Design Example Report

Title	***48W 2 Output Power Supply using TOP246Y***
Specification	Input: 100 – 265 VAC Output: 5V/1.8A, 13V/3A
Application	LCD Monitor
Author	Power Integrations Applications Department
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Revision	1.0

Summary and Features

A TOP246Y is used to create 48W LCD monitor supply that features the following:

- Low Parts Count
- < 250mW No- Consumption @ 230VAC
- < 600mW Standby Consumption @ 230VAC, 200mW output
- Meets CISPR22 EMI

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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.

1 Introduction

This document is an engineering report describing a prototype 2 output universal input power supply utilizing a TOP246. This power supply is intended to power a 17” LCD monitor.

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

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2 Power Supply Specification

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	100		265	VAC	2 Wire – no P.E.
Frequency	f_{LINE}	47	50/60	64	Hz	
No-load Input Power (230 VAC)				0.5	W	
Standby Power (230 VAC)				0.9		5V/0.04A, 13V/0A
Output						
Output Voltage 1	V_{OUT1}	4.75	5.00	5.25	V	± 5%
Output Ripple Voltage 1	$V_{RIPPLE1}$			500	mV	20 MHz Bandwidth
Output Current 1	I_{OUT1}		1	1.8	A	
Output Voltage 2	V_{OUT2}	12.00	13.00	18.0	V	
Output Ripple Voltage 2	$V_{RIPPLE2}$			500	mV	20 MHz Bandwidth
Output Current 2	I_{OUT2}		2.5	3	A	
Total Output Power						
Continuous Output Power	P_{OUT}			48	W	
Peak Output Power	P_{OUT_PEAK}			N/A	W	
Efficiency	η	80			%	Measured at P_{OUT} (43 W), 25 °C
Environmental						
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Surge		TBD			kV	1.2/50 µs surge, IEC 1000-4-5, Series Impedance: Differential Mode 2 Ω Common Mode: 12 Ω
Surge		TBD			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

3 Schematic

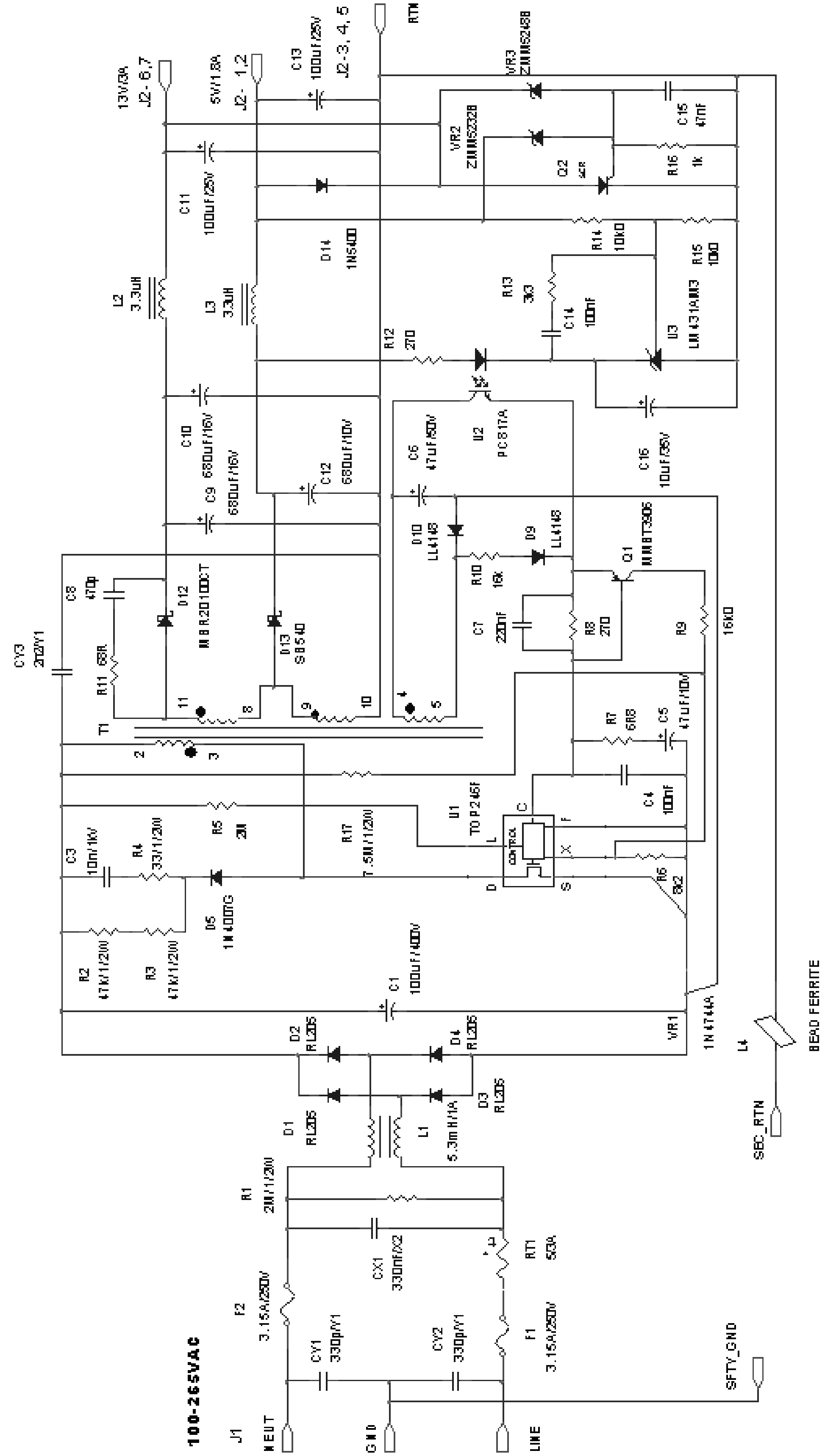

Figure 1 – Schematic.

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4 Circuit Description

The schematic in Figure 1 shows an off-line flyback converter using the TOP246. The circuit is designed for 100 VAC to 265 VAC input, with two outputs: 5V/1.8A, and 13V/3A

4.1 Input EMI Filtering

Capacitor CX1 and the L1 leakage inductance filter differential mode conducted EMI. Inductor L1 and CY1-CY3 filter common mode conducted EMI.

4.2 TOPSwitch Primary

The AC line voltage is rectified and filtered to generate a high voltage DC bus via D1-4 and C1.
Diode D5, C3 ,ad R2-4 clamp leakage spikes generated when the MOSFET in U1 switches off. D5 is a glass-passivated normal recovery rectifier. The slow, controlled recovery time of D5 allows energy stored in C3 to be recycled back to the high voltage bus, significantly increasing efficiency. A normal (non-passivated) 1N4007 should not be substituted for the glass-passivated device. Resistor R5 sets the turn-on voltage of the supply to approximately 76 VAC. C4 bypasses the U1 control pin. C5 has three functions. It provides the energy required by U1 during startup, sets the auto-restart frequency during fault conditions, and also acts to roll off the gain of U1 as a function of frequency. R5 adds a zero to the control loop to stabilize the power supply control loop. Diode D10 and capacitor C6 provide rectified and filtered bias power for U1 and U2. Components Q1, D9, C7, R4, and R8-10 provide a signal to the U1 X pin to program it for current mode operation. The components also allow operation low frequency operation at light or no load, greatly reducing the supply input power consumption under these conditions. Resistor R17 acts to depress the U1 maximum current limit as a function of line voltage, making the maximum overload power more independent of line voltage.

4.3 Output Rectification

The T1output is rectified and filtered by D12 and C9-10 for the 13V output, and by D13 and C12 for the 5V output. Components C8 and R11 provide snubbing for D12. Components L2, L3, C11, and C13 provide additional high frequency output filtering. Ferrite bead L4 provides some high frequency isolation between the secondary return and primary safety ground to improve EMI.

4.4 Output Feedback

Resistors R14 and R15 are used to set the +5V main output voltage. Shunt regulator U3 drives optocoupler U2 through resistor R12 to provide feedback information to the U1 control pin. The optocoupler output also provides power to U1 during normal operating conditions. Capacitor C16 applies drive to the optocoupler during supply startup to reduce output voltage overshoot. Capacitor C14 and R13 provide frequency compensation for error amplifier U3.
Components C5, C14, R7, R12, and R13 all play a role in compensating the power supply control loop. Capacitor C5 rolls off the gain of U1 at relatively low frequency. Resistor R7 provides a zero to cancel the phase shift of C5. Resistor R12 sets the gain of

the direct signal path from the supply output through U2 and U3. Components C14 and R13 reduce the high frequency gain of U3.

4.5 Protection

Components Q2, VR2, VR3, D14, R16, and C15 provide over voltage protection for both supply outputs. On over voltage condition will trigger the Q3 gate via either VR2 or VR3. When SCR Q2 triggers, it directly pulls down the +12V output, and also clamps the +5V output via D4, forcing the power supply into auto-restart. Components R14 and C15 help prevent false triggering of Q2.

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5 PCB Layout

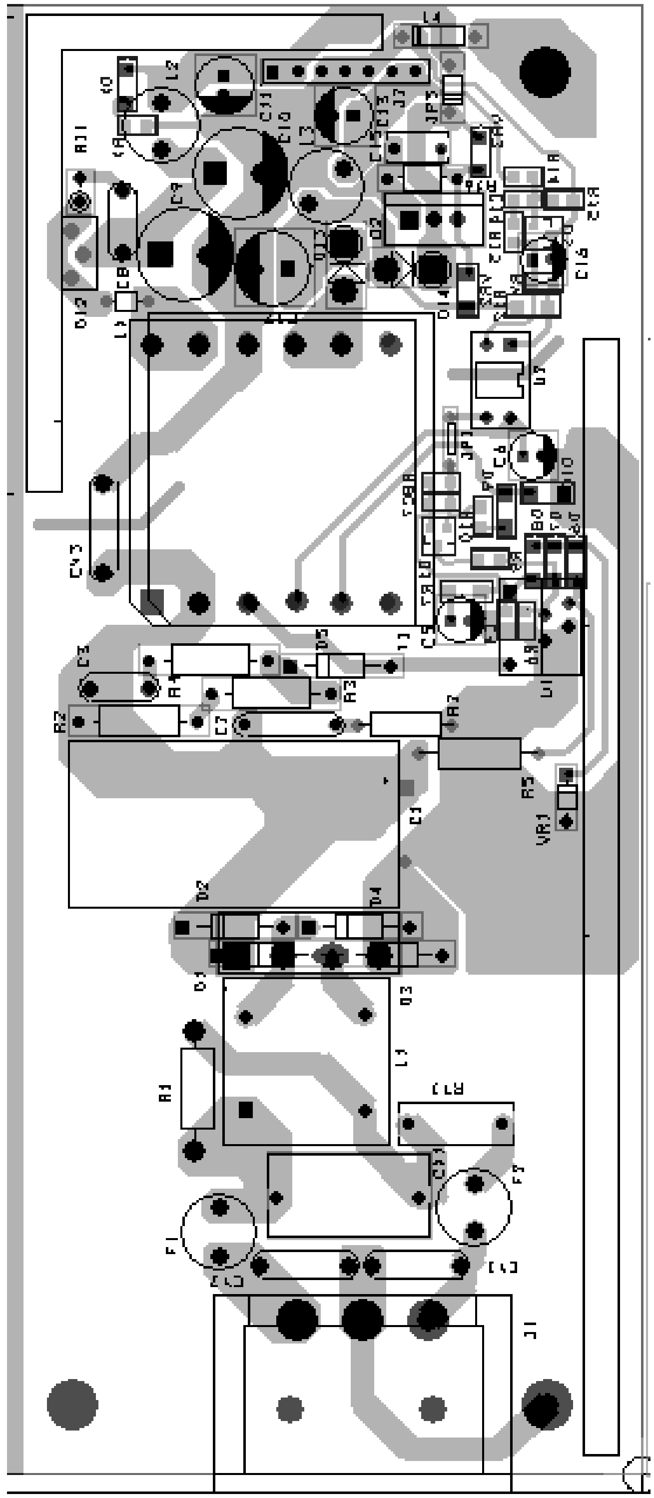

Figure 2 – Printed Circuit Layout.

6 Bill Of Materials

Bill Of Materials

Item	Qty	Reference	Description	P/N	Manufacturer
1	1	U1		TOP246	Power Integrations
2	1	U2	Optocoupler, controlled CTR	LTV817A	Liteon
3	1	U3	Shunt regulator, SOT-23	LM431AIM3	National
4	2	Q1,2	Transistor, PNP, SOT-23	MMBT3906	any
5	1	Q3	SCR, 8A	S2008VS2	Teccor
6	1	VR2	Zener Diode, 5.6V, 500mW	ZMM5232B	Diodes, Inc.
7	1	VR3	Zener Diode, 18V, 500mW	ZMM5248B	Diodes, Inc.
8	1	RT1	Thermistor, 5Ω, 3A		
9	4	D1-4	Diode, 2A, 600V	RL205	Rectron
10	1	D5	1000V, 1A, GP	1N4007G	Diodes, Inc
11	5	D9-10	Diode, Signal	LL4148	Diodes, Inc.
12	1	D12	Schottky,100V, 20A,	MBR20100CT	General Semiconductor
13	1	D13	Schottky, 5A, 40V,	SB540	General Semiconductor
14	1	D14	Diode, 50V, 3A	1N5400	Any
15	1	CX1	X2 capacitor, 330nF		
16	2	CY1,CY2	Y1 Capacitor,330pF		Any
17	1	CY3	Y1 Capacitor,2.2nF		Any
18	1	C1	100 uF, 400V, 105C		Any
19	1	C3	Ceramic Disc, 10nF, 1kV		Any
20	2	C4,14	100 nF, 50V, ceramic 0805		Any
21	1	C5	47 uF, 16V, 105C , 5X11mm		Any
22	1	C7	Capacitor, ceramic, 220nF, 0805		Any
23	1	C6	47uF, 50V, 105C,		Any
24	1	C8	Capacitor, ceramic,470pF, 100V		Any
25	2	C9,10	680uF, 16V Electrolytic. Low ESR		Any
26	2	C11,13	100uF, 25V Electrolytic, 105C		Any
27	1	C12	680uF, 10V Electrolytic, Low ESR		Any
28	1	C15	47nF, 50V Ceramic		Any
29	1	C16	10uF, 35V, 105C, 5X11		Any
30	1	T1	Transformer, EFD30		Custom
21	1	L1	Balun, 5.3 mH, 1A		Any
32	2	L2,3	Inductor, 3.3uH, 3A		Any
33	1	L4	Ferrite Bead	2673021801	Fair-Rite
34	2	F1,2	Fuse, 3.15A, 250 VAC		Any
35	2	R1,5	2M, 5%, 1/2W		Any
36	2	R2,3	47k, 5%, 1/2W		Any
37	1	R4	33Ω, 5%, 1/2W		Any
38	1	R7	6.8Ω, 5%, 1206		Any
39	1	R6	8.2k, 5%, 0805		Any
40	1	R8	270, 5%, 0805		Any
41	2	R9,10	16k, 5%, 0805		
42	2	R10,21	1k, 5%, 0805		Any
43	1	R11	68Ω, 5%, 1/2W		Any
44	1	R12	270, 5%, 1206		Any
45	1	R13	3.3k, 5%, 0805		Any
46	2	R14,15	10k, 1%, 0805		Any
47	1	R16	1k, 5%, 0805		Any
48	1	R17	7.5M, 5%, 1/2W		Any

Note: Components VR1,D6,D7,D8 not required

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7 Transformer Specification

7.1 Electrical Diagram

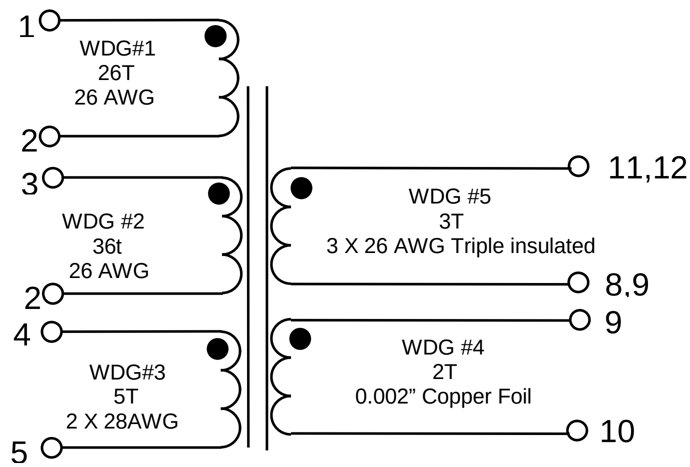

Figure 3 –Transformer Electrical Diagram

7.2 Electrical Specifications

Electrical Strength	1 second, 60 Hz, from Pins 1-6 to Pins 7-12	3000 VAC
Primary Inductance	Pins 2-3, all other windings open, measured at 100 kHz, 0.4 VRMS	364 μH, -0/+20%
Resonant Frequency	Pins 2-3, all other windings open	700 kHz (Min.)
Primary Leakage Inductance	Pins 2-3, with Pins 7-12 shorted, measured at 100 kHz, 0.4 VRMS	15 μH (Max.)

7.3 Materials

Item	Description
[1]	Core, EFD30, Nippon Ceramic NC-2H or equivalent, gap core to A_L of 275 nH/T^2
[2]	Bobbin: EFD 30, 12 pin Horizontal, Phenolic Material
[3]	Magnet Wire: 26 AWG Solderable Double Coated
[4]	Magnet Wire: 28 AWG Solderable Double Coated
[5]	Copper foil, 0.05 mm thick, 10mm wide
[6]	Tape, Polyester Web, 4mm wide, 3M Type 44 or equivalent
[7]	Tape, Polyester Film, Flame retardant, 12.2mm wide, 3M Type 1298 or equivalent
[8]	Tape, Polyester Film, Flame retardant, 15mm wide, 3M Type 1298 or equivalent
[9]	Tape, Polyester Film, Flame retardant, 20.4mm wide, 3M Type 1298 or equivalent
[10]	Teflon Sleeving, 24 AWG
[11]	Tinned Bus Wire, 24 AWG
[12]	Varnish

7.4 Transformer Build Diagram

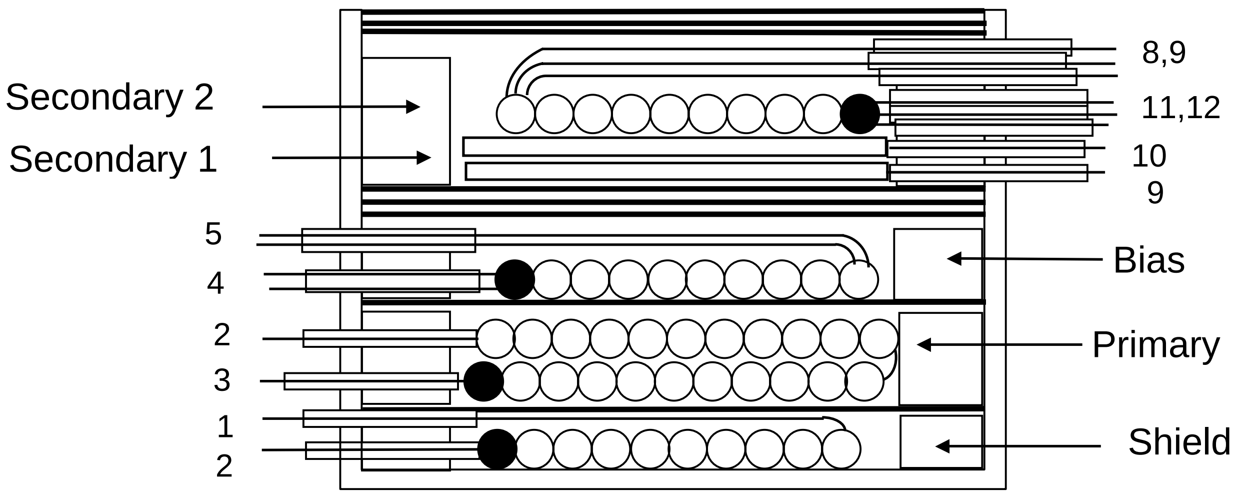

Figure 4 – Transformer Build Diagram.

7.5 Transformer Construction

Primary Margin 1	Apply a 4 mm wide margin to both sides of bobbin using item [6]. Match height of shield winding.
Shield Winding	Starting at Pin 2, wind 26 turns of item [3] in a single layer, finishing at Pin 1. Sleeve start and finish leads using item [10]
Basic Insulation	Use one layer of item [7] for basic insulation.
Primary Margin 2	Apply a 4 mm wide margin to both sides of bobbin using item [6]. Match height of primary and bias windings.
Primary	Starting at Pin 3, wind 36 turns of item [3] in approximately 1.7 layers, finishing on Pin 2. Sleeve start and finish leads using item [10].
Basic Insulation	Use one layer of item [7] for basic insulation.
Bifilar Bias Winding	Starting at Pin 4, wind 5 bifilar turns of item [4]. Spread turns evenly across bobbin. Finish at Pin 5. Sleeve start and finish leads using item [10].
Reinforced Insulation	Use three layers of item [9] for reinforced insulation.
Secondary Margin	Apply a 4 mm wide margin to both sides of bobbin using item [6]. Match height of secondary windings.
5V Foil Assembly	Using items, [5], [8], and [11], construct a cuffed foil assembly with leads 2" long. Starting at Pin 9, wind 2 turns of foil, finishing at pin 10. Sleeve start and finish leads using item [10].
12V Trifilar Secondary	Starting at Pins 11 and 12, Wind 3 trifilar turns of item [3]. Spread turns evenly across bobbin. Finish on Pins 8 and 9. Sleeve start and finish leads using item [10].
Finish Wrap	Wrap windings with 3 layers of tape [item [9].
Final Assembly	Assemble and secure core halves. Varnish impregnate (item [12]).

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8 Transformer Spreadsheet

ACDC_TOPGX_Rev1.2_052901 Copyright Power Integrations Inc. 2001	INPUT	INFO	INFO	OUTPUT	OUTPUT	UNIT	TOP_GX_052901.xls: TOPSwitch-GX Continuous/Discontinuous Flyback Transformer Design Spreadsheet
ENTER APPLICATION VARIABLES							Customer
VACMIN	90					Volts	Minimum AC Input Voltage
VACMAX	265					Volts	Maximum AC Input Voltage
fL	50					Hertz	AC Mains Frequency
VO	5					Volts	Output Voltage
PO	48					Watts	Output Power
n	0.82						Efficiency Estimate
Z	0.5						Loss Allocation Factor
VB	12					Volts	Bias Voltage
tC	3					mSeconds	Bridge Rectifier Conduction Time Estimate
CIN	100					uFarads	Input Filter Capacitor
ENTER TOPSWITCH-GX VARIABLES							
TOP-GX	TOP246					Universal	115 Doubled/230V
Chosen Device		TOP246	TOP246	Power Out	Power Out	90W	150W
KI	0.85						External Ilimit reduction factor (KI=1.0 for default ILIMIT, KI <1.0 for lower ILIMIT)
ILIMITMIN				2.066	2.066	Amps	Use 1% resistor in setting external ILIMIT
ILIMITMAX				2.525	2.525	Amps	Use 1% resistor in setting external ILIMIT
Frequency - (F)=132kHz, (H)=66kHz	f						Full (F) frequency option - 132kHz
fS	132000			1.32E+05	1.32E+05	Hertz	TOPSwitch-GX Switching Frequency: Choose between 132 kHz and 66 kHz
fSmin				1.24E+05	1.24E+05	Hertz	TOPSwitch-GX Minimum Switching Frequency
fSmax				1.40E+05	1.40E+05	Hertz	TOPSwitch-GX Maximum Switching Frequency
VOR	100					Volts	Reflected Output Voltage
VDS	10					Volts	TOPSwitch on-state Drain to Source Voltage
VD	0.5					Volts	Output Winding Diode Forward Voltage Drop
VDB	0.7					Volts	Bias Winding Diode Forward Voltage Drop
KP	0.60						Ripple to Peak Current Ratio (0.4 < KRP < 1.0 : 1.0< KDP<6.0)
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES							
Core Type	EFD30						
Core		EFD30	EFD30			P/N:	EFD30-3F3

Bobbin		EFD30_BOBBIN	EFD30_BOBBIN		P/N:	CSH-EFD30-1S-10P
AE			0.69	0.69	cm^2	Core Effective Cross Sectional Area
LE			6.8	6.8	cm	Core Effective Path Length
AL			1900	1900	nH/T^2	Ungapped Core Effective Inductance
BW			20.1	20.1	mm	Bobbin Physical Winding Width
M	4				mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	1.7					Number of Primary Layers
NS	2					Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS						
VMIN			89	89	Volts	Minimum DC Input Voltage
VMAX			375	375	Volts	Maximum DC Input Voltage
CURRENT WAVEFORM SHAPE PARAMETERS						
DMAX			0.56	0.56		Maximum Duty Cycle
IAVG			0.65	0.65	Amps	Average Primary Current
IP			1.68	1.68	Amps	Peak Primary Current
IR			1.01	1.01	Amps	Primary Ripple Current
IRMS			0.90	0.90	Amps	Primary RMS Current
TRANSFORMER PRIMARY DESIGN PARAMETERS						
LP			364	364	uHenries	Primary Inductance
NP			36	36		Primary Winding Number of Turns
NB			5	5		Bias Winding Number of Turns
ALG			275	275	nH/T^2	Gapped Core Effective Inductance
BM			2430	2430	Gauss	Maximum Flux Density at PO, VMIN (BM<3000)
BP			3657	3657	Gauss	Peak Flux Density (BP<4200)
BAC			729	729	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			1490	1490		Relative Permeability of Ungapped Core
LG			0.27	0.27	mm	Gap Length (Lg > 0.1 mm)
BWE			20.57	20.57	mm	Effective Bobbin Width
OD			0.57	0.57	mm	Maximum Primary Wire Diameter including insulation
INS			0.07	0.07	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.50	0.50	mm	Bare conductor diameter
AWG			25	25	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			323	323	Cmils	Bare conductor effective

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					area in circular mils
CMA		357	357	Cmils/Amp	Primary Winding Current Capacity (200 < CMA < 500)
TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT / SINGLE OUTPUT EQUIVALENT)					
Lumped parameters					
ISP		30.50	30.50	Amps	Peak Secondary Current
ISRMS		14.63	14.63	Amps	Secondary RMS Current
IO		9.60	9.60	Amps	Power Supply Output Current
IRIPPLE		11.05	11.05	Amps	Output Capacitor RMS Ripple Current
CMS		2927	2927	Cmils	Secondary Bare Conductor minimum circular mils
AWGS		15	15	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
DIAS		1.45	1.45	mm	Secondary Minimum Bare Conductor Diameter
ODS		6.05	6.05	mm	Secondary Maximum Outside Diameter for Triple Insulated Wire
INSS		2.30	2.30	mm	Maximum Secondary Insulation Wall Thickness
VOLTAGE STRESS PARAMETERS					
VDRAIN		605	605	Volts	Maximum Drain Voltage Estimate (Includes Effect of Leakage Inductance)
PIVS		26	26	Volts	Output Rectifier Maximum Peak Inverse Voltage
PIVB		60	60	Volts	Bias Rectifier Maximum Peak Inverse Voltage
TRANSFORMER SECONDARY DESIGN PARAMETERS (MULTIPLE OUTPUTS)					
1st output					
VO1	5.0			Volts	Output Voltage
IO1	1.800			Amps	Output DC Current
PO1		9.00	9.00	Watts	Output Power
VD1	0.5			Volts	Output Diode Forward Voltage Drop
NS1		2.00	2.00		Output Winding Number of Turns
ISRMS1		2.744	2.744	Amps	Output Winding RMS Current
IRIPPLE1		2.07	2.07	Amps	Output Capacitor RMS Ripple Current
PIVS1		26	26	Volts	Output Rectifier Maximum Peak Inverse Voltage
CMS1		549	549	Cmils	Output Winding Bare Conductor minimum

					circular mils
AWGS1		22	22	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS1		0.65	0.65	mm	Minimum Bare Conductor Diameter
ODS1		6.05	6.05	mm	Maximum Outside Diameter for Triple Insulated Wire
2nd output					
VO2	13.3			Volts	Output Voltage
IO2	3.000			Amps	Output DC Current
PO2		39.90	39.90	Watts	Output Power
VD2	0.5			Volts	Output Diode Forward Voltage Drop
NS2		5.02	5.02		Output Winding Number of Turns
ISRMS2		4.573	4.573	Amps	Output Winding RMS Current
IRIPPLE2		3.45	3.45	Amps	Output Capacitor RMS Ripple Current
PIVS2		65	65	Volts	Output Rectifier Maximum Peak Inverse Voltage
CMS2		915	915	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS2		20	20	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS2		0.81	0.81	mm	Minimum Bare Conductor Diameter
ODS2		2.41	2.41	mm	Maximum Outside Diameter for Triple Insulated Wire

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9 Performance Data

All measurements performed at room temperature, 60 Hz input frequency. Efficiency measurements were taken at nominal load (5V/1A, 13V/2.5A) and maximum load (5V/1.8A, 13V/3A). Standby load for input power measurements was 5V/0.04A, 13V/0A.

9.1 Efficiency

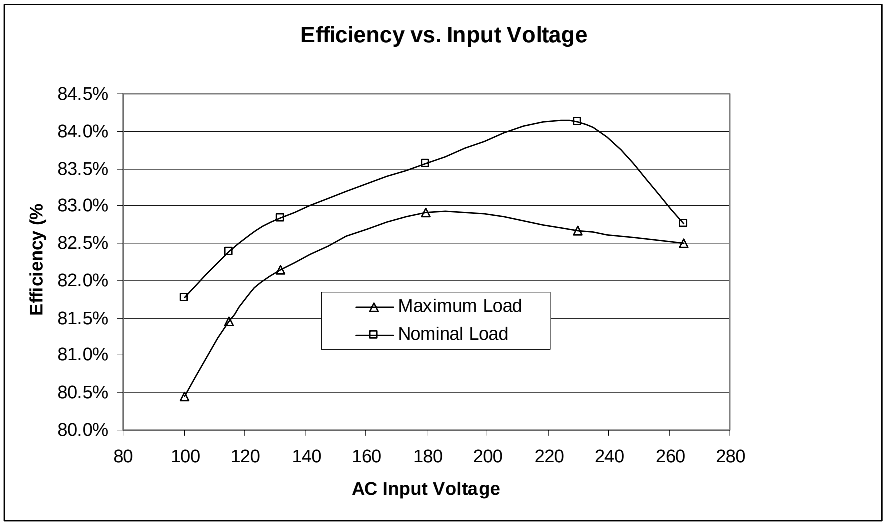

Figure 6- Efficiency vs. Input Voltage, Room Temperature, 60 Hz.

9.2 No-load and Standby Input Power

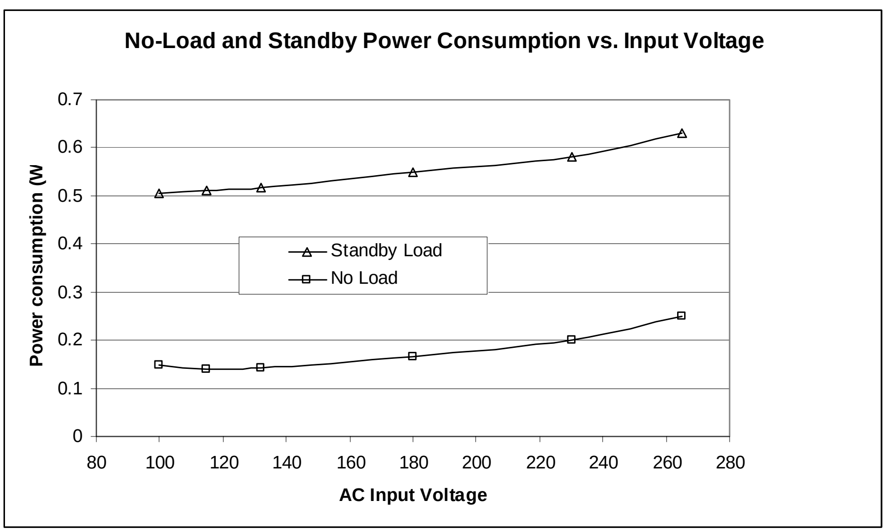

Figure 7- No-Load and Standby Input Power vs. Input Line Voltage, Room Temperature, 60 Hz.

9.3 Regulation Matrix

Vin	Pin	Iin	Vo1	Io1	Vo2	Io2	Pout	Eff
100	45.76	0.626	5.02	1	12.96	2.5	37.42	0.817745
100	53.81	0.735	5.02	1	12.89	3	43.69	0.811931
100	51.54	0.704	5.02	1.8	13.15	2.5	41.911	0.813174
100	60.12	0.82	5.02	1.8	13.11	3	48.366	0.804491
100	0.504	0.0165	5.02	0.04	15.39	0	0.2008	0.398413
100	0.147	0.013	5.02	0	13.35	0	0	0

Vin	Pin	Iin	Vo1	Io1	Vo2	Io2	Pout	Eff
115	45.3	0.557	5.02	1	12.92	2.5	37.32	0.823841
115	53.22	0.646	5.02	1	12.87	3	43.63	0.819805
115	51.15	0.624	5.02	1.8	13.13	2.5	41.861	0.818397
115	59.3	0.717	5.02	1.8	13.09	3	48.306	0.814604
115	0.51	0.017	5.02	0.04	15.48	0	0.2008	0.393725
115	0.139	0.014	5.02	0	13.38	0	0	0

Vin	Pin	Iin	Vo1	Io1	Vo2	Io2	Pout	Eff
132	45.05	0.497	5.02	1	12.92	2.5	37.32	0.828413
132	52.82	0.574	5.02	1	12.87	3	43.63	0.826013
132	50.76	0.553	5.02	1.8	13.12	2.5	41.836	0.824192
132	58.7	0.633	5.02	1.8	13.06	3	48.216	0.821397
132	0.518	0.018	5.02	0.04	15.57	0	0.2008	0.387645
132	0.143	0.016	5.02	0	13.42	0	0	0

Vin	Pin	Iin	Vo1	Io1	Vo2	Io2	Pout	Eff
180	44.57	0.378	5.02	1	12.89	2.5	37.245	0.835652
180	52.4	0.44	5.02	1	12.85	3	43.57	0.831489
180	50.37	0.424	5.02	1.8	13.08	2.5	41.736	0.828588
180	58.05	0.484	5.02	1.8	13.03	3	48.126	0.829044
180	0.55	0.023	5.02	0.04	15.65	0	0.2008	0.365091
180	0.165	0.022	5.02	0	13.51	0	0	0

Vin	Pin	Iin	Vo1	Io1	Vo2	Io2	Pout	Eff
230	44.33	0.31	5.02	1	12.91	2.5	37.295	0.841304
230	52.38	0.361	5.02	1	12.86	3	43.6	0.832379
230	49.95	0.346	5.02	1.8	13.1	2.5	41.786	0.836557
230	58.18	0.398	5.02	1.8	13.02	3	48.096	0.826676
230	0.58	0.028	5.02	0.04	15.64	0	0.2008	0.346207
230	0.2	0.0277	5.02	0	13.59	0	0	0

Vin	Pin	Iin	Vo1	Io1	Vo2	Io2	Pout	Eff
265	45.06	0.287	5.02	1	12.91	2.5	37.295	0.827674
265	52.15	0.326	5.02	1	12.87	3	43.63	0.836625
265	50.04	0.314	5.02	1.8	13.1	2.5	41.786	0.835052
265	58.41	0.359	5.02	1.8	13.05	3	48.186	0.824961
265	0.63	0.036	5.02	0.04	15.51	0	0.2008	0.31873
265	0.25	0.032	5.02	0	13.65	0	0	0

Table 1- Regulation and Efficiency Data

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10 Control Loop Measurements

10.1 115 VAC Maximum Load

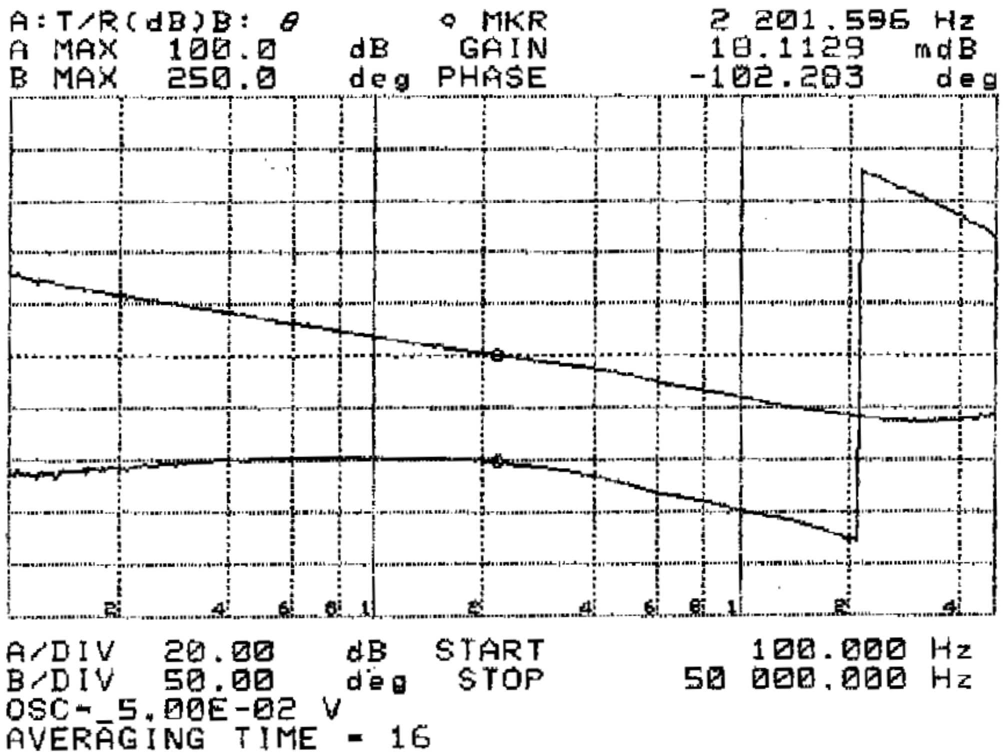

Figure 8 - Gain-Phase Plot, 115 VAC, Maximum Steady State Load
Vertical Scale: Gain = 20 dB/div, Phase = 50 °/div.
Crossover Frequency = 2.20 kHz Phase Margin = 77.7°

10.2 230 VAC Maximum Load

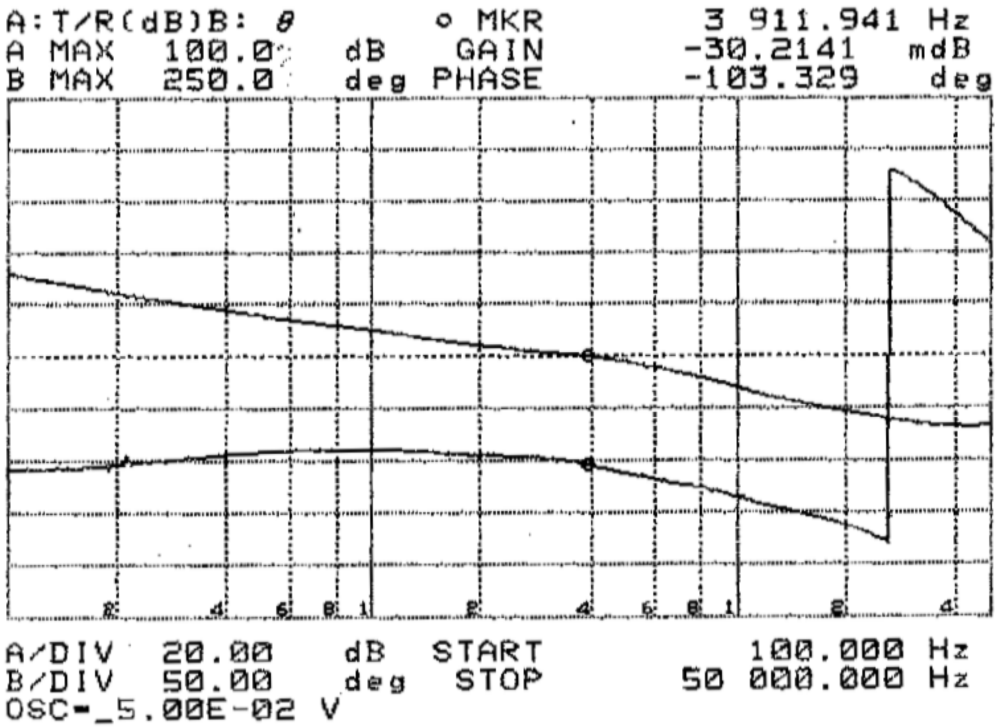

Figure 9 - Gain-Phase Plot, 230 VAC, Maximum Steady State Load
Vertical Scale: Gain = 20 dB/div, Phase = 50 °/div.
Crossover Frequency = 3.91 kHz, Phase Margin = 76.7°

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11 Conducted EMI

The power supply was tested at maximum output power with resistive loads, and mounted to a metal plate connecting secondary return to primary safety ground.

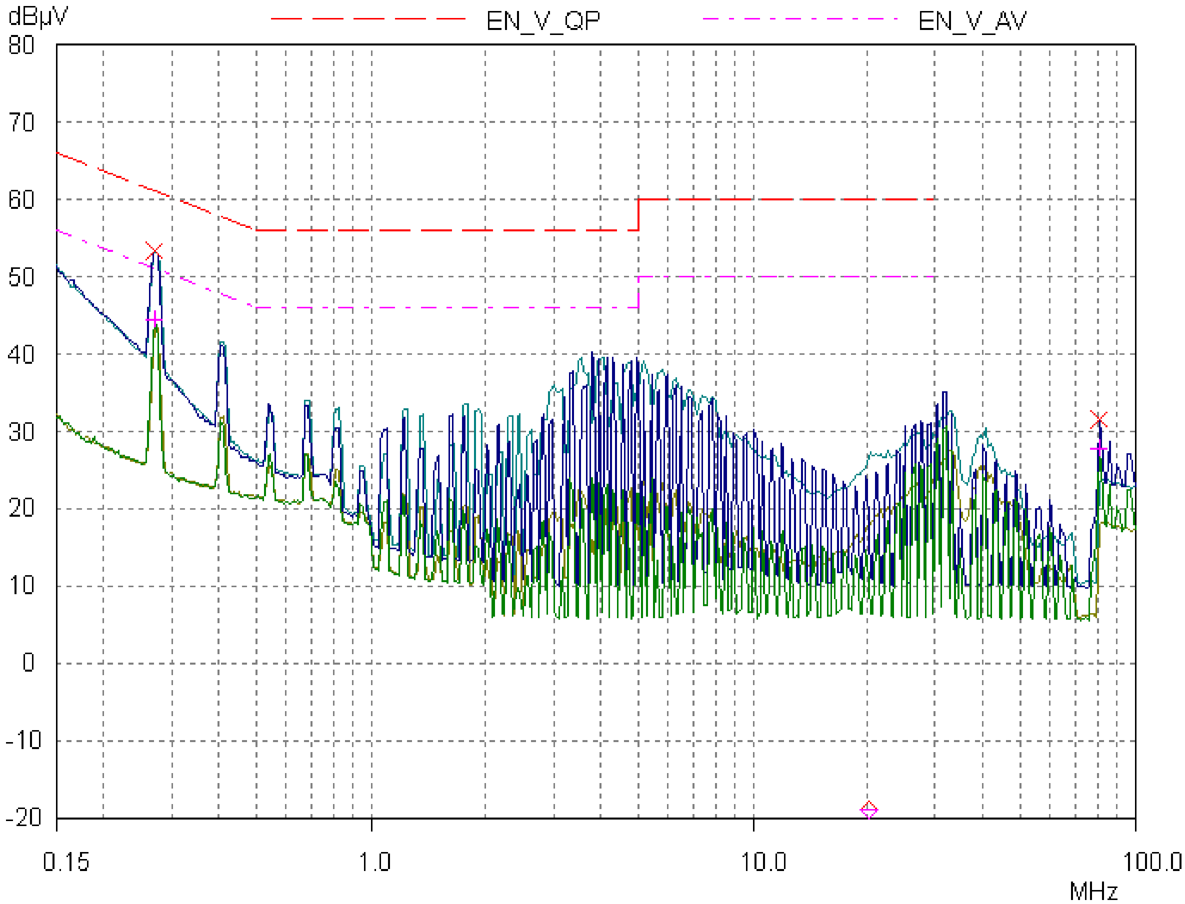

Figure 10 - Conducted EMI, Maximum Steady State Load, 115 VAC and 230V Scans Superimposed, 60 Hz, and EN55022 B Limits.

12 Revision History

Date	Author	Revision	Description & changes	Reviewed
March 30, 2004	RH	1.0	Initial Release	VC / AM

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