Title	***Engineering Prototype Report for EP-84 - <30 mW No-Load Consumption AC-DC Power Supply Using TNY264P*** (***TinySwitch®-II***)
Specification	85 VAC to 265 VAC Input, 5 V, 600 mA, 3 W Output
Application	Cell Phone Charger
Author	Power Integrations Application Department
Document Number	EPR–84
Date	23-May-05
Revision	1.0

Summary and Features

- Less than 30 mW no-load power consumption over universal input range
- Meets EN55022/CISPR22 Class B without a Y capacitor
- Low cost, low component-count solution
- Active mode average efficiency exceeds the minimum CEC requirements with good margin at 115 VAC & 230 VAC

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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Important Note:
Although this circuit board has been designed to meet 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.

1 Introduction

This engineering report describes a constant voltage, constant current (CV/CC) 5 VDC, 600 mA wall-mounted charger for cell phones, PDAs or other battery powered portable devices. It was designed around a *TinySwitch-II* IC and is intended as a general-purpose evaluation platform for the *TinySwitch-II* product family. The key performance characteristic of this circuit is its extremely low no-load power consumption of 30 mW.

This report contains the specification of the power supply, its circuit diagram, the overall bill of materials (BOM) for the supply, transformer construction documentation, including a copy of the *PI Expert* Design results worksheet, the printed circuit board layout, and the circuit's electrical performance data, including conducted EMI measurements.

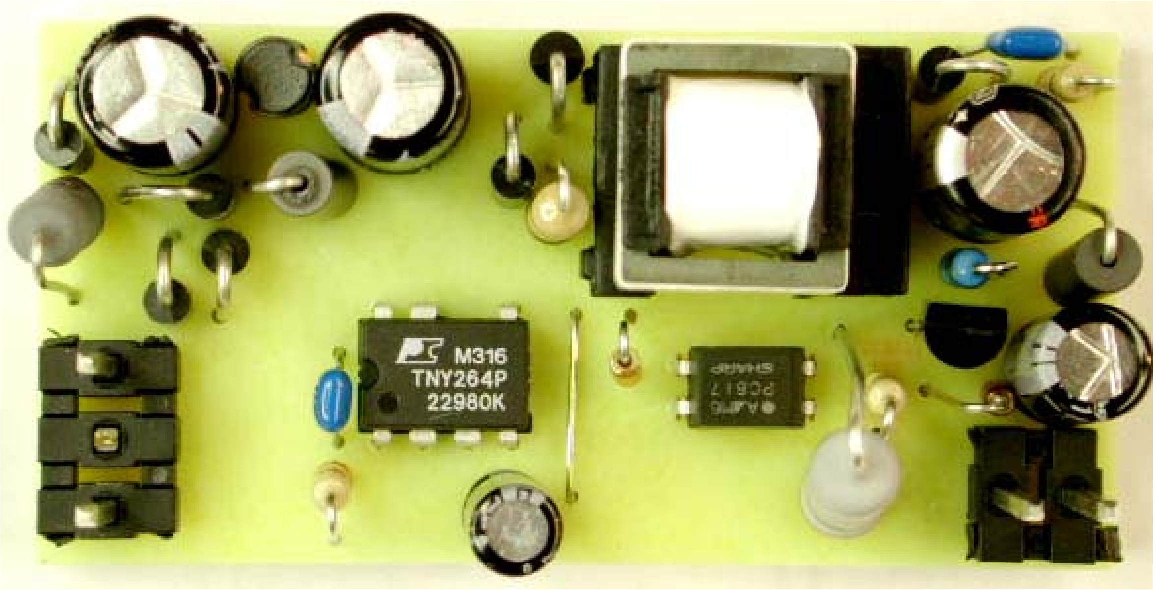


Figure 1 – Populated Circuit Board Photograph.

2 Power Supply Specification

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	85		265	VAC	2 Wire – no Protective Earth
Frequency	f_{LINE}	47	50/60	64	Hz	
No-load Input Power (230 VAC)				0.03	W	
Output						
Output Voltage 1	V_{OUT1}		5.0		V	± 5%
Output Ripple Voltage 1	$V_{RIPPLE1}$			100	mV	20 MHz BW, battery loaded
Output Current 1	I_{OUT1}		0.6		A	CC Mode
Total Output Power						
Continuous Output Power	P_{OUT}			3.0	W	
Peak Output Power	P_{OUT_PEAK}			3.0	W	
Efficiency	η		60		%	Measured at P_{OUT} (3 W), 25 °C
Environmental						
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Ambient Temperature	T_{AMB}	0		40	°C	Free convection, sea level

3 Schematic

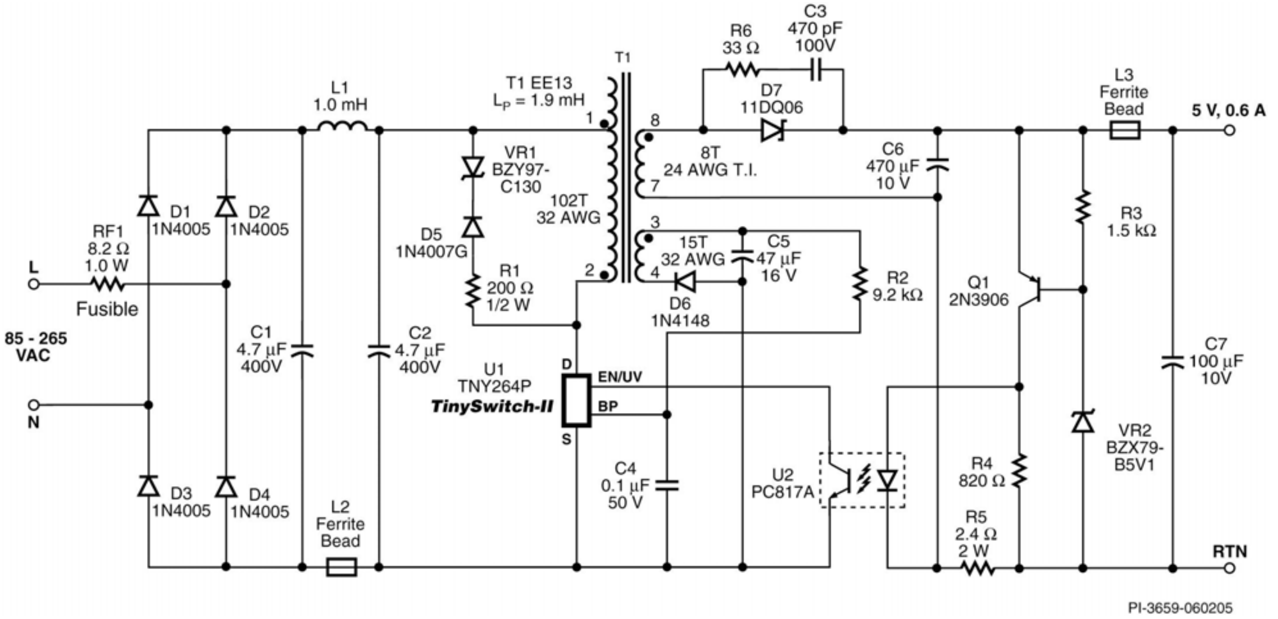


Figure 2 – EP-84 Schematic.

4 Circuit Description

This circuit is configured as a flyback. The ultra-low standby consumption is achieved by powering the IC from an auxiliary primary transformer winding, which disables the internal high voltage current source that normally powers the device directly from its DRAIN pin. Details of specific circuit functions will be described more fully in the following paragraphs.

4.1 Input Rectification, Bulk Capacitance and EMI Filtering

AC input power is rectified by a full bridge, consisting of D1 through D4. The rectified DC is then filtered by the bulk storage capacitors C1 and C2. Inductor L1 and ferrite bead L2 separate C1 and C2 from each other. Components L1, C1 and C2 form a pi (π) filter, which attenuates conducted differential-mode EMI noise. Fusible resistor RF1 has multiple functions. It is a fuse, an in-rush current limiting device, a final low pass filter stage (with C1) for conducted EMI attenuation, and an initial stage of input surge voltage attenuation.

4.2 Primary DRAIN Voltage Clamp Circuit

The DRAIN voltage clamp circuit is comprised of Zener diode VR1, R1 and diode D5. D5 and VR1 clamp the amplitude of the voltage spike that the transformer leakage inductance generates at switch turn-off, to keep it beneath the device's maximum DRAIN-to-SOURCE voltage rating (700 V). Resistor R1 damps the high frequency oscillation caused by leakage inductance, which improves the conducted EMI performance of the circuit. The reflected output voltage V_{OR}, which is determined by the transformer turns ratio (13:1), has been kept low (89 V) to minimize the power dissipation in the clamp circuit.

4.3 Auxiliary Bias Supply

The auxiliary bias supply circuit is made up of the primary-side transformer bias winding, diode D6, capacitor C5 and resistor R2. Diode D6 rectifies the output of the winding and C5 filters it. The winding has just enough turns so that it will provide 550 µA to 600 µA (through R2) into the BYPASS (BP) pin at no-load (which fully disables the internal current source). The bias winding is wound between the main primary winding and the core. By being "sandwiched" in the middle, it acts as a "shield" between the primary and the core. In that capacity, it reduces primary-to-core induced displacement current and therefore, EMI generation. C4 is the standard BP pin decoupling capacitor, which should always be a 50 V, 0.1 µF ceramic capacitor, located close to the IC.

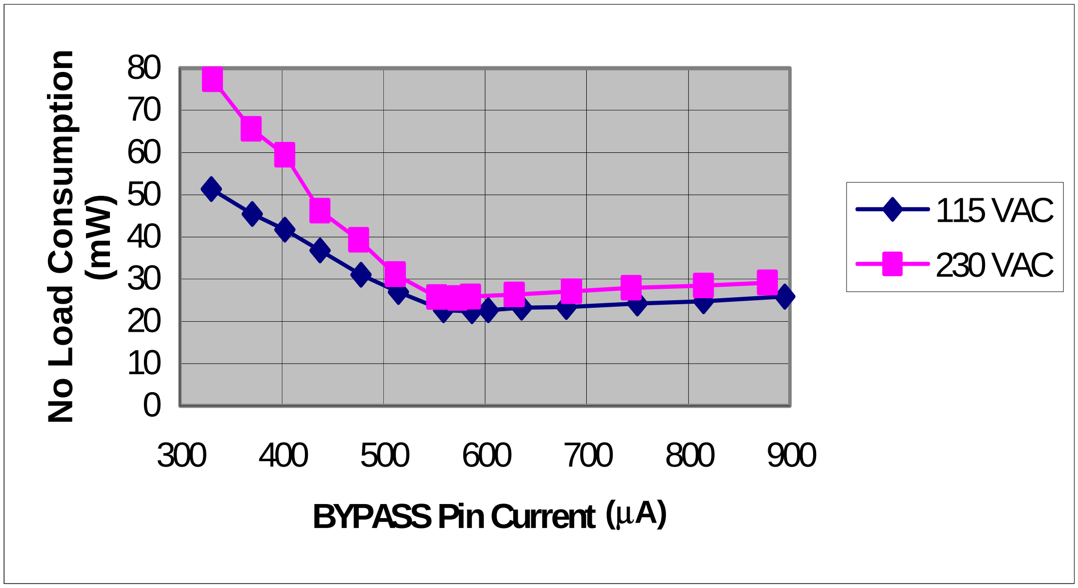


Figure 3 – No-load Consumption vs. BYPASS Pin Current.

4.4 Output Rectification and Filtering

Output rectification and filtering are accomplished by Schottky diode D7, capacitors C6 and C7 and ferrite bead L3. Resistor R6 and C3 dampen out the high frequency interaction between D7, T1 and U1 to reduce conducted EMI noise generation. Capacitor C6 filters the initial rectified output, while L3 and C7 serve as a secondary low-pass filter stage, which further attenuates the output ripple voltage.

4.5 Output Voltage Sensing, Feedback and Constant Current Control

Transistor Q1, resistors R3, R4 and R5, Zener diode VR2, and opto-isolator U2 sense the output voltage and current, and feedback their information to the *TinySwitch-II* controller. Components Q1, R3, VR2 and U2 comprise the constant voltage (CV) mode control loop while R4, R5 and U2 make up the constant current (CC) mode control loop.

<u>CC Mode Operation</u>
When the battery (load) is discharged, little voltage will be developed across the output of the charger before the desired current limit (600 mA) is surpassed. Whenever the current through R5 exceeds 600 mA, enough voltage develops across R4 to forward bias U2's LED, turning its phototransistor on. This causes the *TinySwitch-II* to skip switching cycles until the output current no longer exceeds 600 mA. Thus, until the output current drops below 600 mA, R4, R5 and U2 comprise the CC control loop.

CV Mode Operation

During CV operation the output voltage is determined by the voltage across R3 and the value of VR2. The value of R3 is selected such that as Q1 turns on, at the transition of CC to CV operation, the current through VR2 is close to its test current. The voltage across R3 is equal to the V_{BE} of Q1 (~0.6 V) value to be calculated. By adjusting the value of R3 the output voltage can be tuned to take account of cable drop and the discrete values of VR2. Once Q1 is biased on current is fed thorough U2's LED, turning its phototransistor on.

4.6 Transformer: Conducted EMI Noise Cancellation and Suppression Windings

Transformer T1 has 2 shield windings, one combined with the bias winding and one between primary and secondary. These act to reduce primary to secondary displacement currents, which reduces common-mode conducted EMI. Both additional windings are detailed in Section 7, Transformer Specification.

5 PCB Layout

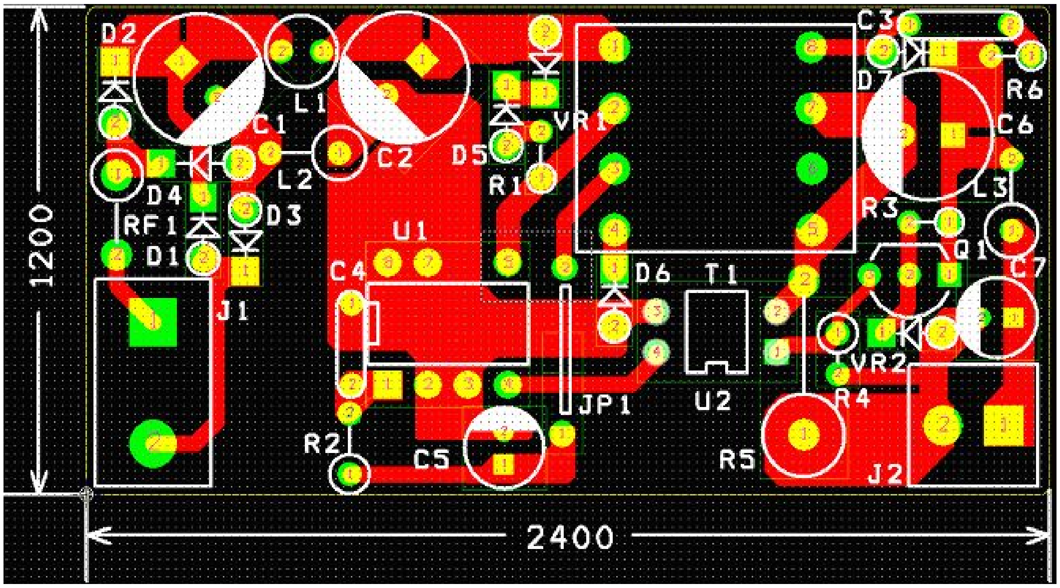


Figure 4 – Printed Circuit Layout (dimensions 0.001″).

6 Bill Of Materials

Item	Qty	Reference	Description	P/N	Manufacturer
1	2	C1, C2	4.7 µF, 400 V, electrolytic capacitor		Any
2	1	C3	470 pF, 100 V, ceramic		Any
3	1	C4	0.1 µF, 50 V, ceramic		Any
4	1	C5	47 µF, 16 V, low ESR electrolytic		Any
5	1	C6	470 µF, 10 V, low ESR electrolytic		Any
6	1	C7	100 µF, 10 V, low ESR electrolytic		Any
7	4	D1–D4	1 A, 600 V, general purpose diode	1N4005	Any
8	1	D5	1 A, 600 V, glass passivated diode	1N4007G	Any
9	1	D6	200 mA, 100 V diode	1N4148	Any
10	1	D7	1 A, 60 V, Schottky diode	11DQ06	Any
11	1	VR1	130 V, 1.5 W, Zener diode	BZY97C130	Vishay
12	1	VR2	5.1 V, 2%, Zener diode	BZX79B5V1	Vishay
13	1	L1	Inductor, 1.0 mH		Tokin
14	2	L2, L3	Ferrite bead		Any
15	1	RF1	8.2 Ω, 1 W fusible resistor		Vitrohm
16	1	R1	200 Ω, 1/2 W		Any
17	1	R2	9.2 kΩ, 1/8 W		Any
18	1	R3	1.5 kΩ, 1/8 W		Any
19	1	R4	820 Ω, 1/8 W		Any
20	1	R5	2.4 Ω, 2.0 W		Any
21	1	R6	33 Ω, 1/4 W		Any
22	1	Q1	General purpose PNP BJT	2N3906	Philips
23	1	T1	Transformer EE13	Custom	
24	1	U1	Low power off-line switcher IC	TNY264P	PI
25	1	U2	Optocoupler	PC817A	Sharp

7 Transformer Specification

7.1 Electrical Diagram

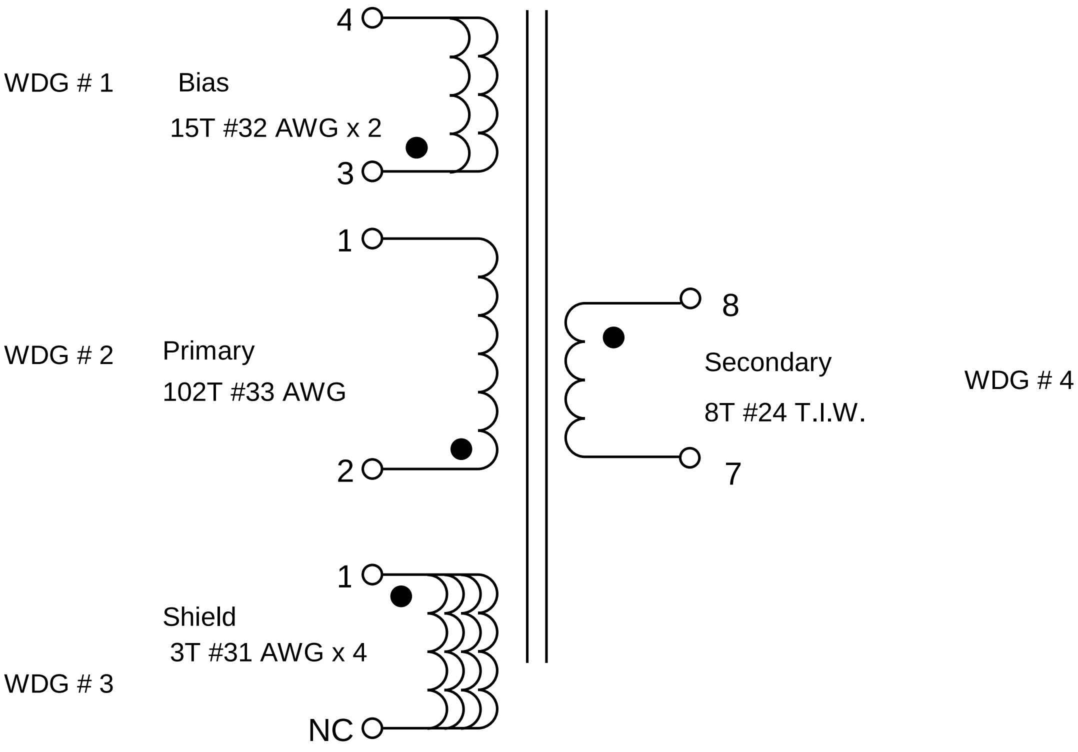


Figure 5 –Transformer Electrical Diagram.

7.2 Electrical Specifications

Electrical Strength	1 second, 60 Hz, from Pins 1-4 to Pins 7-8	3000 VAC
Primary Inductance	Pins 1-2, all other windings open, measured at 100 kHz, 0.4 V RMS	1.89 mH +/- 10%
Resonant Frequency	Pins 1-2, all other windings open	800 kHz (Min.)
Primary Leakage Inductance	Pins 1-2, with Pins 7-8 shorted, measured at 132 kHz, 0.4 V RMS	25 µH (Max.)

7.3 Materials

Item	Description
[1]	Core: EE13, TDK PC40 or equivalent. ALG 180 nH/t^2
[2]	Bobbin: Horizontal 8 pin, EE13, Hical
[3]	Magnet Wire: #31 AWG (Shield winding)
[4]	Magnet Wire: #32 AWG (Bias winding)
[5]	Magnet Wire: #33 AWG (Primary winding)
[6]	Triple Insulated Wire: #24 AWG (Secondary winding)
[7]	Tape: 3M 1298 Polyester Film (white) 299 mils (7.6 mm) wide by 2.0 mils thick

7.4 Transformer Build Diagram

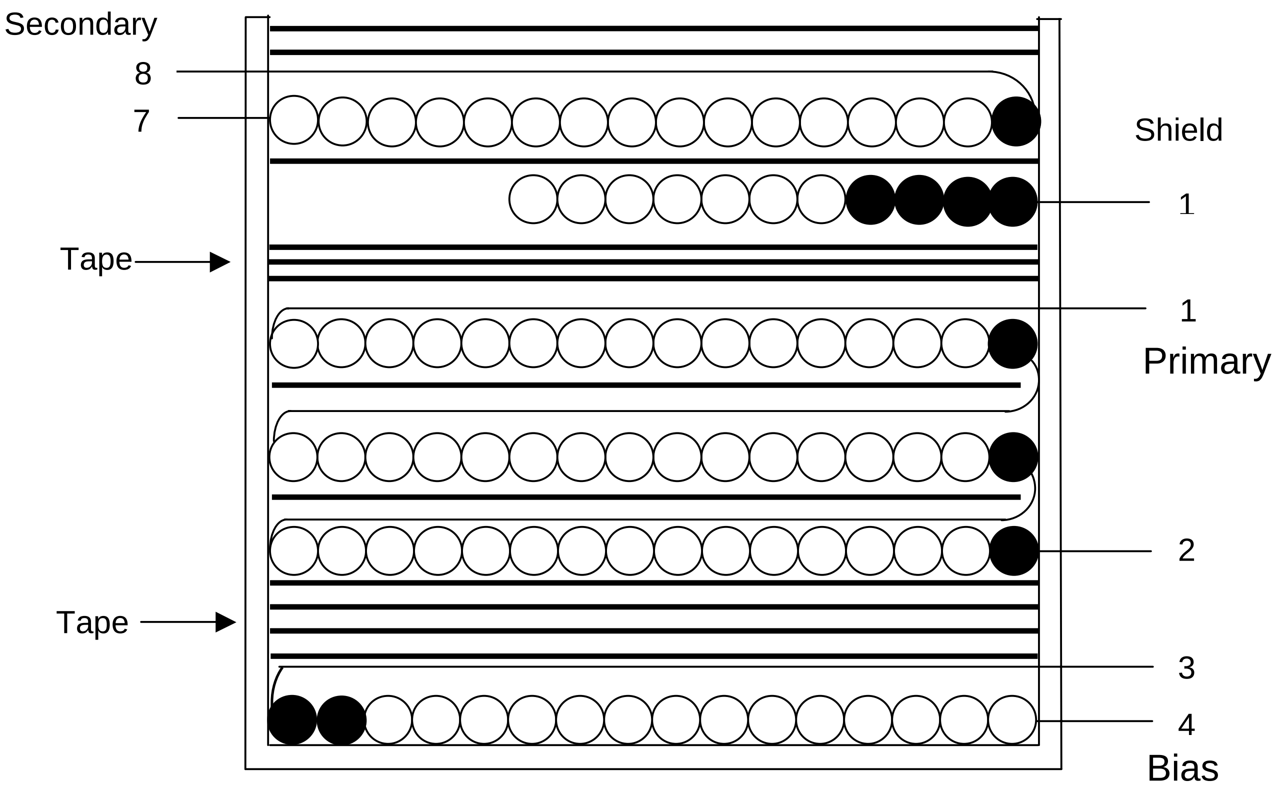


Figure 6 – Transformer Build Diagram.

7.5 Transformer Construction

Set Bobbin	Set the bobbin Pin 1 - Pin 4 right-hand side. Pin 1 would be located at top right side.
Bias and Core Cancellation	Start at Pin 6 temporarily. Wind 15 turns of item [4] with 2 in parallel (bifilar) from left to right uniformly without any space between turns, in a single layer across the entire width of the bobbin. Finish on Pin 4. Move the start end from Pin 6 to Pin 3.
Insulation	Add 4 Layers of tape [7] for insulation.
Primary Winding Layer	Start at Pin 2. Wind 34 turns of item [5] from right to left. After finishing the first layer, return to right and add one layer of the tape. Then wind 34 turns of item [4] from right to left; after finishing the second layer, return to right and add one layer of the tape. Again, wind 34 turns of item [4] from right to left; after finishing the third layer, return to right and finish on Pin 1. Wind all layers uniformly without any space between turns.
Insulation	Add 3 Layers of tape [7] for insulation.
Shield Winding	Start at Pin 1. Wind 3 turns of item [3] with four wires (quadfilar) in parallel from right to left uniformly without any space between turns during winding, in a single layer across 60% of the bobbin width. Cut the wires after finishing the third turn.
Insulation	Add 1 Layer of tape [7] for insulation.
Secondary Winding	Temporarily start at Pin 3. Wind 8 turns of item [6] from right to left in a layer without any space between adjacent turns, across the entire width of the bobbin; finish on Pin 7. Then move the Start lead to Pin 8.
Outer Insulation	Add 2 Layers of tape [7] for insulation.

8 Transformer Spreadsheets

ACDC_TNY-II_Rev1_1_032701 Copyright Power Integrations Inc. 2001	**INPUT**	**INFO**	**OUTPUT**	**UNIT**	**ACDC_TNYII_Rev1_1_032701.xls: TinySwitch-II Continuous/Discontinuous Flyback Transformer Design Spreadsheet**
ENTER APPLICATION VARIABLES					
VACMIN	85			Volts	Minimum AC Input Voltage
VACMAX	265			Volts	Maximum AC Input Voltage
fL	50			Hertz	AC Mains Frequency
VO	5			Volts	Output Voltage
PO	3.38			Watts	Output Power
n	0.52				Efficiency Estimate
Z	0.65				Loss Allocation Factor
tC	3			ms	Bridge Rectifier Conduction Time Estimate
CIN	9.4			uFarads	Input Filter Capacitor
ENTER TinySwitch-II VARIABLES					
TNY-II	**TNY264**			*Universal*	*85 VAC to 265 VAC*
Chosen Device		*TNY264*	*Power Out*	*6W*	*9W*
ILIMITMIN			*0.233*	Amps	*TinySwitch-II* Minimum Current Limit
ILIMITMAX			*0.267*	Amps	*TinySwitch-II* Maximum Current Limit
fS			*132000*	Hertz	*TinySwitch-II* Switching Frequency
fSmin			*120000*	Hertz	*TinySwitch-II* Minimum Switching Frequency (inc. jitter)
fSmax			*144000*	Hertz	*TinySwitch-II* Maximum Switching Frequency (inc. jitter)
VOR	88.8			Volts	Reflected Output Voltage
VDS	9.6			Volts	*TinySwitch-II* on-state Drain to Source Voltage
VD	1.94			Volts	Output Winding Diode Forward Voltage Drop
KP			**0.65**		Ripple to Peak Current Ratio (0.6<KRP<1.0 : 1.0<KDP<6.0)
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES					
Core Type	**ee13**				
Core		*#N/A*		*P/N:*	#N/A
Bobbin		*#N/A*		*P/N:*	#N/A
AE		0.171	0.171	cm^2	Core Effective Cross Sectional Area
LE		3.02	3.02	cm	Core Effective Path Length
AL		1130	1130	nH/T^2	Ungapped Core Effective Inductance
BW		7.4	7.4	mm	Bobbin Physical Winding Width
M	0			mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	**3**				Number of Primary Layers
NS	**8**				Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS					
VMIN			69	Volts	Minimum DC Input Voltage
VMAX			375	Volts	Maximum DC Input Voltage

CURRENT WAVEFORM SHAPE PARAMETERS					
DMAX			0.60		Maximum Duty Cycle
IAVG			0.09	Amps	Average Primary Current
IP			0.23	Amps	Minimum Peak Primary Current
IR			0.15	Amps	Primary Ripple Current
IRMS			0.13	Amps	Primary RMS Current
TRANSFORMER PRIMARY DESIGN PARAMETERS					
LP			1890	uHenries	Primary Inductance
NP			102		Primary Winding Number of Turns
ALG			180	nH/T^2	Gapped Core Effective Inductance
BM			**2883**	Gauss	Flux Density, IP (BP<3000)
BAC			819	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur			1588		Relative Permeability of Ungapped Core
LG			**0.10**	mm	Gap Length (Lg > 0.1 mm)
BWE			22.2	mm	Effective Bobbin Width
OD			0.22	mm	Maximum Primary Wire Diameter including insulation
INS			0.04	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA			0.17	mm	Bare conductor diameter
AWG			34	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM			40	Cmils	Bare conductor effective area in circular mils
CMA			**319**	Cmils/Amp	Primary Winding Current Capacity (200 < CMA < 500)
TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT / SINGLE OUTPUT EQUIVALENT)					
Lumped parameters					
ISP			2.98	Amps	Peak Secondary Current
ISRMS			1.32	Amps	Secondary RMS Current
IO			0.68	Amps	Power Supply Output Current
IRIPPLE			1.14	Amps	Output Capacitor RMS Ripple Current
CMS			264	Cmils	Secondary Bare Conductor minimum circular mils
AWGS			25	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
DIAS			0.46	mm	Secondary Minimum Bare Conductor Diameter
ODS			0.93	mm	Secondary Maximum Outside Diameter for Triple Insulated Wire
INSS			0.23	mm	Maximum Secondary Insulation Wall Thickness
VOLTAGE STRESS PARAMETERS					
VDRAIN			581	Volts	Maximum Drain Voltage Estimate (Includes Effect of Leakage Inductance)
PIVS			34	Volts	Output Rectifier Maximum Peak Inverse Voltage

TRANSFORMER SECONDARY DESIGN PARAMETERS (MULTIPLE OUTPUTS)					
1^{st} output					
VO1	5.0			Volts	Output Voltage
IO1	0.600			Amps	Output DC Current
PO1			3.00	Watts	Output Power
VD1	1.9			Volts	Output Diode Forward Voltage Drop
NS1			8.00		Output Winding Number of Turns
ISRMS1			1.173	Amps	Output Winding RMS Current
IRIPPLE1			1.01	Amps	Output Capacitor RMS Ripple Current
PIVS1			34	Volts	Output Rectifier Maximum Peak Inverse Voltage
CMS1			235	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS1			26	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS1			0.41	mm	Minimum Bare Conductor Diameter
ODS1			0.93	mm	Maximum Outside Diameter for Triple Insulated Wire
2nd output					
VO2	12.0			Volts	Output Voltage
IO2	0.001			Amps	Output DC Current
PO2			0.01	Watts	Output Power
VD2	0.7			Volts	Output Diode Forward Voltage Drop
NS2			14.64		Output Winding Number of Turns
ISRMS2			0.001	Amps	Output Winding RMS Current
IRIPPLE2			0.00	Amps	Output Capacitor RMS Ripple Current
PIVS2			66	Volts	Output Rectifier Maximum Peak Inverse Voltage
CMS2			0	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS2			56	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS2			0.01	mm	Minimum Bare Conductor Diameter
ODS2			0.51	mm	Maximum Outside Diameter for Triple Insulated Wire

9 Performance Data

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

9.1 Efficiency

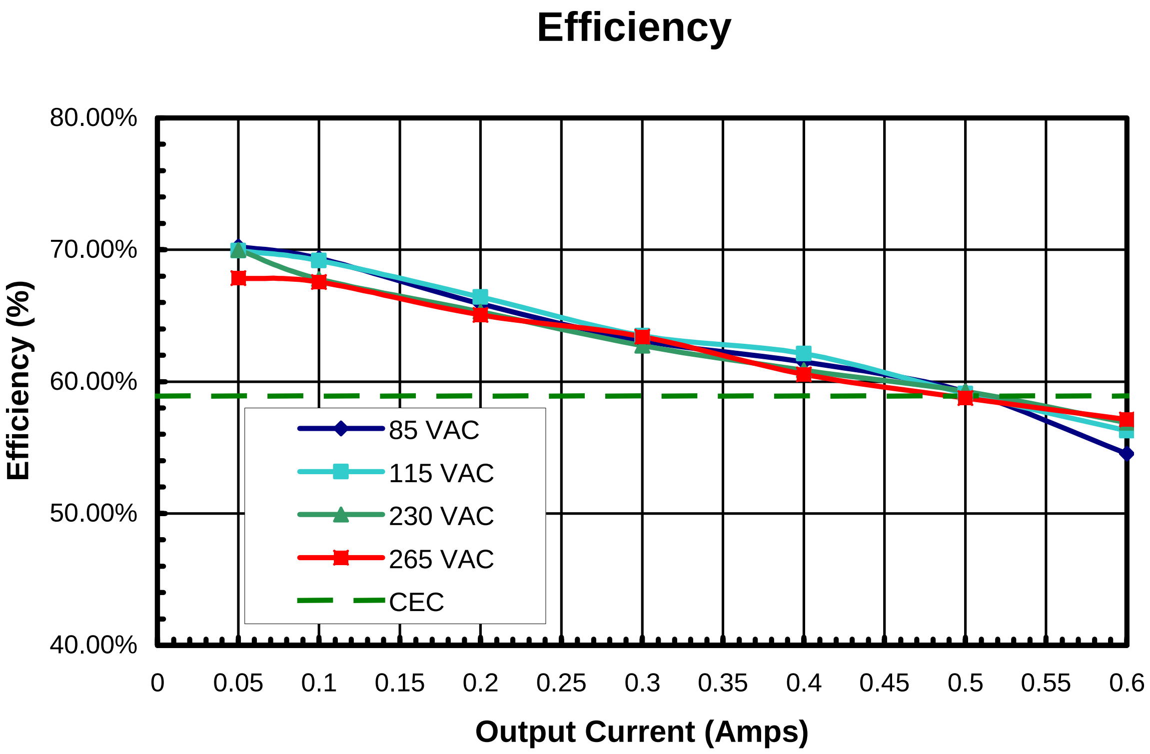


Figure 7 – Efficiency vs. Output Current at Four Line Voltages, Room Temperature, 60 Hz.

The CEC requirement for a 3 W charger is an average of 58.9% at both 115 VAC and 230 VAC*.

POWER LEVEL	25%	50%	75%	100%	Ave
115 VAC	67.8%	63.5%	60.6%	56.7%	62.2%
230 VAC	66.5%	62.6%	60.1%	56.9%	61.5%

The average efficiency exceeds the CEC requirement by a considerable margin at both input voltages.

*Refer to the California Energy Commission Appliance Efficiency Regulations (CEC 400-2005-012).

9.2 No-load Input Power

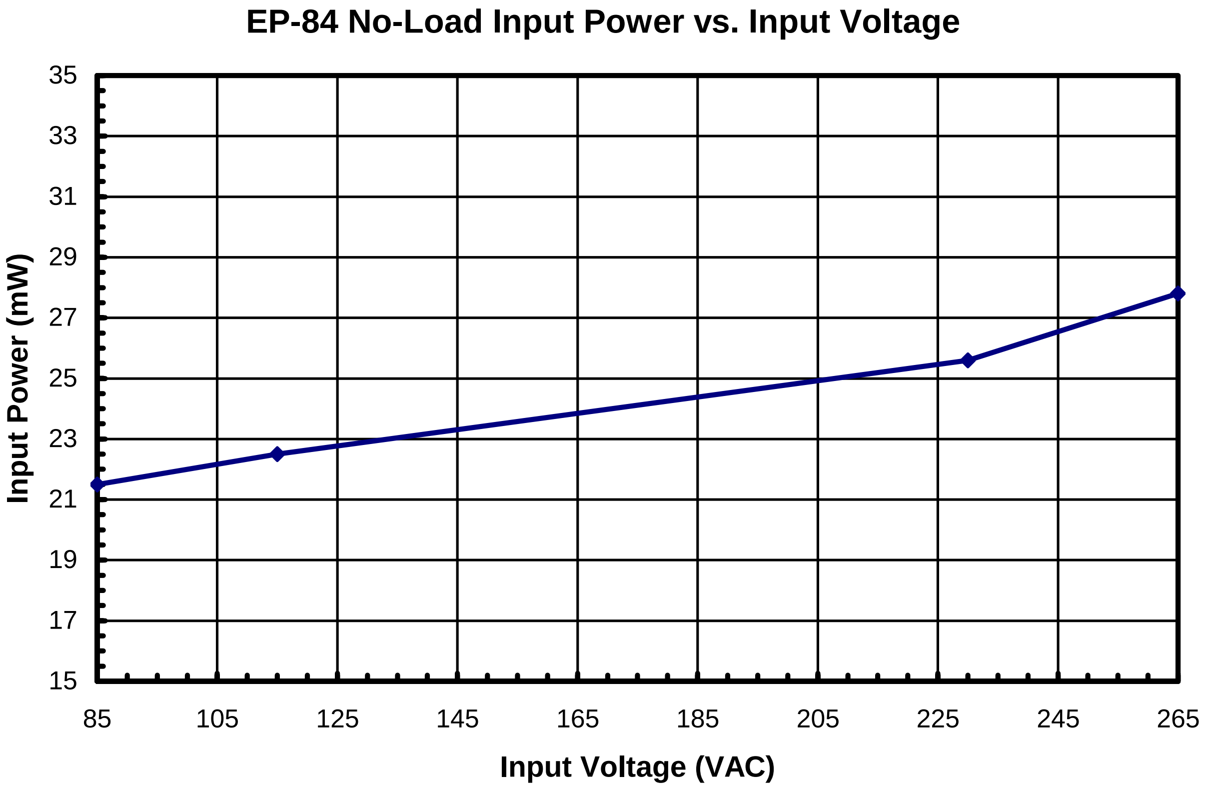


Figure 8 – No-Load Input Power vs. Input Line Voltage, Room Temperature, 60 Hz.

9.3 Regulation

9.3.1 Load

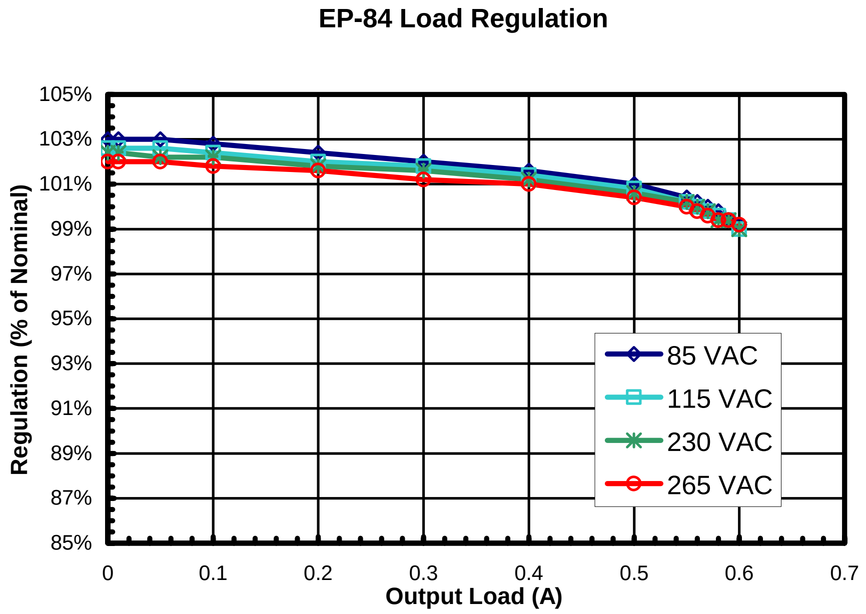


Figure 9 – Load Regulation, Room Temperature.

9.3.2 Line

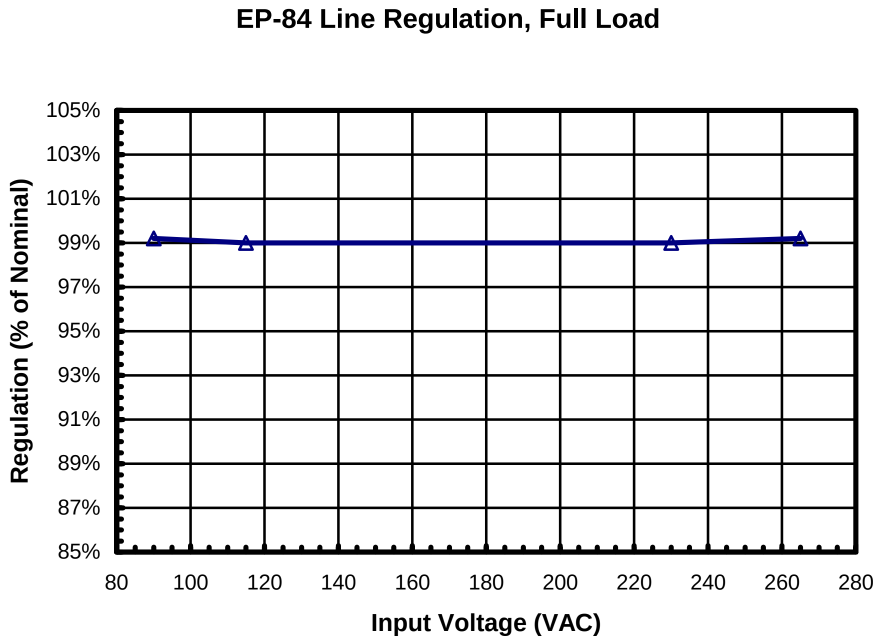


Figure 10 – Line Regulation, Room Temperature, Full Load.

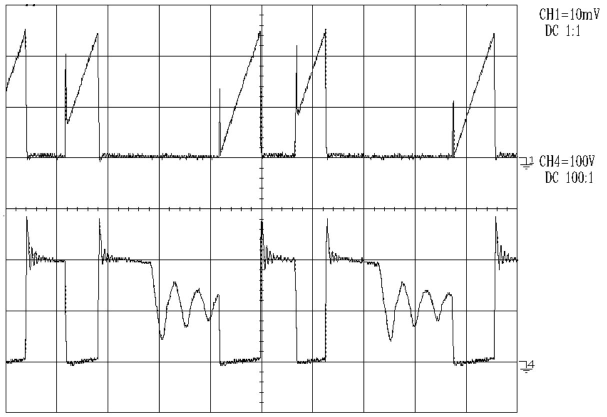
10 Thermal Performance

Temperature (°C)		
Item	**85 VAC**	**230 VAC**
Ambient	40 °C	
***TinySwitch* (U1)**	106	84
Transformer (T1)	87	83
Rectifier (D7)	85	82
Clamp Zener (VR1)	83	72
Common Mode (L1)	78	67
Output Capacitor (C6)	80	79

Test Conditions: The power supply was sealed in a plastic enclosure. The size for the enclosure was 2.86 x 1.97 x 1.06 (in inches). The enclosure was installed into a cardboard box to reduce the influence from the air circulation inside of the environment chamber. The cardboard box was placed in the environmental chamber. The ambient temperature was measured inside the cardboard box.

11 Waveforms

11.1 Drain Voltage and Current, Normal Operation



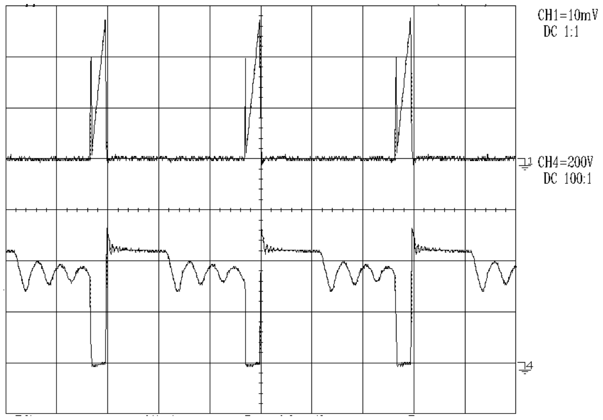
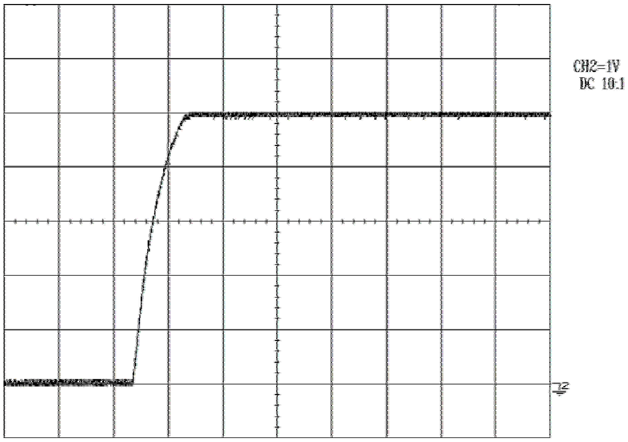


Figure 11 – 85 VAC, Full Load.
Upper: I_{DRAIN}, 0.1 A / div.
Lower: V_{DRAIN}, 100 V, 5 µs / div.

Figure 12 – 265 VAC, Full Load.
Upper: I_{DRAIN}, 0.1 A / div.
Lower: V_{DRAIN}, 200 V / div, 5 µs / div.

11.2 Output Voltage Start-up Profile



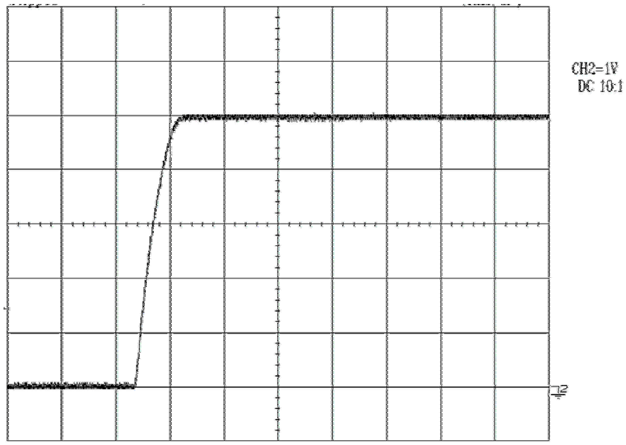


Figure 13 – Start-up Profile, 115 VAC
1 V, 5 ms / div.

Figure 14 – Start-up Profile, 230 VAC
1 V, 5 ms / div.

11.3 Drain Voltage and Current Start-up Profile

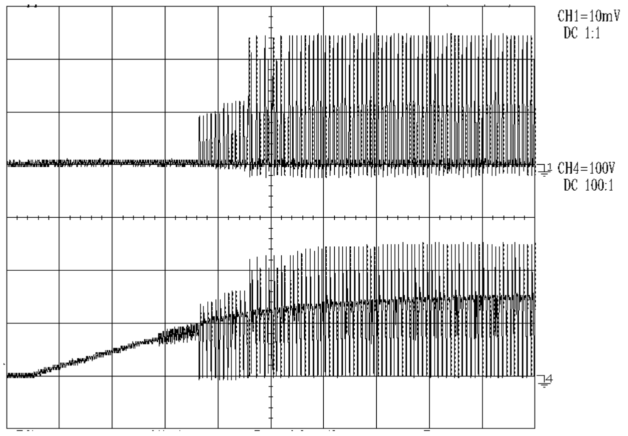


Figure 15 – 85 VAC Input and Maximum Load.
Upper: I_{DRAIN}, 0.1 A / div.
Lower: V_{DRAIN}, 100 V, 100 µs / div.

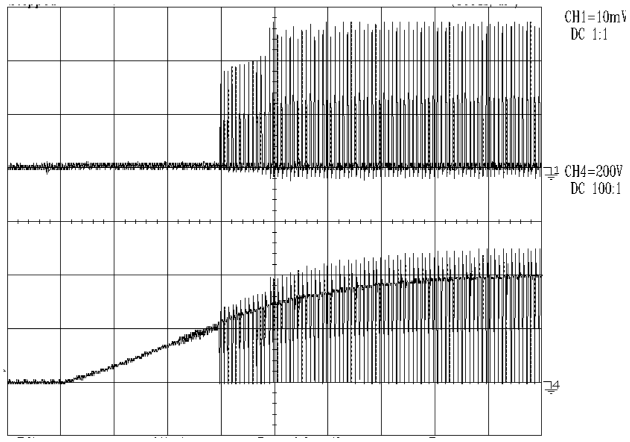


Figure 16 – 265 VAC Input and Maximum Load.
Upper: I_{DRAIN}, 0.1 A / div.
Lower: V_{DRAIN}, 200 V, 100 µs / div.

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.

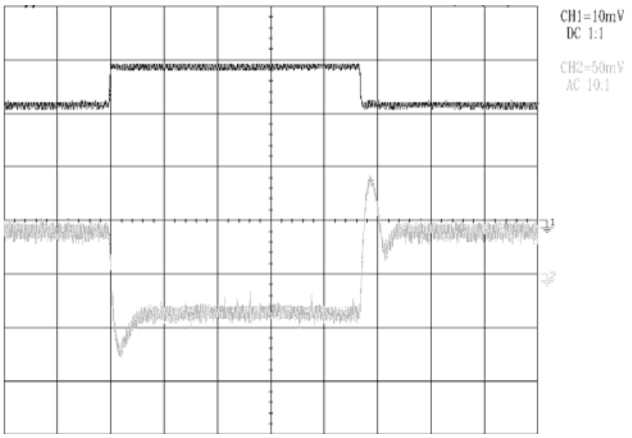


Figure 17 – Transient Response, 115 VAC,
75-100-75% Load Step.
Upper: Load Current, 0.2 A / div.
Lower: Output Voltage
50 mV, 1 ms / div.

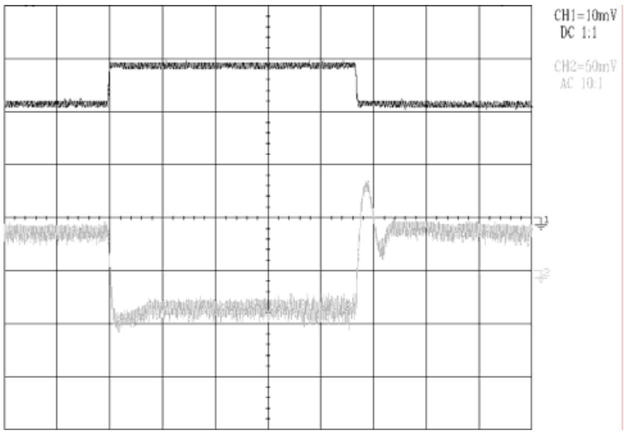


Figure 18 – Transient Response, 230 VAC,
75-100-75% Load Step.
Upper: Load Current, 0.2 A / div.
Lower: Output Voltage
50 mV, 1 ms / div.

11.5 Output Ripple Measurements

11.5.1 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 19 and Figure 20.

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).***

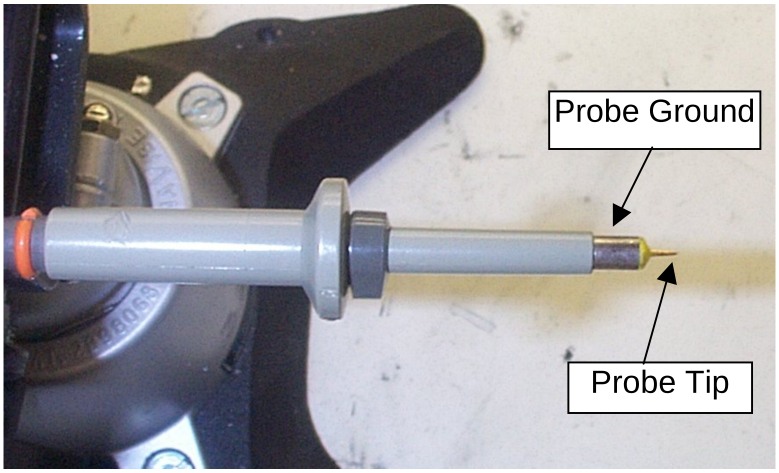


Figure 19 - Oscilloscope Probe Prepared for Ripple Measurement. (End cap and ground lead removed).

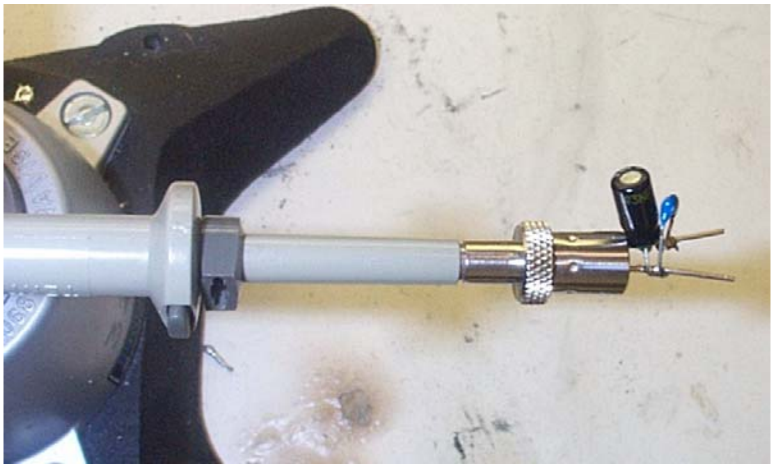


Figure 20 - Oscilloscope Probe with Probe Master 5125BA BNC Adapter. (Modified with wires for probe ground for ripple measurement, and two parallel decoupling capacitors added).

11.5.2 Measurement Results

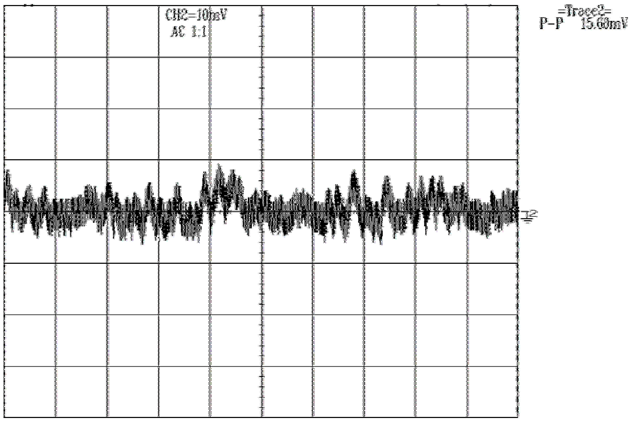


Figure 21 – Ripple, 85 VAC, Full Load.
2 ms, 10 mV / div.

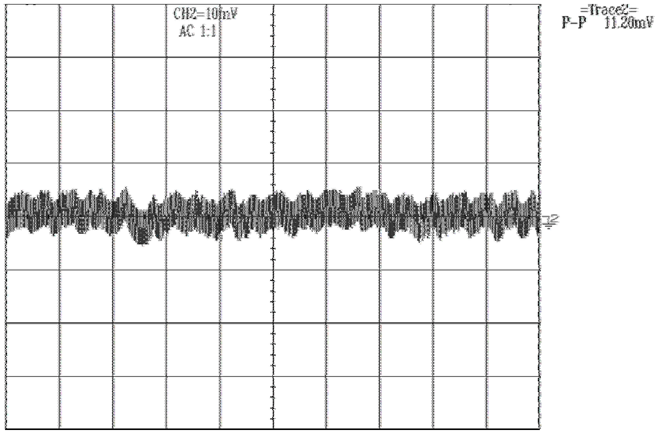


Figure 22 – 5 V Ripple, 115 VAC, Full Load.
2 ms, 10 mV / div.

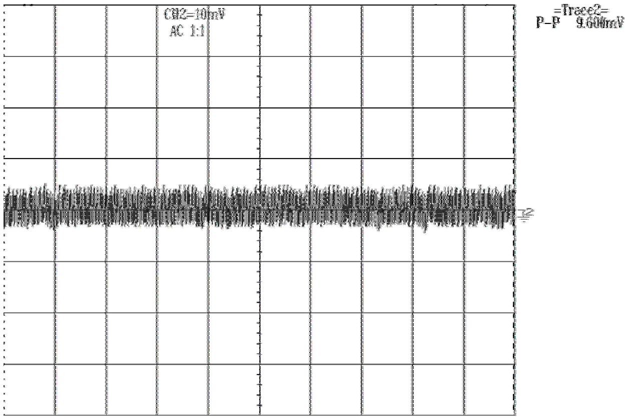


Figure 23 – Ripple, 230 VAC, Full Load.
2 ms, 10 mV / div.

12 Conducted EMI

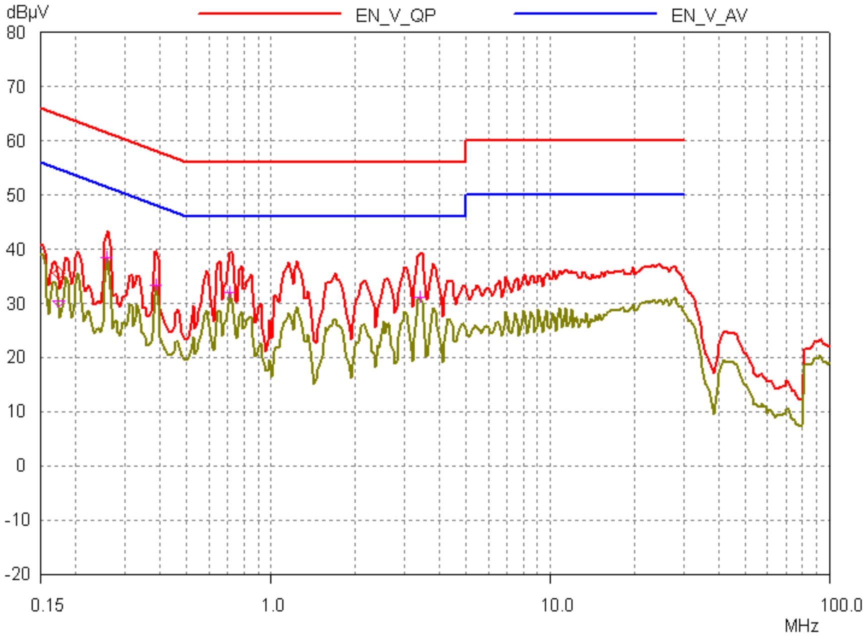


Figure 24 – Conducted EMI, Maximum Steady State Load, 230 VAC, 60 Hz, Line, Artificial Hand Connected and EN55022 B Limits.

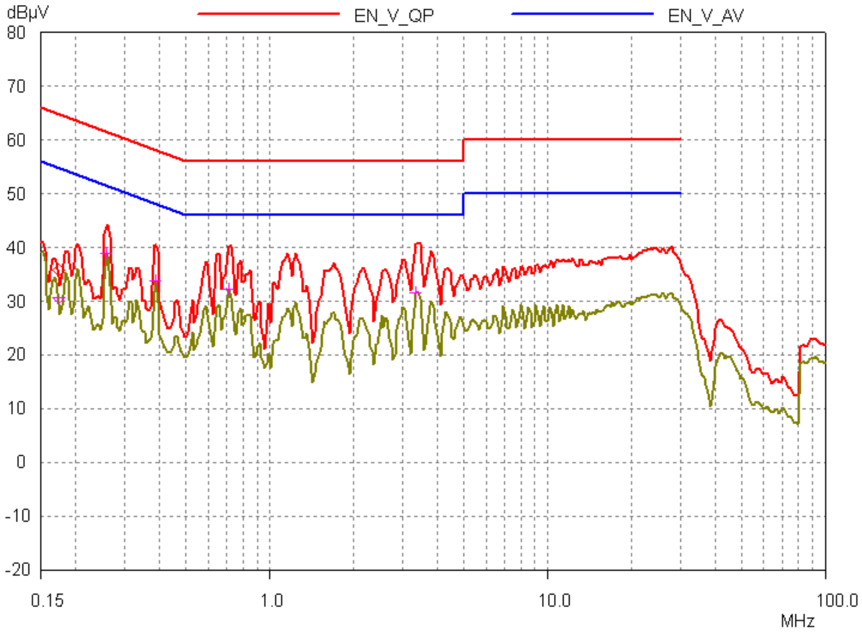


Figure 25 – Conducted EMI, Maximum Steady State Load, 230 VAC, 60 Hz, Neutral, Artificial Hand Connected and EN55022 B Limits.

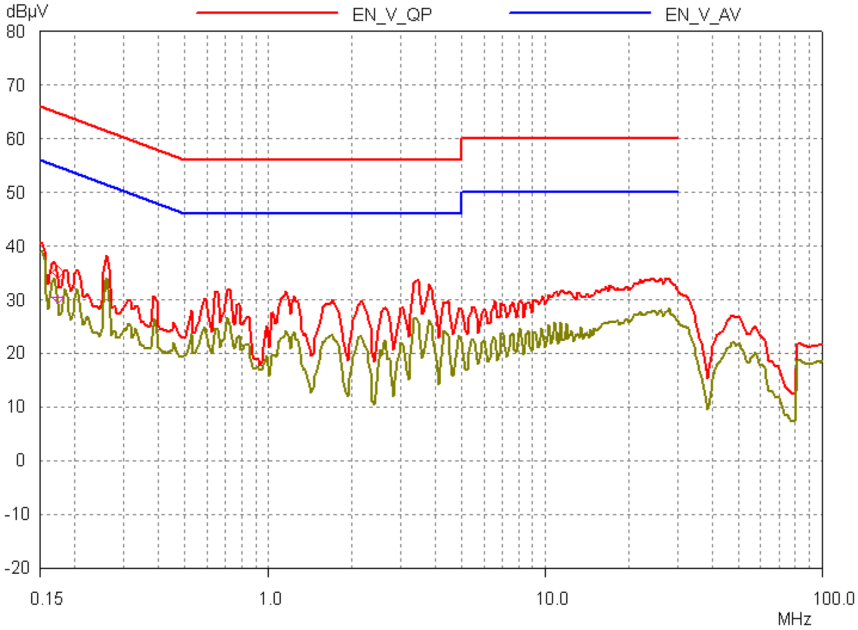


Figure 26 – Conducted EMI, Maximum Steady State Load, 230 VAC, 60 Hz, Line, Without Artificial Hand Connected and EN55022 B Limits.

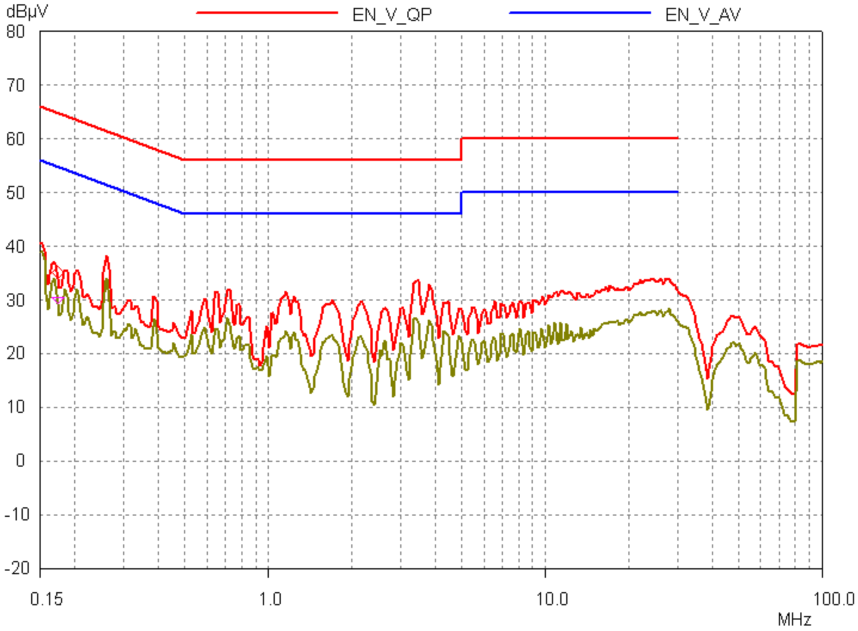


Figure 27 – Conducted EMI, Maximum Steady State Load, 230 VAC, 60 Hz, Neutral, Without Artificial Hand Connected and EN55022 B Limits.

13 Revision History

Date	Author	Revision	Description & changes
23-May-05	AJM	1.0	First Release

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The products and applications illustrated herein (including transformer construction and circuits external to the products) 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. Power Integrations grants its customers a license under certain patent rights as set forth at http://www.powerint.com/ip.htm.

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