Design Example Report

Title	***3.7W Power Supply Using TNY263P***
Specification	Input: 80 – 288 VAC Output: 5V/300mA, 22V/100mA
Application	LCD TV Standby
Author	Power Integrations Applications Department
Document Number	DER-41
Date	November 18, 2004
Revision	1.0

Summary and Features

- Extremely low (< 25 mW) No Load Power Consumption at 288VAC
- Low EMI for low signal interference
- Very good EMI margin with respect to EN55022 B limits with no Y-cap, no X-cap, no common mode choke
- Low cost and simple design for two output power supply

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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 an engineering report describing a prototype power supply for an LCD TV Standby application. The design uses TNY263P. E-shield™ technology is adopted to achieve good EMI performance without using X cap, Y cap and common mode choke.

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

The design passes EMI with a very small EMI filter, made possible by TNY263 built-in frequency jitter. In the actual system, the standby supply can be connected to the EMI filter of the main power supply.

2 Photograph

Figure 1 – Circuit Board Photograph

Note: In this prototype, R9 is placed on the topside of the PCB and soldered in series with R6

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3 Power Supply Specification

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	80		288	VAC	2 Wire – no P.E.
Frequency	f_{LINE}	47	50/60	64	Hz	
Output						
Output Voltage 1	V_{OUT1}	4.85	5	5.15	V	3%
Output Ripple Voltage 1	$V_{RIPPLE1}$				mV	20 MHz Bandwidth
Output Current 1	I_{OUT1}			300	mA	
Output Voltage 2	V_{OUT2}		22		V	Primary side
Output Ripple Voltage 2	$V_{RIPPLE2}$				mV	20 MHz Bandwidth
Output Current 2	I_{OUT2}			100	mA	
Total Output Power						
Continuous Output Power	P_{OUT}			3.7	W	
No Load Input Power	P_{NoLoad}			25	mW	@ 240 Vac Input
Efficiency	η	76			%	Measured at 3.7W load
Environmental						
Conducted EMI		Meets CISPR22 / EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Ambient Temperature	T_{AMB}		40		°C	

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4 Schematic

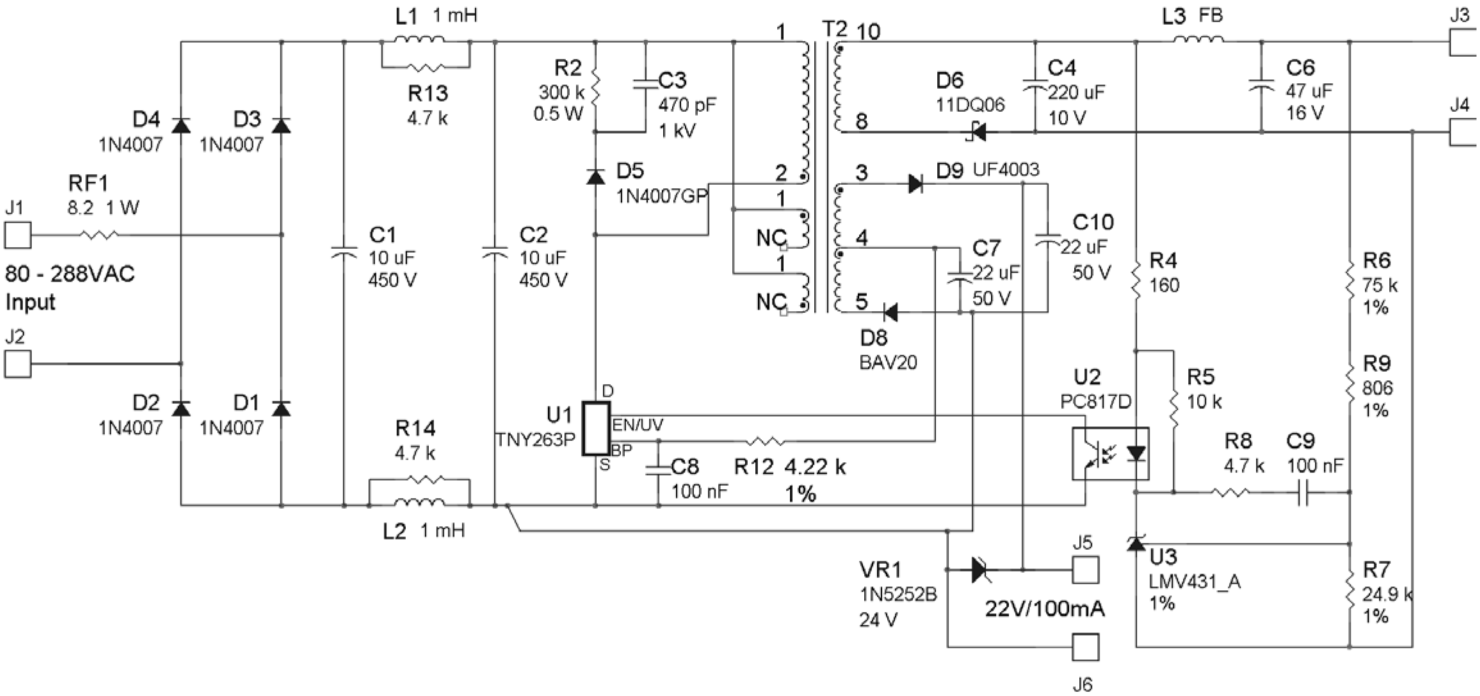

Figure 2 – Schematic

Note: R9 is placed on the topside of the PCB and soldered in series with R6.

L1, L2, R13, R14, C1 and C2 form an EMI filter. C1 and C2 form the bulk capacitance. In the actual system, the standby supply can be connected to the EMI filter and bulk capacitor of the main power supply; it may be possible to simplify the input circuit to take advantage of the main power supply filter and bulk capacitor. If the main PSU bulk capacitor is far from the standby supply, other configurations of simplified filtering may be possible for optimal noise and cost performance.

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5 Circuit Description

This circuit is configured as an AC to DC two-output Flyback power supply using the highly integrated TNY263P power IC. The circuit is designed for 80 Vac to 288 Vac input with 5V and 22V outputs.

5.1 Input Rectification

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 L2, C1 and C2 form a pi (π) filter, which attenuates conducted differential-mode EMI noise. R13 and R14 damp the oscillation caused by L1 and L2.

5.2 Auxiliary Bias Supply and the 22V Primary Output

The auxiliary bias supply circuit and the 22V primary output are made up of the primary-side transformer bias windings, diode D8, D9, capacitor C7, C10, resistor R12 and Zener diode VR1. R12 was set for just enough current to disable the internal current source. As a result, the standby power consumption is minimized. VR1 improves 22V regulation when 22V is not loaded and 5V output is fully loaded. The 22V winding and the bias winding are wound next to the 5V winding for good cross-regulation.

5.3 Primary DRAIN Voltage Clamp Circuit

The DRAIN voltage clamp circuit is comprised of C3, R2 and diode D5. D5 and C3 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). R2 damps the high frequency ringing caused by leakage inductance, which improves the conducted EMI performance of the circuit.

5.4 Output Rectification and Filtering

Output rectification and filtering are accomplished by Schottky diode D6, capacitors C4, C6 and L3.

5.5 Output Voltage Sensing and Feedback

LMV431 U3, resistors R4, R5, R6, R7, R8, R9, C9 and Opto-coupler U2 sense the output voltage and current, and feedback their information to the TNY263P controller.

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6 PCB Layout

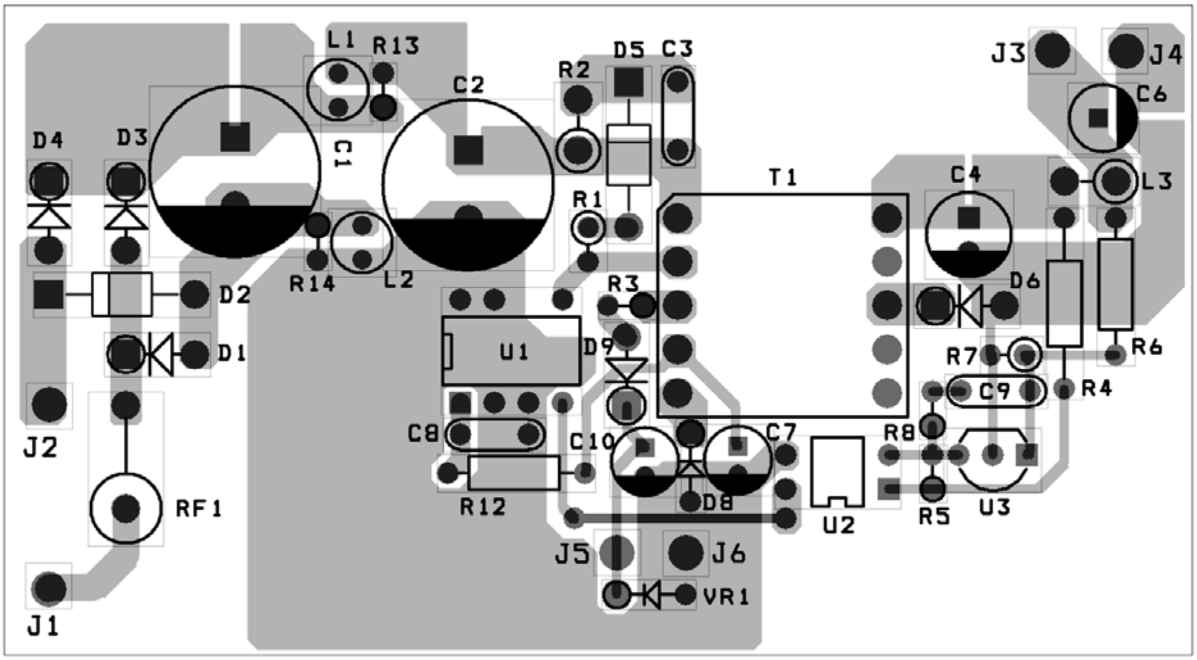

Figure 3 – Printed Circuit Layout.

Note: R9 is placed on the topside of the PCB and soldered in series with R6. R1 and R3 are replaced by jumpers.

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7 Bill Of Materials

Item	Qua.	Part Reference	Value	Description	Mfg Part Number	Mfg
1	2	C1 C2	10 uF	10 uF, 450 V, Electrolytic	Customer Provided	N/A
2	1	C3	470 pF	470 pF, 1 kV, Disc Ceramic	NCD471K1KVY5F	NIC Components Corp
3	1	C4	220 uF	220 uF, 10 V, Electrolytic, Very Low ESR, 130 mOhm, (6.3 x 11)	KZE10VB221MF11LL	United Chemi-Con
4	1	C6	47 uF	47 uF, 16 V, Electrolytic, Low ESR, 500 mOhm, (5 x 11.5)	LXZ16VB47RME11LL	United Chemi-Con
5	2	C7 C10	22 uF	22 uF, 50 V, Electrolytic, Low ESR, 900 mOhm, (5 x 11.5)	LXZ50VB22RME11LL	United Chemi-Con
6	2	C8 C9	100 nF	100 nF, 50 V, Ceramic, X7R	ECU-S1H104KBB	Panasonic
7	4	D1 D2 D3 D4	1N4007	1000 V, 1 A, Rectifier, DO-41	1N4007	Vishay
8	1	D5	1N4007GP	1000 V, 1 A, Rectifier, Glass Passivated, 2 us, DO-41	1N4007GP	Vishay
9	1	D6	11DQ06	60 V, 1.1 A, Schottky, DO-41	11DQ06	International Rectifier
10	1	D8	BAV20	200 V, 200 mA, Fast Switching, 50 ns, DO-35	BAV20	Vishay
11	1	D9	UF4003	200 V, 1 A, Ultrafast Recovery, 50 ns, DO-41	UF4003	Vishay
12	6	J1 J2 J3 J4 J5 J6	Terminal	PCB Terminal Hole	N/A	N/A
13	2	L1 L2	1 mH	1 mH, 0.15 A, Ferrite Core	SBCP-47HY102B	Tokin
14	1	L3	FB	3.5 mm x 7.6 mm, 75 Ohms at 25 MHz, 22 AWG hole, Ferrite Bead	2743004112	Fair-Rite
15	1	R2	300 k	300 k, 5%, 1/2 W, Carbon Film	CFR-50JB-300K	Yageo
16	1	R4	160	160 R, 5%, 1/8 W, Carbon Film	CFR-12JB-160R	Yageo
17	1	R5	10 k	10 k, 5%, 1/4 W, Carbon Film	CFR-25JB-10K	Yageo
18	1	R6	75 k	75 k, 1%, 1/4 W, Metal Film	MFR-25FBF-75K0	Yageo
19	1	R7	24.9 k	24.9 k, 1%, 1/4 W, Metal Film	MFR-25FBF-24K9	Yageo
20	3	R8 R13 R14	4.7 k	4.7 k, 5%, 1/8 W, Carbon Film	CFR-12JB-4K7	Yageo
21	1	R9	806	806 R, 1%, 1/4 W, Metal Film	MFR-25FBF-806R	Yageo
22	1	R12	4.22 k	4.22 k, 1%, 1/4 W, Metal Film	MFR-25FBF-4K22	Yageo
23	1	RF1	8.2	8.2 R, 2.5 W, Fusible/Flame Proof Wire Wound	CRF253-4 5T 8R2	Vitrohm
24	1	T2	TRANSFORMER	Custom		
25	1	U1	TNY263P	TinySwitch-II, TNY263P, DIP-8B	TNY263P	Power Integrations
26	1	U2	PC817D	Opto coupler, 35 V, CTR 300-600%, 4-DIP	ISP817D, PC817X4	Isocom, Sharp
27	1	U3	LMV431_A	1.24V Shunt Reg IC	LMV431ACZ	National Semiconductor
28	1	VR1	1N5252B	24 V, 5%, 500 mW, DO-35	1N5252B	Microsemi

Note: L1, L2, R13, R14, C1 and C2 form an EMI filter. C1 and C2 form the bulk capacitance. In the actual system, the standby supply can be connected to the EMI filter and bulk cap of the main power supply. If the main PSU bulk cap is far from the standby supply, a small HF bypass cap, 0.01uF/400V, should be used in the position of C2.

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8 Transformer Specification

8.1 Electrical Diagram

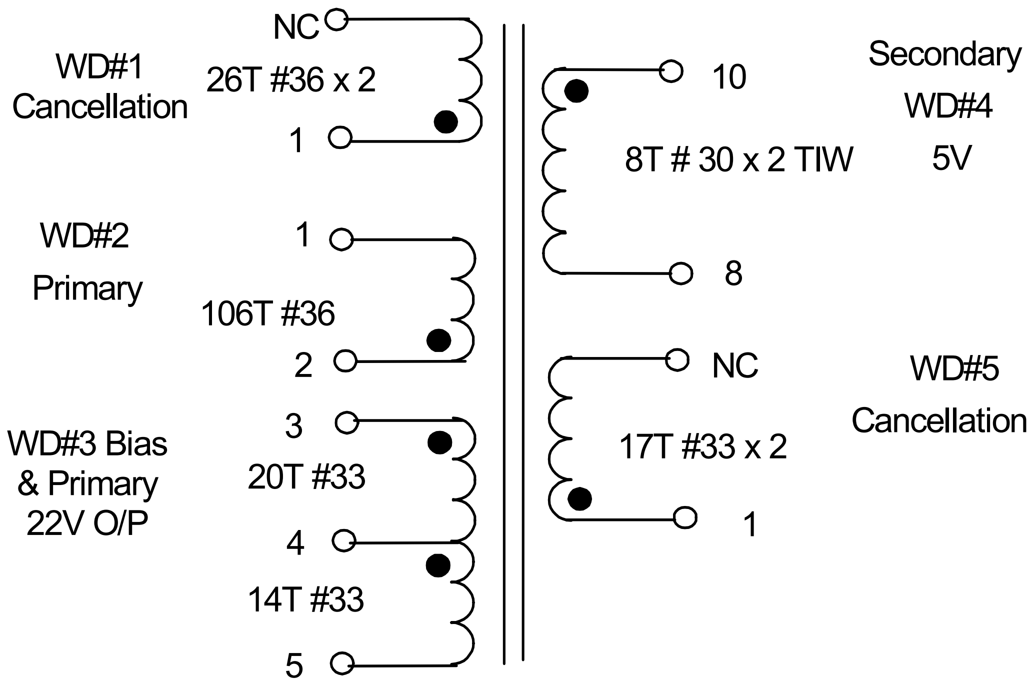

Figure 4 –Transformer Electrical Diagram

8.2 Electrical Specifications

Electrical Strength	1 second, 60 Hz, from Pins 1 - 5 to Pins 8 -10	3000 VAC
Primary Inductance	Pins 1-2, all other windings open, measured at 132 kHz, 0.4 VRMS	2.36 mH, -10/+10%
Resonant Frequency	Pins 1-2, all other windings open	500 kHz (Min.)
Primary Leakage Inductance	Pins 1-2, with Pins 8-10 shorted, measured at 132 kHz, 0.4 VRMS	50 μH (Max.)

8.3 Materials

Item	Description
[1]	Core: PC40EE16-Z, TDK or equivalent Gapped for AL of 209 nH/T^2
[2]	Bobbin: Horizontal 10 pin
[3]	Magnet Wire: #36 AWG
[4]	Magnet Wire: #33 AWG
[5]	Triple Insulated Wire: #30 AWG
[6]	Tape: 3M 1298 Polyester Film, 2.0 mils thick, 8.2 mm wide

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8.4 Transformer Build Diagram

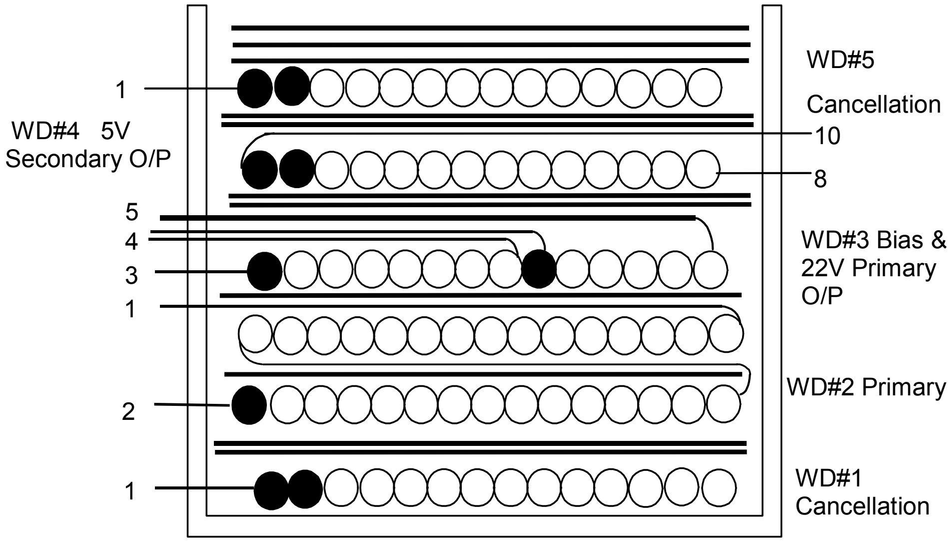

Figure 5 – Transformer Build Diagram.

8.5 Transformer Construction

Bobbin Preparation	Primary pin side of the bobbin orients to the left hand side.
WD#1 Cancellation	Start on Pin 1, wind 26 turns bifilar of item [3] from left to right. Wind with tight tension across entire bobbin evenly. Cut the end lead after finishing the 26th turn.
Insulation	2 Layers of tape [6] for insulation
WD#2 Primary	Start on pin 2, wind 53 turns of item [3] from left to right. After finishing the first layer, apply 1 layer of tape [6]. Bring the wire back to the left side and continue to wind the wire from left to right with another 53 turns. After finishing the 53rd turn, bring the wire back and finish it on Pin 1.
Insulation	1 Layer of tape [6] for insulation.
WD #3 Bias and Primary O/P 22V	The first winding section: start on Pin 3, wind 20 turns of item [4]. Wind from left to right with tight tension. After finishing the 20th turn, bring the wire back and finish it on pin 4. The second winding section: start from Pin 4, rout the wire to the position at where the previous winding finished, wind 14 runs of item [4] from left to right with tight tension. After finishing the 14th turn, bring the wire back and finish it on Pin 5.
Insulation	2 Layers of tape [6] for insulation.
WD #4 Secondary	Start at pin 3 temporally, wind 8 turns bifilar of item [5] from left to right, wind uniformly. Tie the finishing lead to pin 8. Bring the starting lead to right side and finish it on Pin 10.
Insulation	2 Layers of tape [6] for insulation.
WD #5 Cancellation	Start at pin 1, wind bifilar turns of item [4] from left to right, wind uniformly. Cut the finishing lead.
Insulation	3Layers of tape [6] for insulation.
Finish	Grind the core to get 2.36mH. Secure the core with tape. Varnish the transformer.

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9 Transformer Spreadsheets

ACDC_TNY-II_040104; Rev.1.1; Copyright Power Integrations Inc. 2004	INPUT	OUTPUT	UNIT	ACDC_TNYII_040104_Rev1-1.xls; TinySwitch-II Continuous/Discontinuous Flyback Transformer Design Spreadsheet
ENTER APPLICATION VARIABLES				
VACMIN	80		Volts	Minimum AC Input Voltage
VACMAX	288		Volts	Maximum AC Input Voltage
fL	50		Hertz	AC Mains Frequency
VO	5		Volts	Output Voltage
PO	4		Watts	Output Power
n	0.7			Efficiency Estimate
Z		0.5		Loss Allocation Factor
tC		3	mSeconds	Bridge Rectifier Conduction Time Estimate
CIN	20		uFarads	Input Filter Capacitor
ENTER TinySwitch-II VARIABLES				
TinySwitch-II	**TNY263**		*Universal*	*115 Doubled/230V*
Chosen Device		*Power Out*	*4.7W*	*7.5W*
ILIMITMIN		*0.195*	Amps	TinySwitch-II Minimum Current Limit
ILIMITMAX		*0.225*	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	74		Volts	Reflected Output Voltage
VDS	12	12	Volts	TinySwitch-II on-state Drain to Source Voltage
VD	0.56		Volts	Output Winding Diode Forward Voltage Drop
KP		**0.68**		Ripple to Peak Current Ratio (0.6<KRP<1.0 : 1.0<KDP<6.0)
ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES				
Core Type	**EE16**			
Core			*P/N:*	PC40EE16-Z
Bobbin			*P/N:*	BE-16-118CPH
AE		0.192	cm^2	Core Effective Cross Sectional Area
LE		3.5	cm	Core Effective Path Length
AL		1140	nH/T^2	Ungapped Core Effective Inductance
BW		8.5	mm	Bobbin Physical Winding Width
M			mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
L	2			Number of Primary Layers
NS	8			Number of Secondary Turns
DC INPUT VOLTAGE PARAMETERS				
VMIN		94	Volts	Minimum DC Input Voltage
VMAX		407	Volts	Maximum DC Input Voltage
CURRENT WAVEFORM SHAPE PARAMETERS				
DMAX		0.47		Maximum Duty Cycle
IAVG		0.06	Amps	Average Primary Current

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IP		0.20	Amps	Minimum Peak Primary Current
IR		0.13	Amps	Primary Ripple Current
IRMS		0.09	Amps	Primary RMS Current
TRANSFORMER PRIMARY DESIGN PARAMETERS				
LP		2364	uHenries	Primary Inductance
NP		106		Primary Winding Number of Turns
ALG		209	nH/T^2	Gapped Core Effective Inductance
BM		2602	Gauss	Maximum Flux Density, (BP<3100)
BAC		772	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
ur		1654		Relative Permeability of Ungapped Core
LG		0.09	mm	!!! INCREASE GAP>>0.1 (increase NS, increase VOR, use a bigger Core
BWE		17	mm	Effective Bobbin Width
OD		0.16	mm	Maximum Primary Wire Diameter including insulation
INS		0.04	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
DIA		0.12	mm	Bare conductor diameter
AWG		37	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
CM		20	Cmils	Bare conductor effective area in circular mils
CMA		218	Cmils/Amp	Primary Winding Current Capacity (200 < CMA < 500)
TRANSFORMER SECONDARY DESIGN PARAMETERS				
Lumped parameters				
ISP		2.60	Amps	Peak Secondary Current
ISRMS		1.29	Amps	Secondary RMS Current
IO		0.80	Amps	Power Supply Output Current
IRIPPLE		1.01	Amps	Output Capacitor RMS Ripple Current
CMS		258	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		1.06	mm	Secondary Maximum Outside Diameter for Triple Insulated Wire
INSS		0.30	mm	Maximum Secondary Insulation Wall Thickness
VOLTAGE STRESS PARAMETERS				
VDRAIN		583	Volts	Maximum Drain Voltage Estimate (Includes Effect of Leakage Inductance)
PIVS		36	Volts	Output Rectifier Maximum Peak Inverse Voltage
TRANSFORMER SECONDARY DESIGN PARAMETERS (MULTIPLE OUTPUTS)				
1st output				
VO1	5	5	Volts	Output Voltage (if unused, defaults to single output design)
IO1	0.3	0.300	Amps	Output DC Current
PO1		1.50	Watts	Output Power
VD1		0.56	Volts	Output Diode Forward Voltage Drop
NS1		8.00		Output Winding Number of Turns
ISRMS1		0.484	Amps	Output Winding RMS Current
IRIPPLE1		0.38	Amps	Output Capacitor RMS Ripple Current
PIVS1		36	Volts	Output Rectifier Maximum Peak Inverse Voltage
CMS1		97	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS1		30	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS1		0.26	mm	Minimum Bare Conductor Diameter

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ODS1		1.06	mm	Maximum Outside Diameter for Triple Insulated Wire
Bias output				
VO2	9		Volts	Output Voltage
IO2	0.1		Amps	Output DC Current
PO2		0.90	Watts	Output Power
VD2	0.7		Volts	Output Diode Forward Voltage Drop
NS2		13.96		Output Winding Number of Turns
ISRMS2		0.161	Amps	Output Winding RMS Current
IRIPPLE2		0.13	Amps	Output Capacitor RMS Ripple Current
PIVS2		62	Volts	Output Rectifier Maximum Peak Inverse Voltage
CMS2		32	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS2		34	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS2		0.16	mm	Minimum Bare Conductor Diameter
ODS2		0.61	mm	Maximum Outside Diameter for Triple Insulated Wire
Pirmary output				
VO3	22		Volts	Output Voltage
IO3	0.1		Amps	Output DC Current
PO3		2.20	Watts	Output Power
VD3	1.4		Volts	Output Diode Forward Voltage Drop
NS3		33.67		Output Winding Number of Turns
ISRMS3		0.161	Amps	Output Winding RMS Current
IRIPPLE3		0.13	Amps	Output Capacitor RMS Ripple Current
PIVS3		151	Volts	Output Rectifier Maximum Peak Inverse Voltage
CMS3		32	Cmils	Output Winding Bare Conductor minimum circular mils
AWGS3		34	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
DIAS3		0.16	mm	Minimum Bare Conductor Diameter
ODS3		0.25	mm	Maximum Outside Diameter for Triple Insulated Wire
Total power		4.6	Watts	!!! Total power does not match entered power in cell B7

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10 Performance Data

All measurements performed at room temperature, 60 Hz input frequency.

10.1 Line and Load Regulation

-	5V Output		22V Output		Note
Input (VAC)	**Voltage (V)**	**Current (mA)**	**Voltage (V)**	**Current (mA)**	
80	5.01	300	21.65	100	
	5.01	9	19.98	100	**5V minimum load for 22V O/P 10% Regulation**
	5.01	300	23.64	0	
	5.01	0	18.96	100	
	5.01	0	21.41	0	
288	5.01	300	21.62	100	
	5.01	1	19.96	100	**5V minimum load for 22V O/P 10% Regulation**
	5.01	300	23.58	0	
	5.01	0	19.55	100	
	5.01	0	21.43	0	

10.2 Efficiency

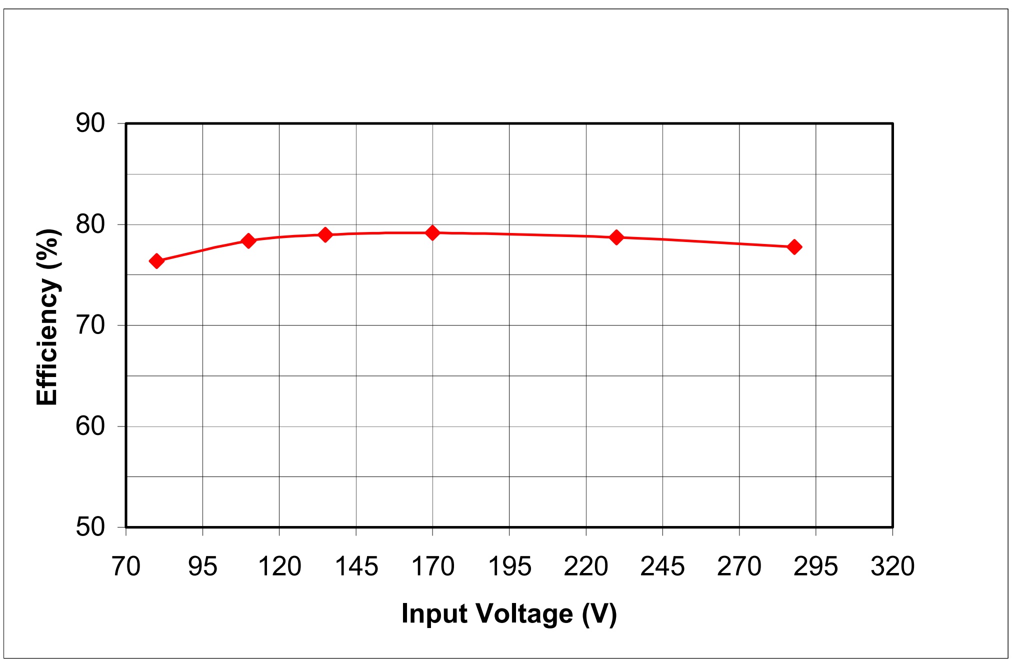

Figure 6 - Efficiency vs. Input Voltage at full load, Room Temperature, 60 Hz.

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10.3 No-Load and Minimum Load Input Power

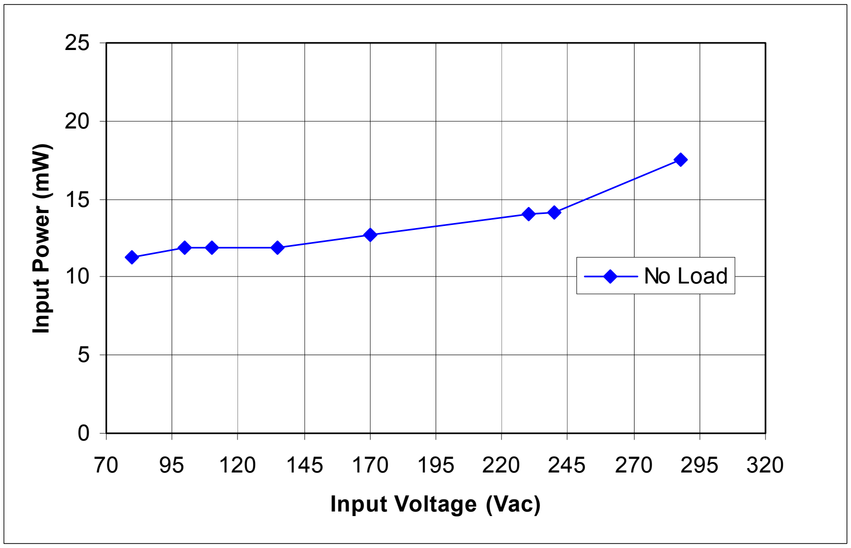

Figure 7 - No Load Input Power vs. Input Line Voltage

Conditions of the measurement: The power supply has to be turned on for at least 30 minutes for thermal stabilization before the No-Load power consumption is taken. Or, turn the power supply on at full load for 5 minutes, then measure the No-Load input power.

10.4 Overload Protection

Requirement: At 100VAC, when 22V is set at 100mA, the PS should go to auto restart if 5V is loaded up to 1.2A

Test Result: Under the specified condition, the PS goes to auto restart when the 5V is loaded up to 0.66A

Comment: **PASS**

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11 Thermal Performance

Test Condition: The power supply is set on the bench, open air, full load. The test is done at room temperature.

Temperature (°C)		
Item	**80 VAC**	**288 VAC**
Ambient (Deg.C)	25	
TNY263P (U1)	45	43

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12 Waveforms

12.1 Drain Voltage Normal Operation

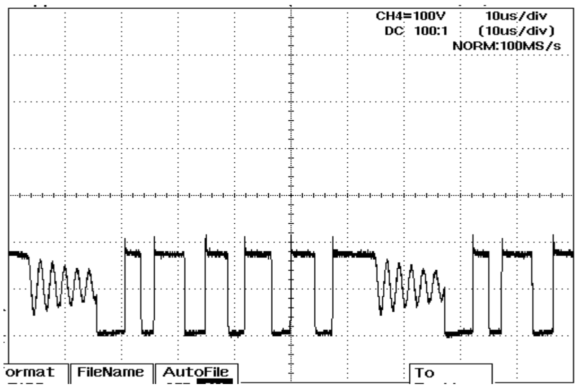

Figure 8 - 80 VAC, Full Load. V_{DRAIN}, 100 V, 10 µs / div

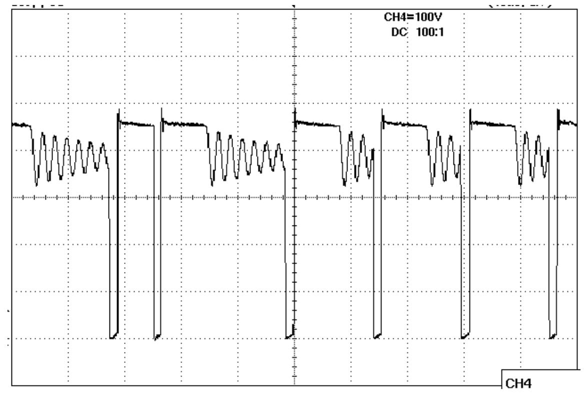

Figure 9 - 288 VAC, Full Load. V_{DRAIN}, 100 V, 10 µs / div

12.2 Output Voltage Start-up Profile

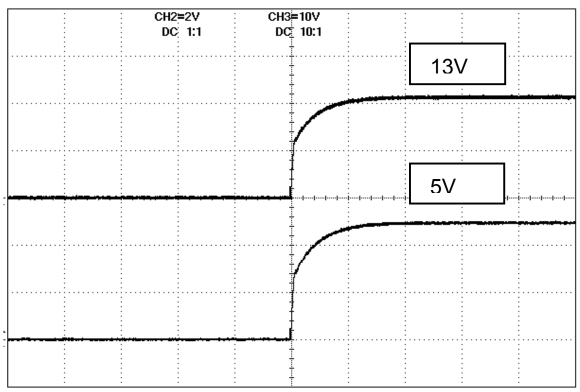

Figure 10 – Start-up Profile, 80 VAC
2V/div for 5V, 10V/div for 22V, 20 ms / div.

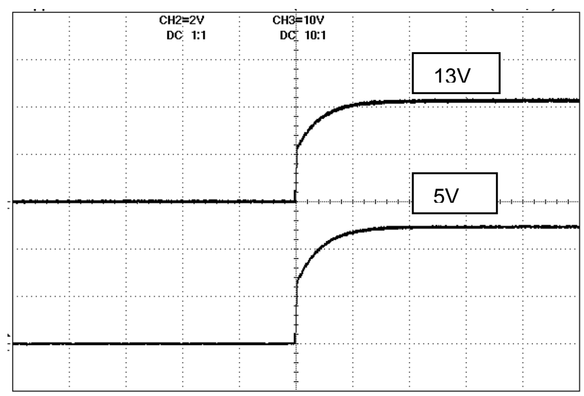

Figure 11 – Start-up Profile, 288 VAC
2V/div for 5V, 10V/div for 22V, 20 ms / div.

12.3 Drain Voltage Start-up Profile

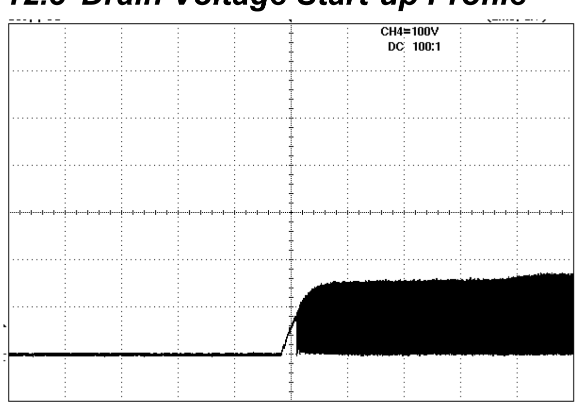

Figure 12 - 80 VAC Input and Maximum Load. V_{DRAIN}, 100 V & 2 ms / div.

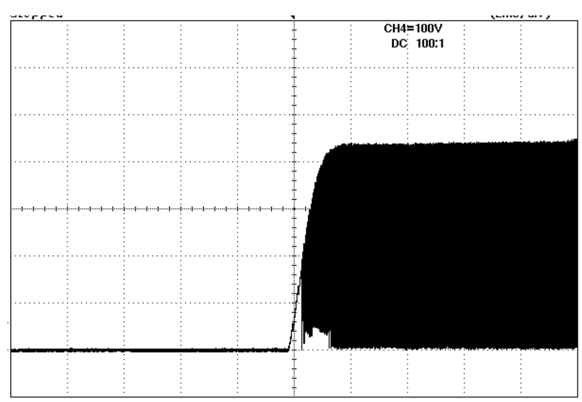

Figure 13 - 288 VAC Input and Maximum Load. V_{DRAIN}, 100 V & 2 ms / div.

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12.4 Output Ripple Measurements

12.4.1 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 14 and Figure 15.

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).***

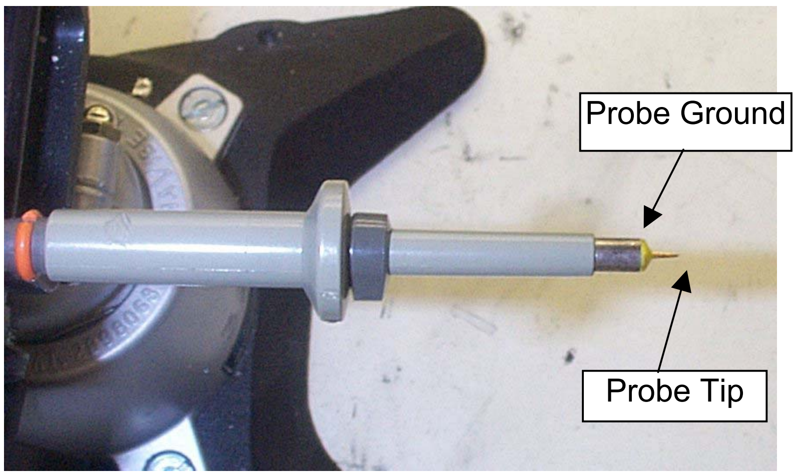

Figure 14 - Oscilloscope Probe Prepared for Ripple Measurement. (End Cap and Ground Lead Removed)

Figure 15 - 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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12.4.2 Measurement Results

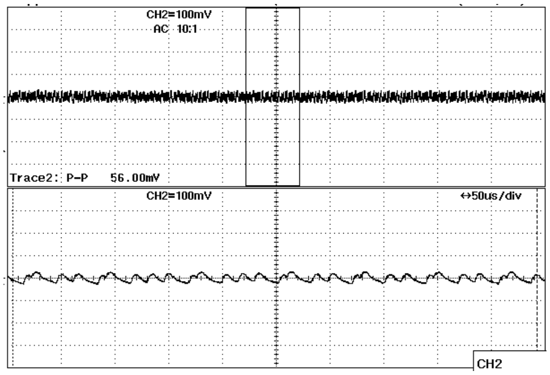

Figure 16 - 80 VAC, Full Load. 5V
500 us, 100 mV / div

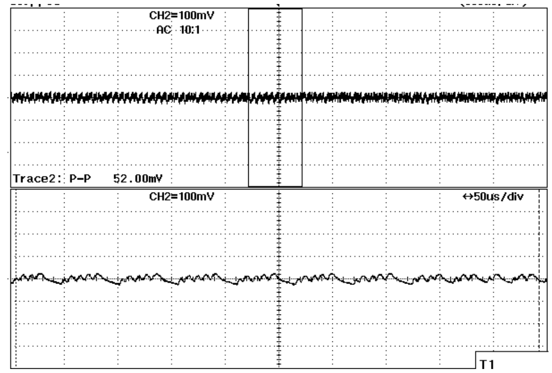

Figure 17 - 288 VAC, Full Load. 5V
500 us, 100 mV / div

Figure 18 - 80 VAC, Full Load. 22V
500 us, 200 mV / div

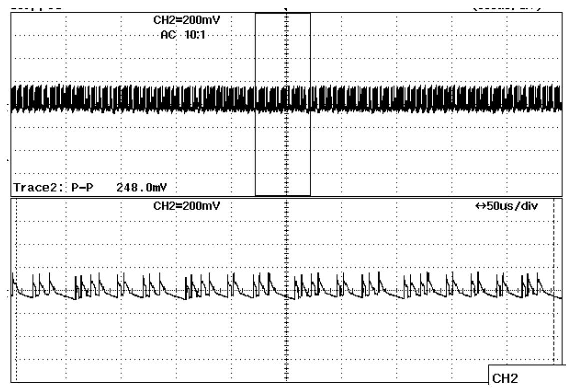

Figure 19 - 288 VAC, Full Load. 22V
500 us, 200 mV / div

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13 Conducted EMI

L1, L2, R13, R14, C1 and C2 form an EMI filter. C1 and C2 form the bulk capacitance. In the actual system, the standby supply can be connected to the EMI filter and bulk cap of the main power supply. If the main PSU bulk cap is far from the standby supply, a small HF bypass cap, 0.01uF/400V, should be used in the position of C2.

EMI was tested at room temperature, 230 VAC input (worst case), full load.

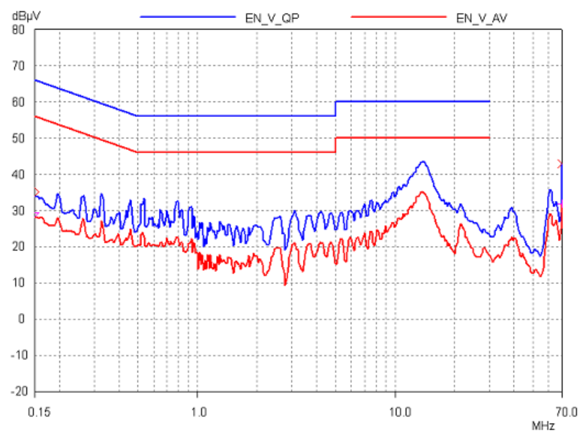

Figure 20 - Line, secondary connected with Ground of the LISN

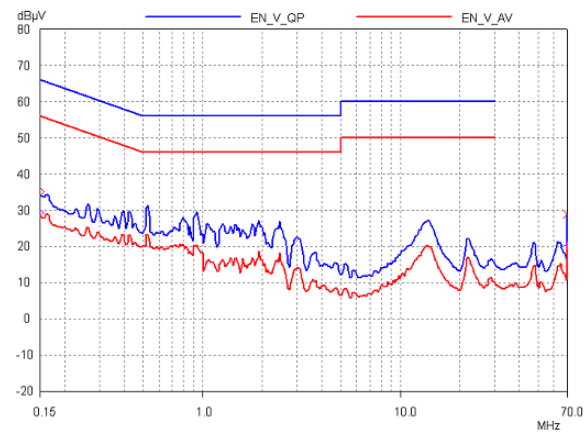

Figure 21 - Line, secondary floating

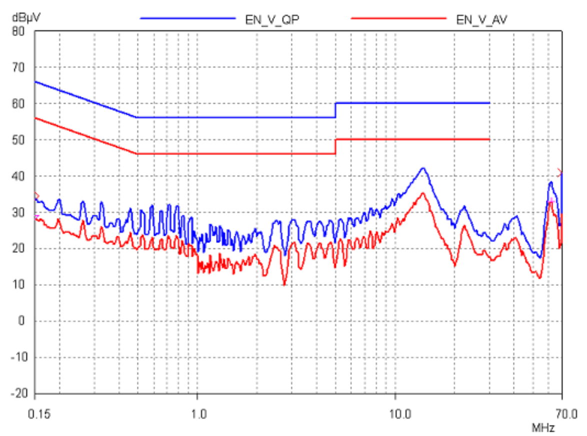

Figure 22 - Neutral, secondary connected with Ground of the LISN

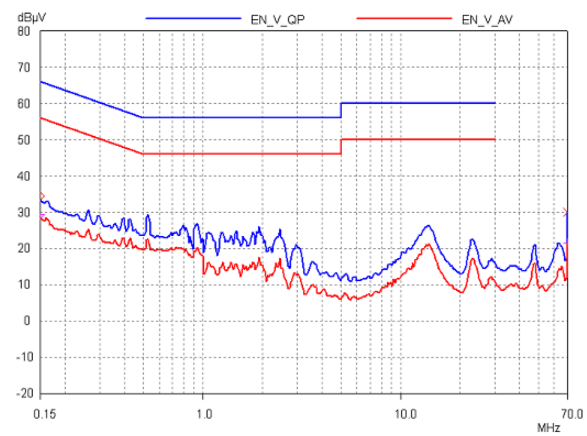

Figure 23 - Neutral, secondary floating

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14 Revision History

Date	Author	Revision	Description & changes	Reviewed
November 19, 2004	DZ	1.0	Initial Release	VC / AM

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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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