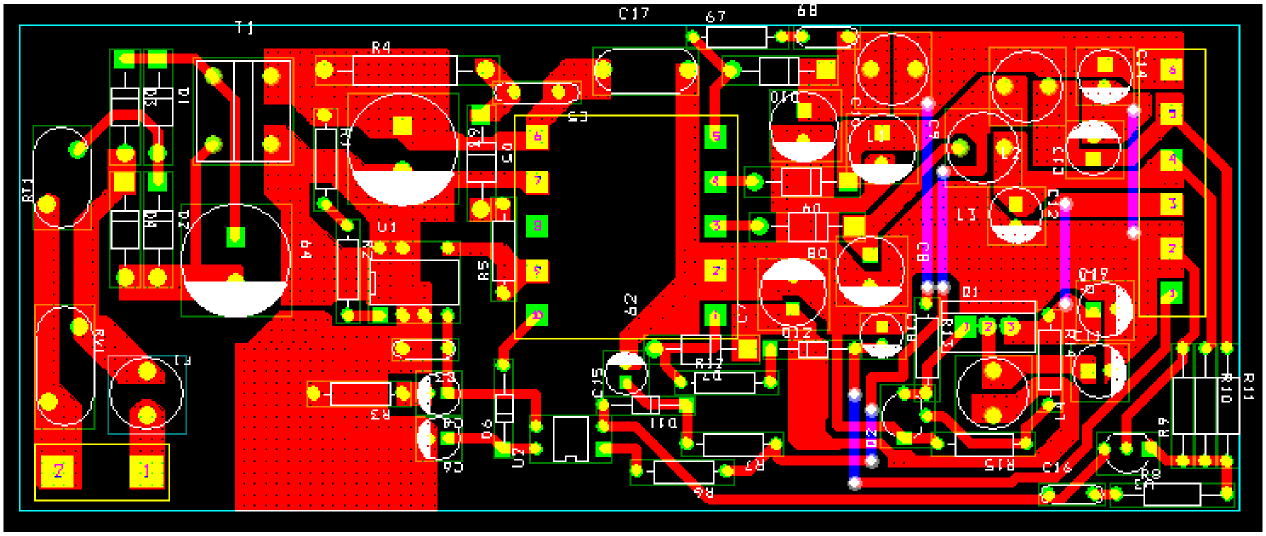

Figure 3 – Printed Circuit Layout

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6 Bill Of Materials

Part Reference	Value	Description	Quantity	Manufacturer	Mfg Part Number
C1 C2	10uF, 400V		2		
C3 C16	100nF, 50V	100 nF, 50 V, Ceramic, X7R	2	Panasonic	ECU-S1H104KBB
C4 C18	47uF, 10V		2		
C5	1nF, 450V	1.0 uF, 450 V, Disc Ceramic	1	Panasonic	ECQ-E2W105KC
C6	1uF, 50V		1		
C7 C8 C9 C10	220uF, 35V	220 uF, 35 V, Electrolytic, Very Low ESR, 56 mOhm, (8 x 15)	4	United Chemi-Con	KZE35VB221MH15LL
C11 C12 C13	100uF, 16V	100 uF, 16 V, Electrolytic, Low ESR, 250 mOhm, (6.3 x 11.5)	3	United Chemi-Con	LXZ16VB101MF11LL
C15	10uF, 50V	10 uF, 50 V, Electrolytic, Gen Purpose, (5 x 11.5)	1	Panasonic	ECA-1HHG100
C17	1nF, 250VAC	1 nF, Ceramic, Y1	1	Vishay	440LD10
D1 D2 D3 D4	1N4007	1000 V, 1 A, Rectifier, DO-41	4	Vishay	1N4007
D5	1N4007G	1000 V, 1 A, Rectifier, Glass Passivated, 2 us, DO-41	1	Vishay	1N4007GP
D6 D11 D12	1N4148	75 V, 300 mA, Fast Switching, DO-35	3	Vishay	1N4148
D7 D8	SB120	60 V, 1.1 A, Schottky, DO-41	2	International Rectifier	11DQ06
D13	UG2D		1		
D14	UG2B		1		
F1	1A, 250V	1 A, 250V, Slow, TR5	1	Wickman	3,721,315,041
L2 L3 L4	3.3uH	3.3 uH, 2.66 A	3	Toko	822LY-3R3M
R1 R2	1M0	1 R, 5%, 1/4 W, Carbon Film	2	Yageo	CFR-25JB-1M0
R3	6R8	6.8 R, 5%, 1/4 W, Carbon Film	1	Yageo	CFR-25JB-6R8
R4	100k	100 k, 5%, 1 W, Metal Oxide	1	Yageo	RSF200JB-100K
R5	100R	100 R, 5%, 1/4 W, Carbon Film	1	Yageo	CFR-25JB-100R
R6	150R	150 R, 5%, 1/4 W, Carbon Film	1	Yageo	CFR-25JB-150R
R7	10k	10 k, 5%, 1/4 W, Carbon Film	1	Yageo	CFR-25JB-10K
R8	3k3	3.3 k, 5%, 1/4 W, Carbon Film	1	Yageo	CFR-25JB-3K3
R9	10k0	10 k, 1%, 1/4 W, Metal Film	1	Yageo	MFR-25FBF-10K0
R10	6k04	6.04 k, 1%, 1/4 W, Metal Film	1	Yageo	MFR-25FBF-6K04
R11	20k0	20 k, 1%, 1/4 W, Metal Film	1	Yageo	MFR-25FBF-20K0
R13	130	130 R, 5%, 1/4 W, Carbon Film	1	Yageo	CFR-25JB-130R
RT1	10R	NTC Inrush resistor	1		
RV1	275	275 V, 45 J, 10 mm, RADIAL	1	Littlefuse	V275LA10
T1	10mH, 0.1A	680 uH, 0.25 A,	1	Tokin	SBC1-681-251
T2	EF25	Custom EF25			
U1	TOP243P	TOPSwitch-GX, TOP242P, DIP-8B	1	Power Integrations	TOP242P
U2	PC817	PC817	1	Sharp	PC817X1
U3	TL431CLP	2.495 V Shunt Regulator IC, 2%, 0 to 70C, TO-92	1	Texas Instruments	TL431CLP

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7 Transformer Specification

7.1 Electrical Diagram

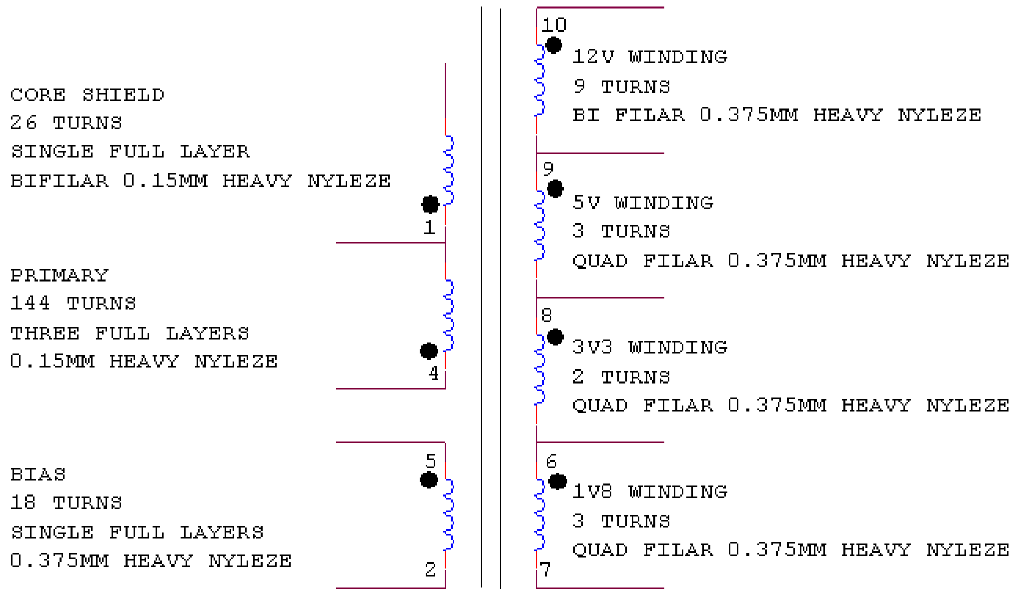

Figure 4 –Transformer Electrical Diagram

7.2 Electrical Specifications

Electrical Strength	1 second, 60 Hz, from Pins 1 - 5 to Pins 6 - 10	3000 VAC
Primary Inductance	Pins 1-4, all other windings open, measured at 100 kHz, 0.4 VRMS	2357 µH, -0/+20%
Resonant Frequency	Pins 1-4, all other windings open	600 kHz (Min.)
Primary Leakage Inductance	Pins 1-4, with Pins 5-10 shorted, measured at 100 kHz, 0.4 VRMS	70 µH (Max.)

7.3 Materials

Item	Description
[1]	Core: EF25, 3F3 material or magnetic equivalent
[2]	Bobbin: 10 pin EF25 bobbin
[3]	Magnet Wire: 0.15MM Heavy Nyleze
[4]	Magnet Wire: 0.375MM Heavy Nyleze
[5]	Tape: 3M Type 1298 Polyester Film or Equivalent
[6]	Margin Tape 3mm wide
[7]	Varnish

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7.4 Transformer Build Diagram

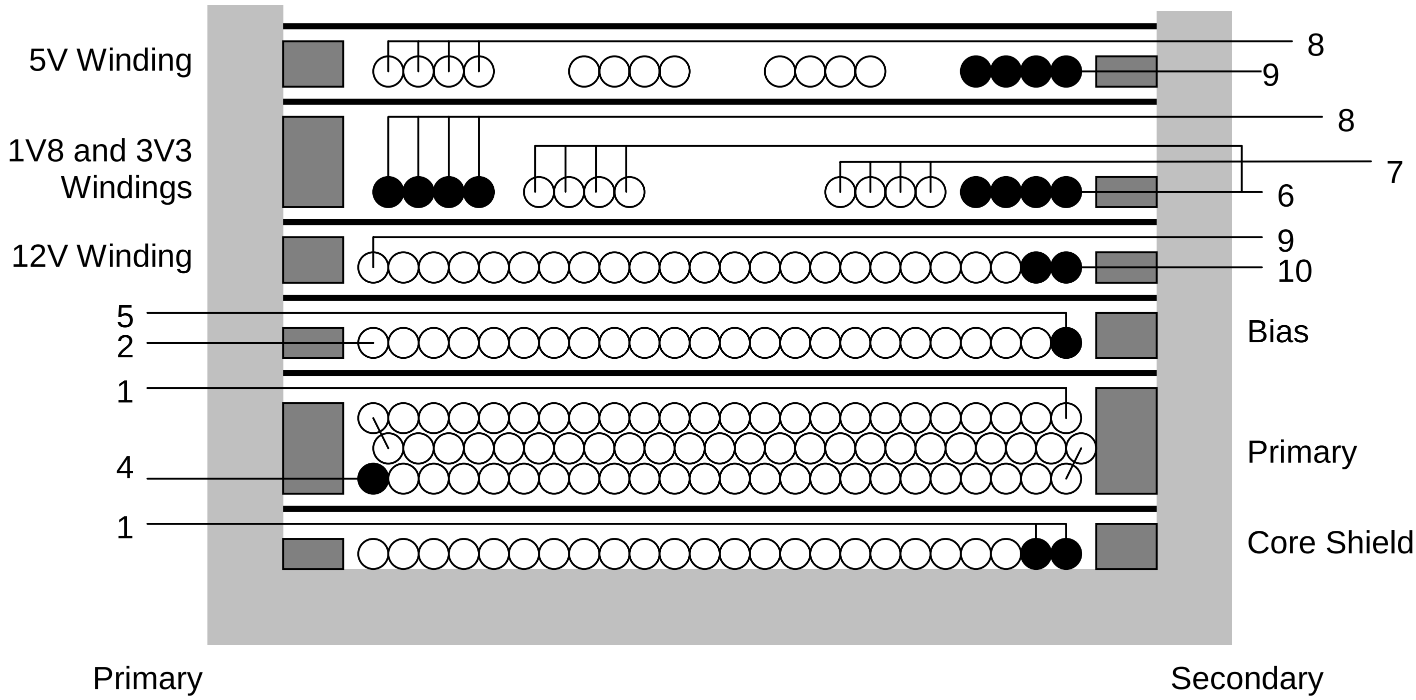

Figure 5 – Transformer Build Diagram

7.5 Transformer Construction

Preparation	Orient the bobbin with the primary on the left. Apply 3mm margin tape [6] to each side of the bobbin.
Core Shield	Start temporarily on the right hand side of the bobbin. Wind 26 bifilar turns of item [3] from right to left over a single full layer. Don't terminate the left hand side of the winding but fix it in place with tape. Bring the right hand side of the winding across to the left hand side and terminate onto pin 1.
Basic Insulation	Use two layers of item [5] for basic insulation.
Primary	Start at Pin 4 on the left hand side of the bobbin. Wind 48 turns of item [3] in approximately 1 layer from left to right. Continue with one further full layer of 48 turns from right to left in a single layer. Finish with one further full layer of 48 turns from left to right. Bring finish lead back across bobbin window and terminate onto pin 1.
Basic Insulation	Use two layers of item [5] for basic insulation.
Bias Winding	Start temporarily on the right hand side of the bobbin. Wind 18 turns of item [4] from right to left in a single full layer. Finish on pin 2. Bring temporary start of the winding across the bobbin and termiante on pin 5. .
Basic Insulation	Use two layers of item [5] for basic insulation.
12V Winding	Start at Pin 10 on the right hand side of the bobbin. Wind 9 birifilar turns of item [4] from right to left in a single layer. Bring the end of the winding across the bobbin and terminate onto pin 9.

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Basic Insulation	Use two layers of item [5] for basic insulation
1V8 and 3V3 windings	Start on pin 6 on the right hand side of the bobbin. Wind 3 quadrafilar turns of item [4] from right to left, spreading evenly over the bobbin width. Finish on pin 7. Start on pin 8 on the right hand side of the bobbin. Wind 2 quadrafilar turns of item [4] from right to left, interposing the winding with the 1V8 winding. Finish on pin 6.
Basic Insulation	Use two layers of item [5] for basic insulation
5V Winding	Start on pin 10 on the right hand side of the bobbin. Wind 3 quadrafilar turns of item [4] from right to left. Terminate on pin 9.
Basic Insulation	Use two layers of item [5] for basic insulation
Final Assembly	Assemble and secure core halves. Varnish impregnate.

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8 Design Spreadsheet

Power Supply Input

Var	Value	Output 1 (main)	Output 2	Output 3	Output 4	Units	Description
VACMIN	195					Volts	Min Input AC Voltage
VACMAX	265					Volts	Max Input AC Voltage
FL	50					Hertz	Line Frequency
TC	1.75					mSeconds	Diode Conduction Time
Z	0.59						Loss Allocation Factor
N	85.0					%	Efficiency Estimate

Power Supply Outputs

Var	Value	Output 1 (main)	Output 2	Output 3	Output 4	Units	Description
VOx		1.80	3.30	5.00	12.00	Volts	Output Voltage
IOx		0.60	0.75	0.52	0.80	Amps	Output Current
VB	12.0					Volts	Bias Voltage
IB	0.006					Amps	Bias Current

Device Variables

Var	Value	Output 1 (main)	Output 2	Output 3	Output 4	Units	Description
Device	TOP243P						PI Device Name
PO	15.8					Watts	Total Output Power
VDRAIN	605					Volts	Maximum Drain Voltage
VDS	3.25					Volts	Drain to Source Voltage
FS	132000					Hertz	Switching Frequency
KRPKDP	0.60						Continuous/Discontinuous Operating Ratio
KI	1.00						KI Factor
ILIMITEXT	0.70					Amps	Device Current Limit External Minimum
ILIMITMIN	0.70					Amps	Current Limit Minimum
ILIMITMAX	0.80					Amps	Current Limit Maximum
IP	0.37					Amps	Peak Primary Current
IRMS	0.14					Amps	Primary RMS Current
DMAX	0.28						Maximum Duty Cycle

Power Supply Components Selection

Var	Value	Output 1 (main)	Output 2	Output 3	Output 4	Units	Description
CIN	32.0					uFarads	Input Capacitance
VMIN	257.8					Volts	Minimum DC Input Voltage
VMAX	374.8					Volts	Maximum DC Input Voltage
VCLO	150					Volts	Clamp Zener Voltage
PZ	2.5					Watts	Primary Zener Clamp Loss
VDB	0.70					Volts	Bias Diode Forward Voltage Drop
PIVB	60					Volts	Bias Rectifier Max Peak Inverse Voltage
RLS1	4.7					MOhms	Line sense resistor
VUVON_MIN	207.19					Volts	Minimum undervoltage threshold beyond which Power supply will start-up
VUVON_MAX	253.71					Volts	Maximum undervoltage threshold before which Power Supply will start-up
VOVOFF_MIN	979.43					Volts	Minimum overvoltage threshold after which Power Supply will turn off after an over voltage condition
VOVOFF_MAX	1118.99					Volts	Maximum overvoltage threshold before the Power Supply will turn off after an over voltage condition Comment: Drain voltage close to

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							BVDSS at maximum OV threshold Tip: Verify BVDSS during line surge, decrease VUVON_MAX or reduce VOR.

Power Supply Output Parameters

Var	Value	Output 1 (main)	Output 2	Output 3	Output 4	Units	Description
VDx		0.30	0.50	0.50	0.70	Volts	Output Winding Diode Forward Voltage Drop
PIVSx		10	18	26	60	Volts	Output Rectifier Maximum Peak Inverse Voltage
ISPx		1.12	1.40	0.97	1.49	Amps	Peak Secondary Current
ISRMSx		0.68	0.85	0.59	0.91	Amps	Secondary RMS Current
IRIPPLEx		0.32	0.41	0.28	0.43	Amps	Output Capacitor RMS Ripple Current

Transformer Construction Parameters

Var	Value	Output 1 (main)	Output 2	Output 3	Output 4	Units	Description
Core/Bobbin	E25/13/7 (EF25)						Core Type
Core Manuf.	Generic						Core Manufacturer
Bobbin Manuf	Generic						Bobbin Manufacturer
LP	2357					uHenries	Primary Inductance
NP	142.9						Primary Number of Turns
NB	18.1						Bias Winding Number of Turns
AWG	35					AWG	Primary Wire Gauge
CMA	228					Cmils/A	Primary Winding Current Capacity
VOR	100.00					Volts	Reflected Output Voltage
BW	15.30					mm	Bobbin Winding Width
M	3.0					mm	Safety Margin Width
L	3.00						Primary Number of Layers
AE	52.50					mm^2	Core Cross Sectional Area
ALG	115					nH/T^2	Gapped Core Effective Inductance
BM	1150					Gauss	Maximum Flux Density
BP	2520					Gauss	Peak Flux density
BAC	345					Gauss	AC Flux Density for Core Loss
LG	0.53					mm	Gap Length
LL	47.1					uHenries	Primary Leakage Inductance
LSEC	20					nHenries	Secondary Trace Inductance

Secondary Parameters

Var	Value	Output 1 (main)	Output 2	Output 3	Output 4	Units	Description
NSx		3.0	5.4	7.9	18.1		Secondary Number of Turns
Rounded Down NSx			5	7	18		Rounded to Integer Secondary Number of Turns
Rounded Down Vox			3.00	4.40	11.90	Volts	Auxiliary Output Voltage for Rounded down to Integer Secondary Number of Turns
Rounded Up NSx			6	8	19		Rounded to Next Integer Secondary Number of Turns
Rounded Up Vox			3.70	5.10	12.60	Volts	Auxiliary Output Voltage for Rounded up to Next Integer Secondary Number of Turns
AWGSx Range		27 - 31	27 - 30	28 - 32	26 - 30	AWG	Secondary Wire Gauge Range

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9 Performance Data

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

9.1 Efficiency

All rails were loaded to full specified power as defined in section 2. Figure 6 below shows the conversion efficiency as a function of input line voltage.

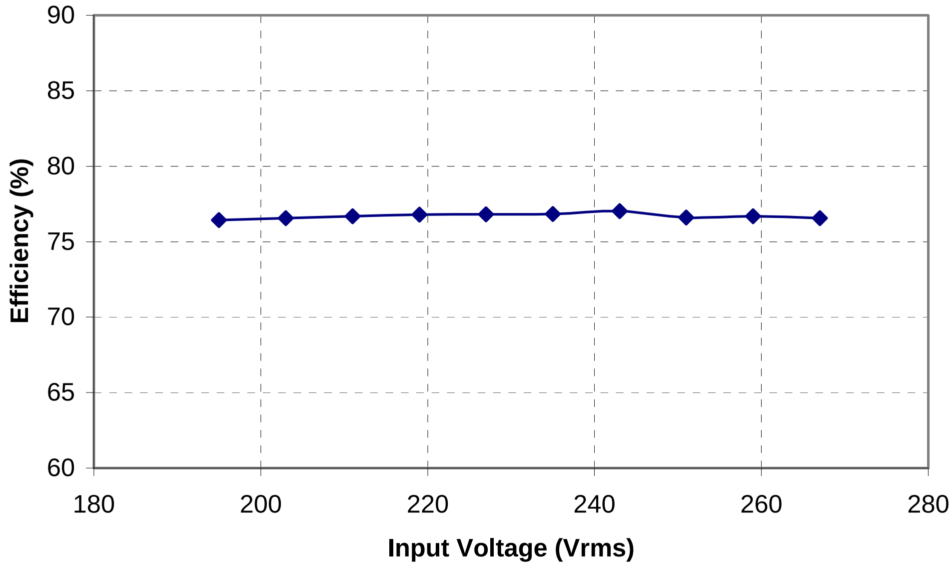

Figure 6- Efficiency vs. Input Voltage

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9.2 Regulation

9.2.1 Line

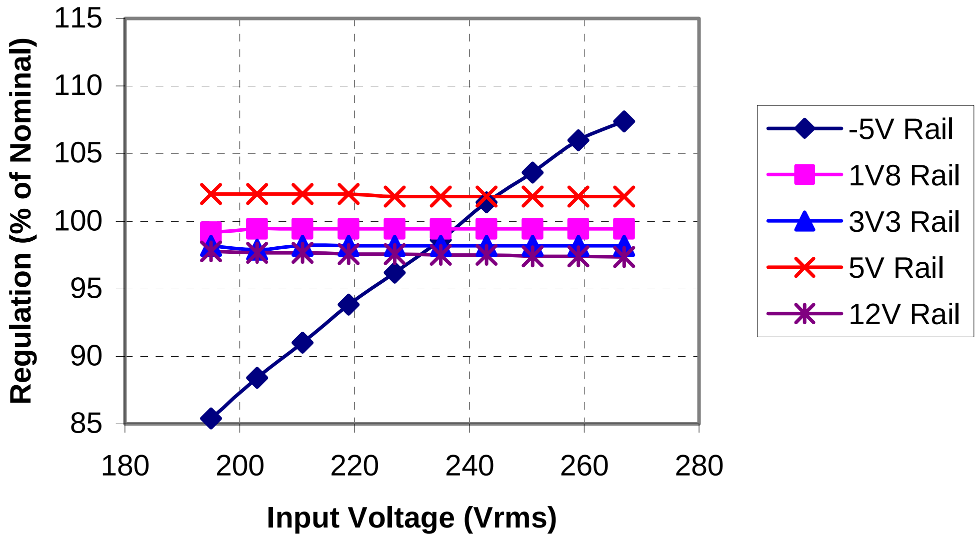

Figure 7 –Load Regulation.

9.2.2 Cross Regulation

The defined minimum and maximum loads for the power supply are given in Table 1 below.

Rail Voltage (V)	Min Current (A)	Max Current (A)
-5	0.01	0.01
1.8	0.3	0.6
3.3	0.4	0.75
5	0.2	0.52
12	0.01	0.8

Table 1 - Minimum and Maximum Loads

Since realistic load combinations are as yet unknown, cross-regulation results are based on all possible combinations of minimum and maximum load. Table 2 gives the output voltages for each load combination based on the min/max loads given above.

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Combination	Rail Voltages				
1V8 - 3V3 - 5V - 12V	**-5V**	**1V8**	**3V3**	**5V**	**12V**
XXXX	-3.92	1.79	3.25	5.08	12.47
XXXM	-4.91	1.82	3.24	5.08	11.49
XXMX	-4.28	1.80	3.27	5.02	12.77
XXMM	-4.88	1.82	3.26	5.04	11.56
XMXX	-4.10	1.81	3.22	5.16	12.80
XMXM	-4.92	1.83	3.23	5.14	11.62
XMMX	-4.85	1.83	3.25	5.08	13.10
XMMM	-4.88	1.84	3.24	5.09	11.69
MXXX	-4.00	1.72	3.25	5.09	12.57
MXXM	-4.90	1.76	3.24	5.08	11.50
MXMX	-4.61	1.74	3.27	5.02	12.87
MXMM	-4.87	1.77	3.26	5.04	11.57
MMXX	-4.33	1.75	3.22	5.16	12.94
MMXM	-4.90	1.78	3.23	5.14	11.63
MMMX	-4.91	1.77	3.24	5.08	13.19
MMMM	-4.89	1.79	3.24	5.09	11.70
Minimum Voltage (V)	-4.92	1.72	3.22	5.02	11.49
Maximum Voltage (V)	-3.92	1.84	3.27	5.16	13.19
Minimum % of Nominal (%)	98.40	95.56	97.58	100.40	95.75
Maximum % of Nominal (%)	78.40	102.22	99.09	103.20	109.92

Table 2 - Cross Regulation Measurements at 230Vac input

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10 Thermal Performance

The operating temperature of key power stage components was measured for full output power as a function of input line voltage. The PCB was mounted horizontally in free air with a recorded lab ambient temperature of 28°C. Figure 8 shows the temperature of the TOP243P, the transformer core, the 12V rail output cap and the input 22uF, 400V bulk capacitor.

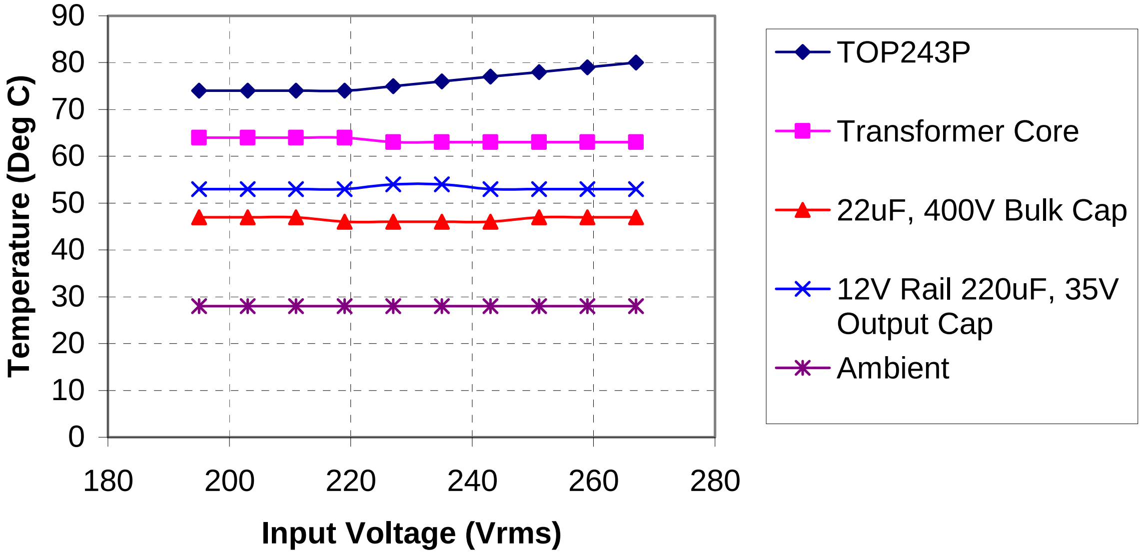

Figure 8 - Key Component Operating Temperature

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11 Waveforms

11.1 Drain Voltage and Current, Steady State Full Power Operation

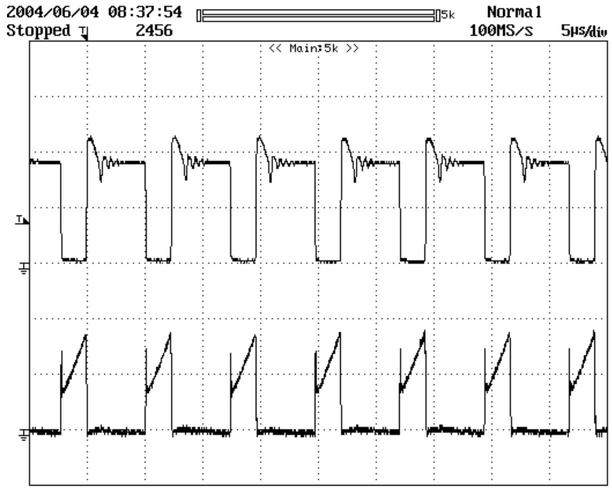

Figure 9 - 195 VAC, Full Load.
Lower: I_{DRAIN}, 0.2 A / div
Upper: V_{DRAIN}, 200 V, 5 µs / div

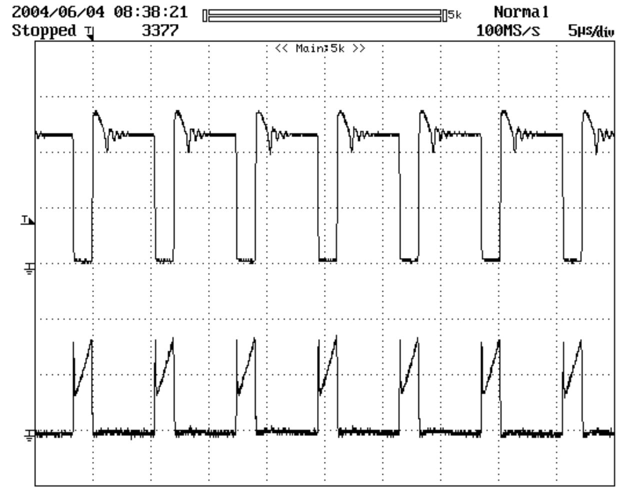

Figure 10 - 265 VAC, Full Load
Lower: I_{DRAIN}, 0.2 A / div
Upper: V_{DRAIN}, 200 V / div

11.2 Drain Voltage and Current Start-up Profile

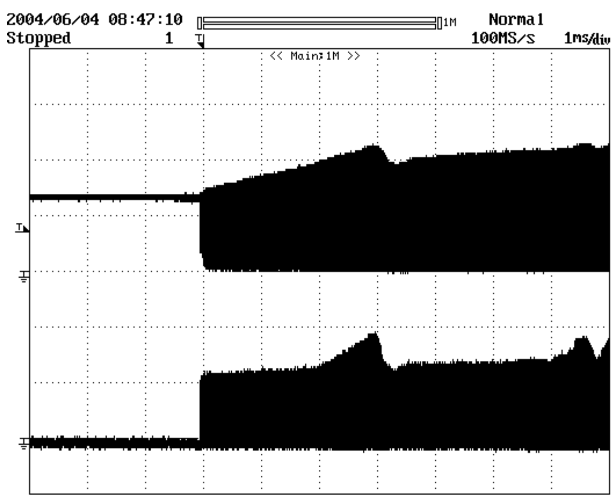

Figure 11 - 195 VAC Input and Maximum Load.
Lower: I_{DRAIN}, 0.2 A / div.
Upper: V_{DRAIN}, 200 V & 1 ms / div.

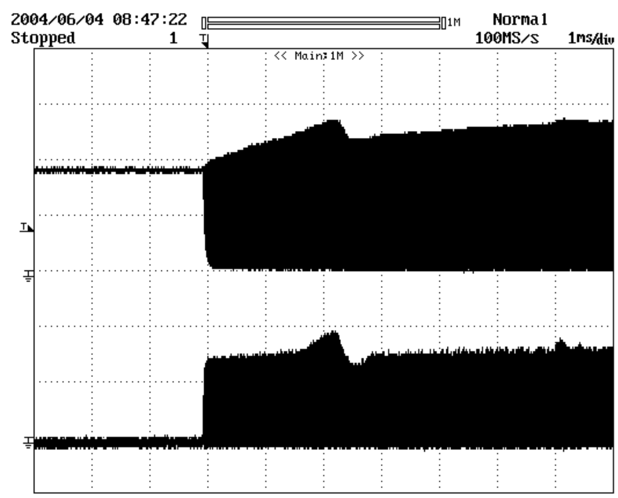

Figure 12 - 265 VAC Input and Maximum Load.
Lower: I_{DRAIN}, 0.2 A / div.
Upper: V_{DRAIN}, 200 V & 1 ms / div.

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11.3 Output Voltage Start-up Profile

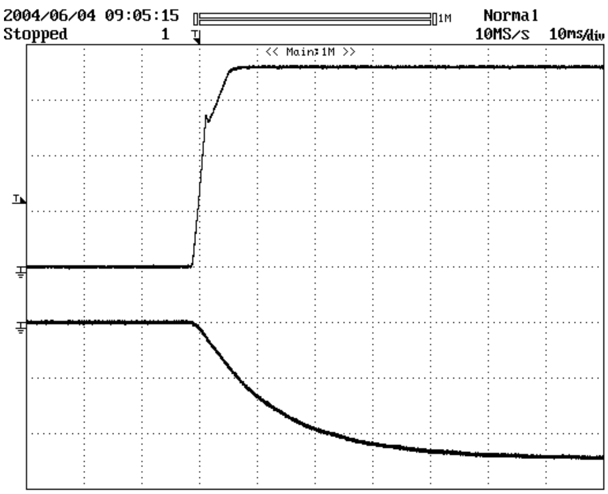

Figure 13 - 230 VAC Input and Maximum Load.
Upper: 1V8 Voltage, 0.5 V / div.
Lower: -5V Voltage, 2 V & 10 ms / div.

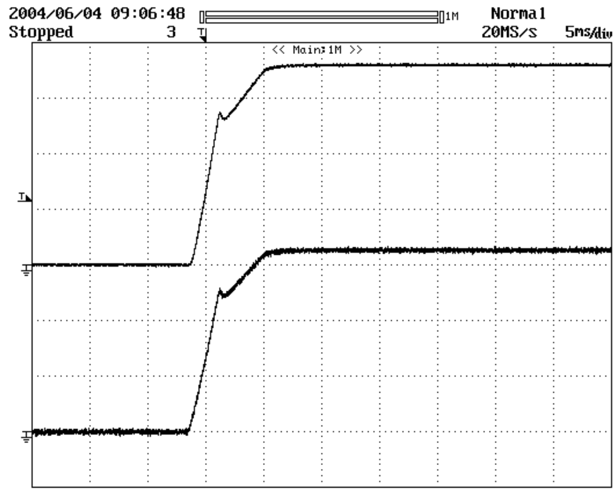

Figure 14 - 230 VAC Input and Maximum Load.
Upper: 1V8 Voltage, 0.5 V / div.
Lower: 3V3 Voltage, 1 V & 10 ms / div.

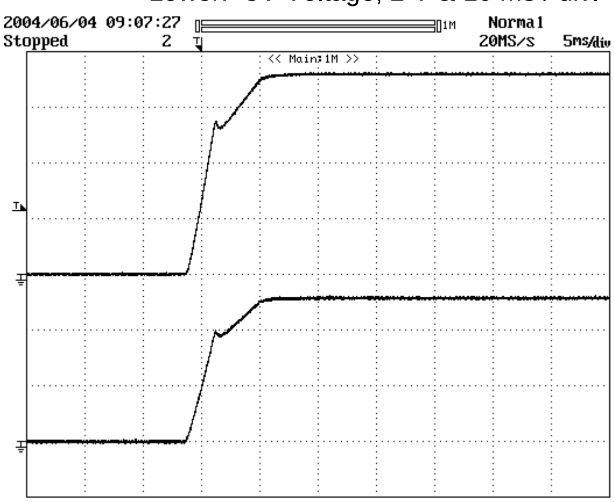

Figure 15 - 230 VAC Input and Maximum Load.
Upper: 1V8 Voltage, 0.5 V / div.
Lower: 5V Voltage, 2 V & 10 ms / div.

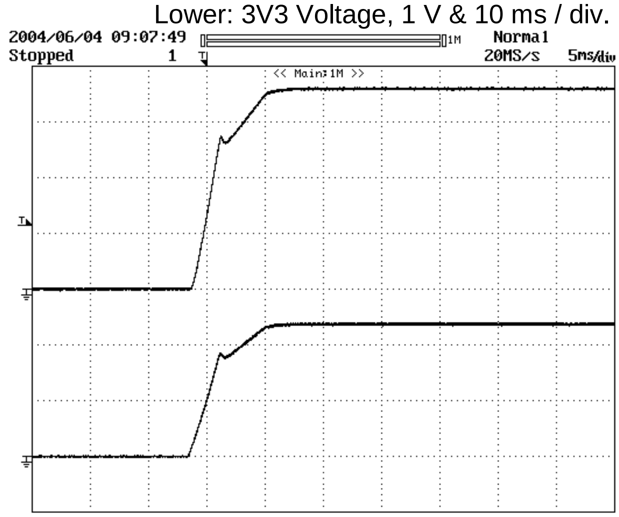

Figure 16 - 230 VAC Input and Maximum Load.
Upper: 1V8 Voltage, 0.5 V / div.
Lower: 12V Voltage, 5 V & 10 ms / div.

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11.4 Load Transient Response (75% to 100% Load Step)

In the figures shown below, signal averaging was used to better enable viewing the load transient response. The oscilloscope was triggered using the load current step as a trigger source. Since the output switching and line frequency occur essentially at random with respect to the load transient, contributions to the output ripple from these sources will average out, leaving the contribution only from the load step response.

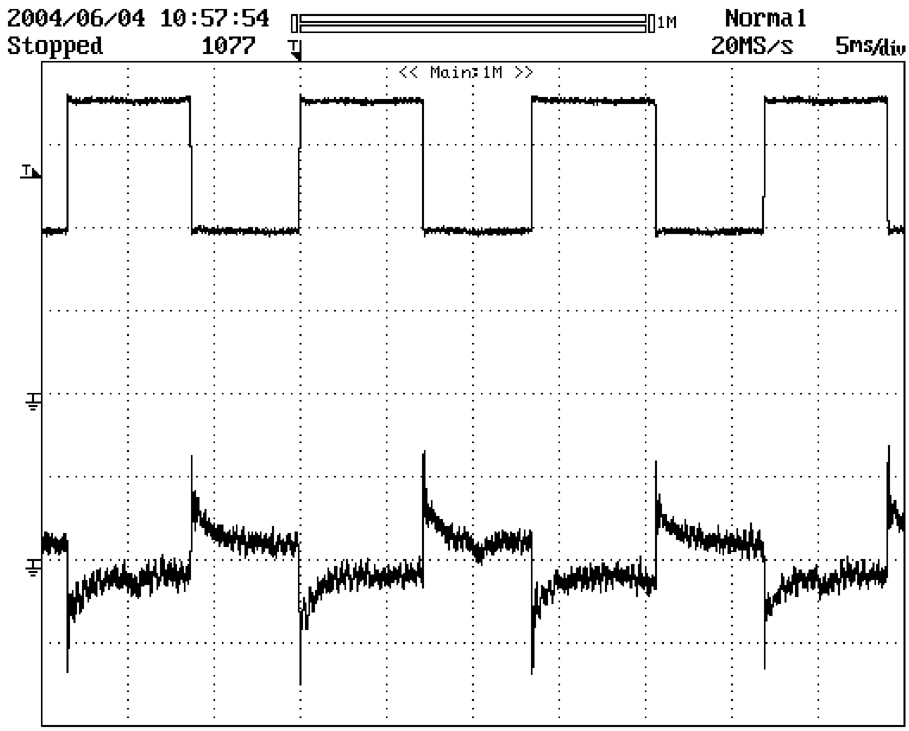

Figure 17 – Transient Response, 230 VAC, 0.4A to 0.75A Current Change on 3V3 output.
Top: 3V3 Rail Current, 0.2 A/div.
Bottom: AC Coupled 3V3 Rail Output Voltage
50 mV, 5 ms / div.

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11.5 Hold-up Time

Hold-up time was measured at full power output with 230Vac input. Figure 18 and Figure 19 below show the hold-up is greater than 60ms in worst case.

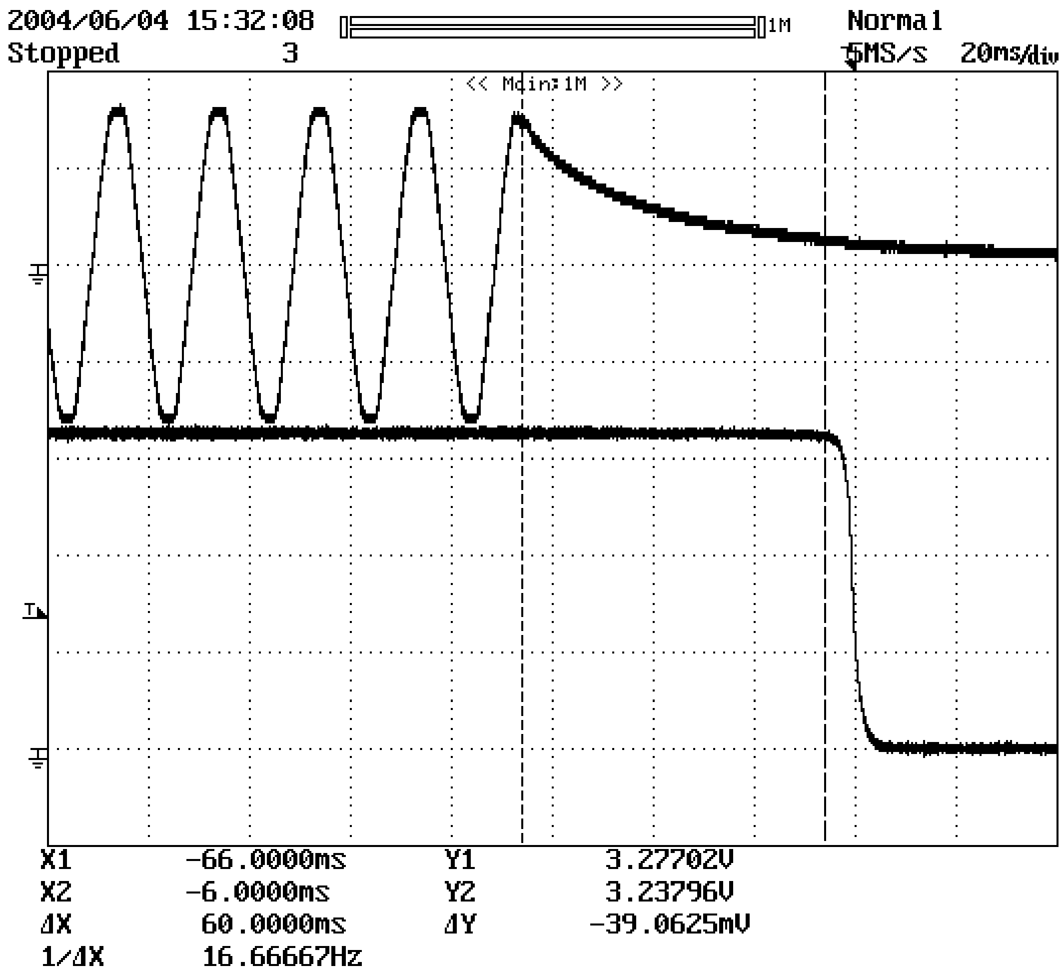

Figure 18 - Hold-up measured from top of mains cycle. Upper trace is mains voltage at 200V/div and lower trace is 3V3 rail output voltage at 1V/div. Timebase is 20ms/div.

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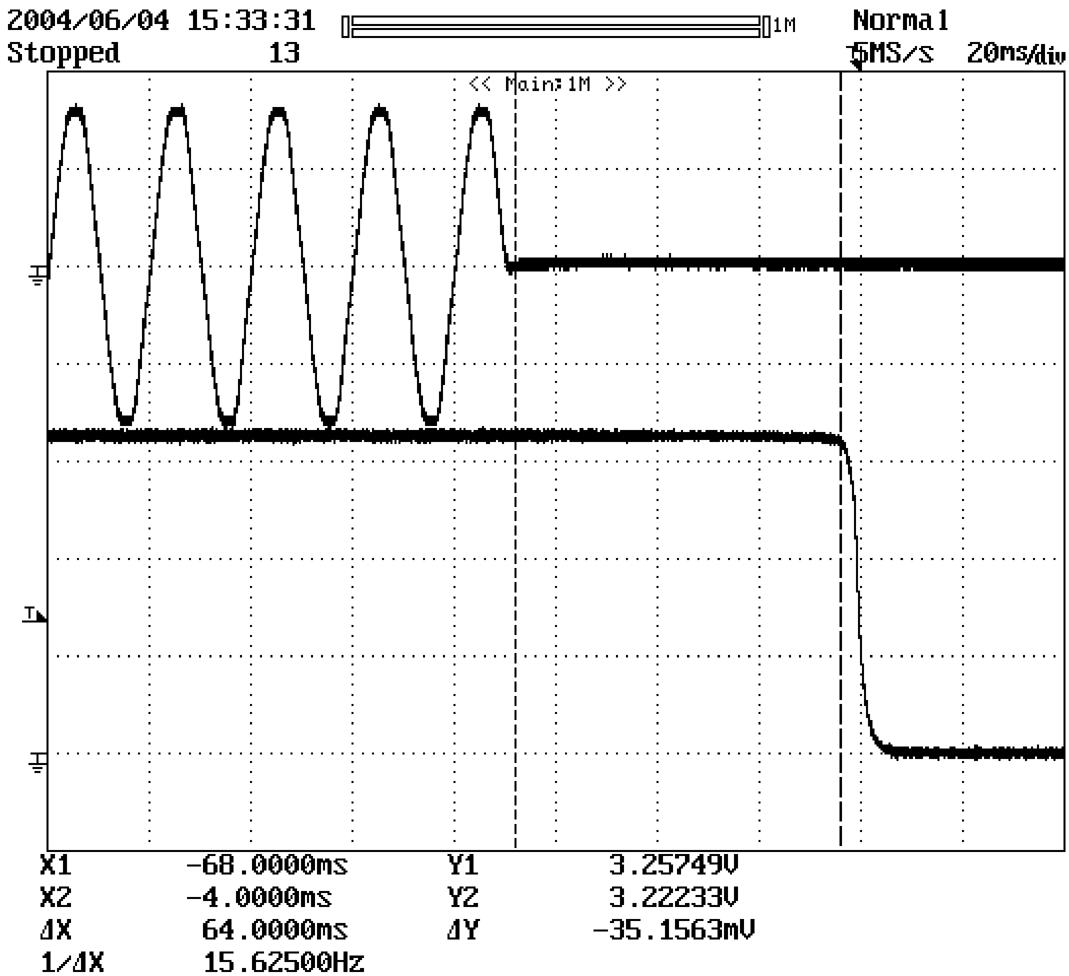

Figure 19- Hold-up measured from center of mains cycle. Upper trace is mains voltage at 200V/div and lower trace is 3V3 rail output voltage at 1V/div. Timebase is 20ms/div.

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11.6 Output Ripple Measurements

11.6.1 Ripple Measurement Technique

For DC output ripple measurements, a modified oscilloscope test probe must be utilized in order to reduce spurious signals due to pickup. Details of the probe modification are provided in Figure 20 and Figure 21.

The 5125BA probe adapter is affixed with two capacitors tied in parallel across the probe tip. The capacitors include one (1) 0.1 μF/50 V ceramic type and one (1) 1.0 μF/50 V aluminum electrolytic. ***The aluminum electrolytic type capacitor is polarized, so proper polarity across DC outputs must be maintained (see below).***

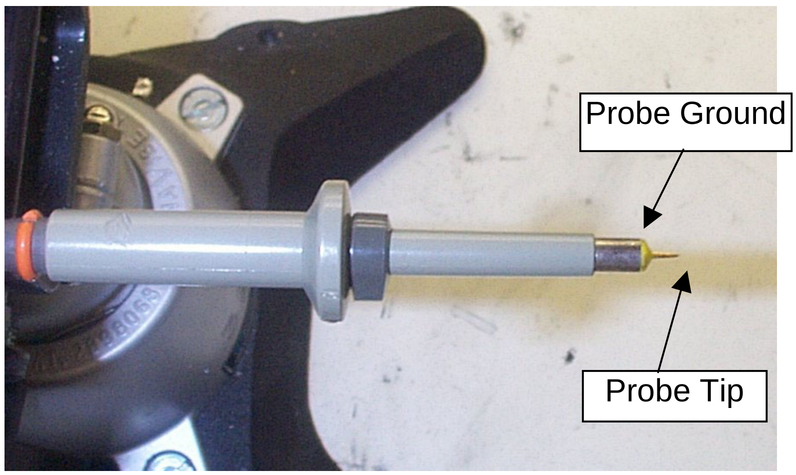

Figure 20 - Oscilloscope Probe Prepared for Ripple Measurement. (End Cap and Ground Lead Removed)

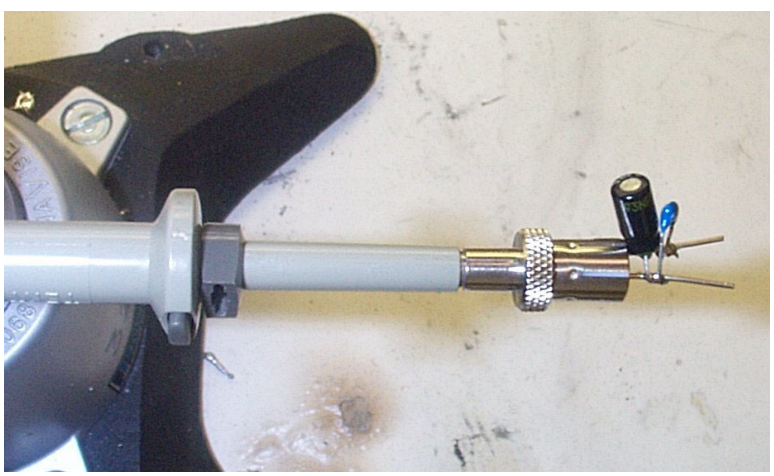

Figure 21 - Oscilloscope Probe with Probe Master 5125BA BNC Adapter. (Modified with wires for probe ground for ripple measurement, and two parallel decoupling capacitors added)

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11.6.2 Measurement Results

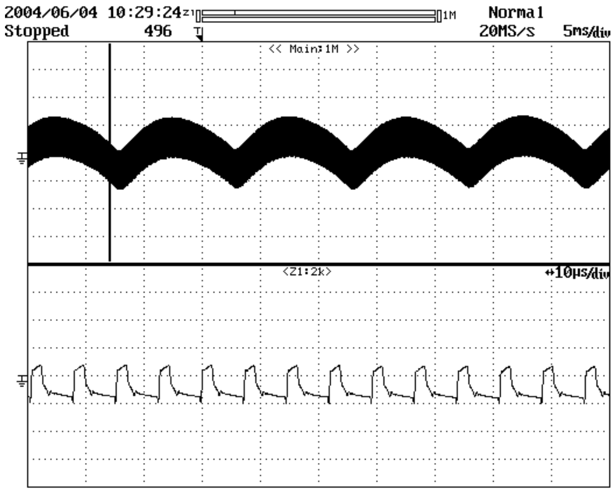

Figure 22 - -5V Rail Ripple, 230 VAC, Full Load.
5 ms, 20 mV / div

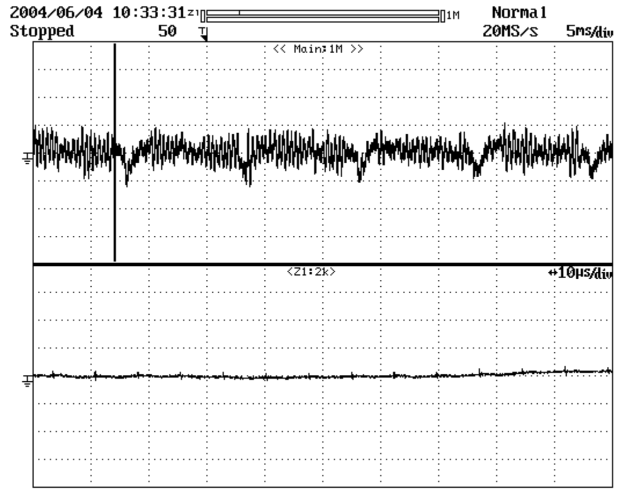

Figure 23 – 1V8 Rail Ripple, 230 VAC, Full Load.
5 ms, 5 mV / div

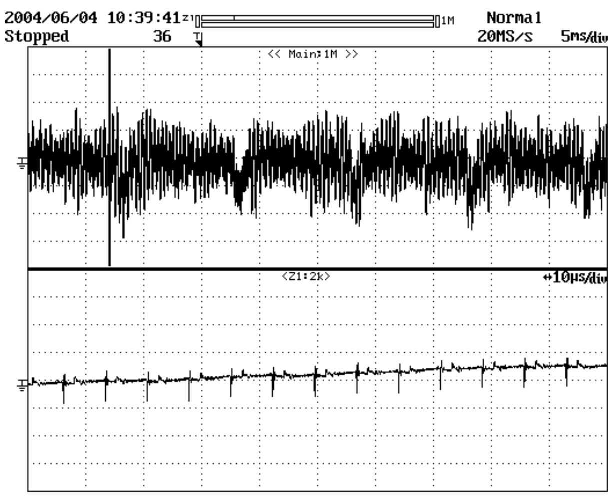

Figure 24 – 3V3 Rail Ripple, 230 VAC, Full Load.
5 ms, 5 mV / div

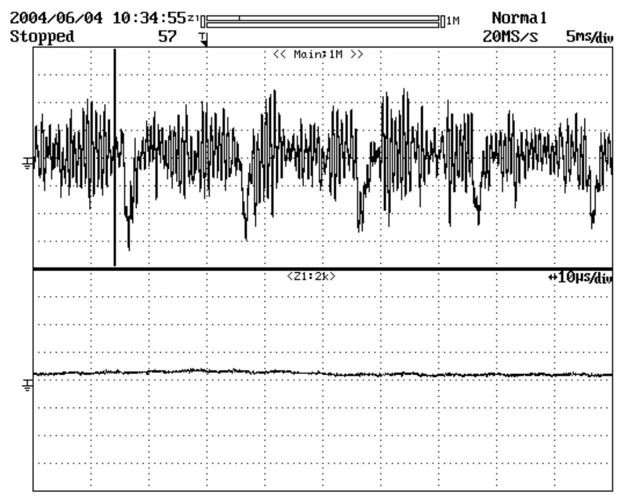

Figure 25 – 5V Rail Ripple, 230 VAC, Full Load.
5 ms, 5 mV / div

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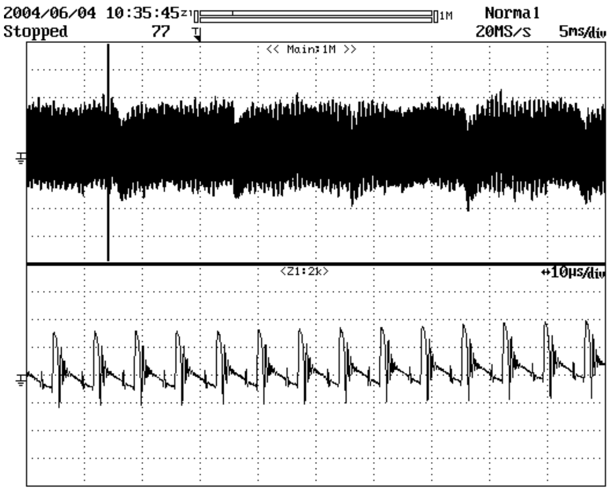

Figure 26 – 12V Rail Ripple, 195 VAC, Full Load.
5 ms, 50 mV / div

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12 Surge Test Results

Surge tests were performed according to EN61000-4-5 for both differential and common-mode surge.

12.1 Differential Mode Surge Tests

The surge equipment guarantees 10% accuracy so the programmed surge level was set 10% higher than the required levels 1kV, 2kV and 3kV to ensure that in worse case the surge level was high enough. Surges were performed at phase angles of 0°, 90°, 180°, 270° and 359° with two strikes of both positive and negative surge.

For 1kV, 2kV and 3kV levels, the surge had no effect on the PSU and power was provided continually throughout the duration of the surge. With 4kV surge, the radial fuse (3.15A) was destroyed but the PSU continued to operate when the fuse had been replaced.

12.2 Common Mode Surge Tests

Common mode surge voltage of 3.3kV was applied between Live and Earth with phase angles of 0°, 90°, 180°, 270° and 359° with both positive and negative going pulses. Figure 27 below summarizes the results.

		Phase Angle				
Pulse Polarity		0	90	180	270	359
Positive	Strike 1	Normal Operation	Normal Operation	Normal Operation	Normal Operation	Normal Operation
	Strike 2	Normal Operation	Normal Operation	Power dropout for about 0.5 second	Normal Operation	Power dropout for about 0.5 second
Negative	Strike 1	Normal Operation	Power dropout for about 0.5 second	Normal Operation	Normal Operation	Power dropout for about 1 second
	Strike 2	Normal Operation	Normal Operation	Normal Operation	Normal Operation	Normal Operation

Figure 27 – Results of Common-Mode Surge Testing

In all cases above, any PSU dropout was followed by full automatic recovery of the power supply.

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13 Conducted EMI

The measurements presented below are pre-compliance and should only be used for guidance. Results are presented both with and without the output grounded. Output grounded is indicative of functional grounding through a SCART lead.

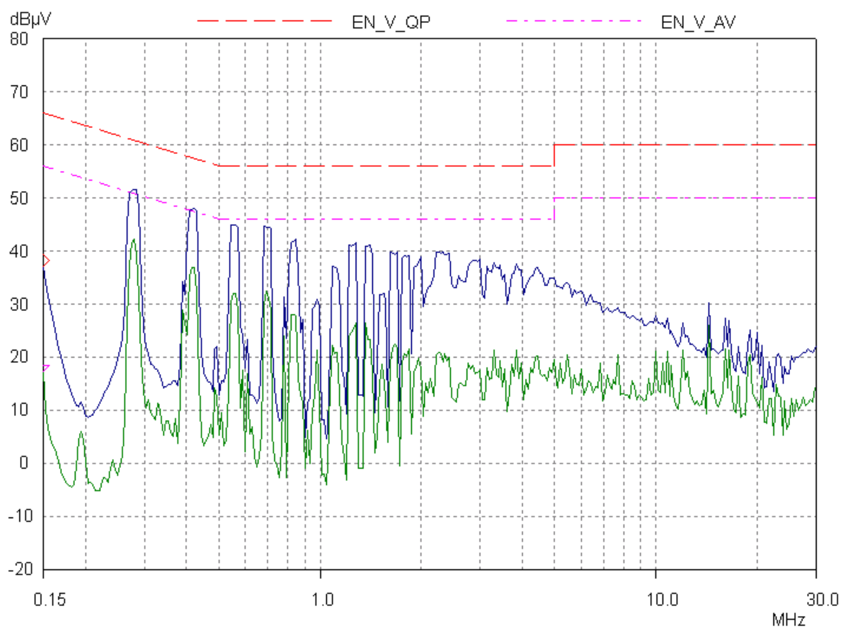

Figure 28 – 230VAC input. Full load output with output floating

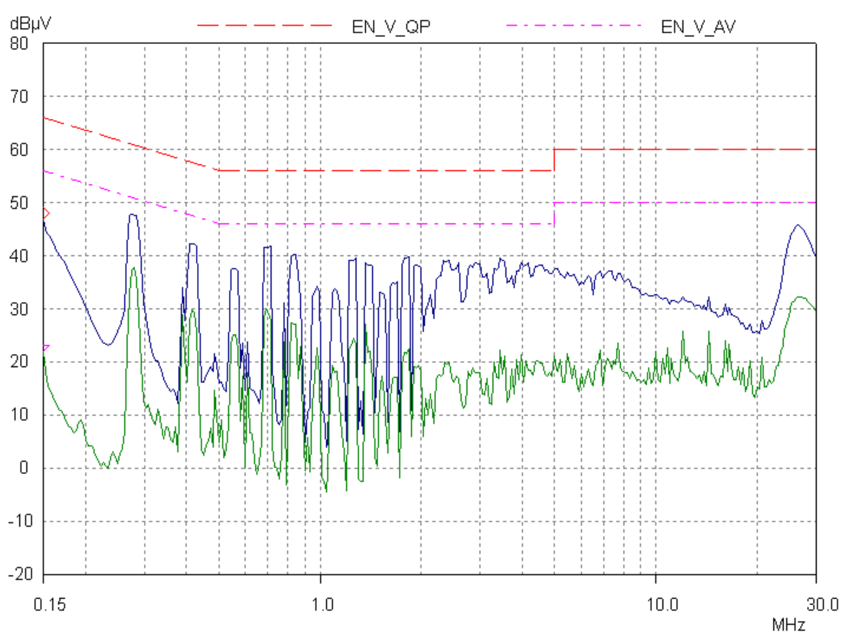

Figure 29 – 230VAC input. Full load output with output grounded to protective Earth

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14 Revision History

Date	Author	Revision	Description & changes	Reviewed
April 20, 2005	IM	1.0	Initial release	VC / JC / AM

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PATENT INFORMATION

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*.

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