Title	***Engineering Prototype Report*** 1W PC Standby using TNY266P
Specification	INPUT: 140 ~ 375 VDC OUTPUT: 5 V @ 0 ~ 2.0 A 15V @ 0 ~ 50 mA
Customer	Generic
Application	PC - Standby
Author	Y.G.
Document Number	EPR23
Date	4-Nov-01
Revision	1.0

Features

- Low cost solution for voltage-doubled PC Standby, (<1W standby specification)
- Very high light-load efficiency
- Standby power consumption 780 mW at 600mW output
- Operates from 140 Vdc to 375 Vdc @ full load
- Good cross-regulation
- Low parts count

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Important Note:
Although the APP-010168 is designed to satisfy safety requirement, however this engineering prototype has not been agency approved. And some substitution parts may not meet safety requirement. Therefore all testing should be performed using an isolation transformer to provide the input to the prototype board.

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1 Introduction

This document is an engineering report describing the performance of a dual output, power supply using TNY266P. This unit is designed to deliver continuous 10 W, with DC input from 140 V to 375 V. This is for PC - standby applications with <1W standby consumption. It draws 780mW at 600 mW out (if using a zener snubber).

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

Two sets of data for standby consumption, and cross-regulation, and efficiency are provided: one using an RCD snubber (as delivered) and a second using a zener snubber (BZY97C200)

The zener provides better standby consumption but inferior cross-regulation.

2 Power Supply Specification

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	140		375	V_{dC}	
Standby Input Power (115 V_{AC})		-	0.78	1.0	W	Measured at 230 Vac to situlate 115 Vac with doubler 5 V @ 120 mA, no load on others
Output						
Output Voltage - 1	V_{01}	4.75	5	5.25	V	± 5%
Output Ripple Voltage	V_{RIPPLE}	-	-	50	mV	20 MHz Bandwidth
Output Current - 1	I_{O1}	0	2.0	-	A	
Output Voltage - 2	V_{02}	12	15	16	V	
Output Current - 2	I_{O2}	0		50	mA	
Total Output Power				11	W	
Continuous Output Power	P_{OUT}			10.6	W	
Efficiency	η		75		%	Measured at full load, 25 °C
Conducted EMI						Meets CISPR22B / EN55022B
Ambient Temperature	T_{AMB}			50	°C	
TNY266 temperature				100	°C	At 50 °C ambient, max load, low line

- = not specified

Table 1 - Power Supply Specification

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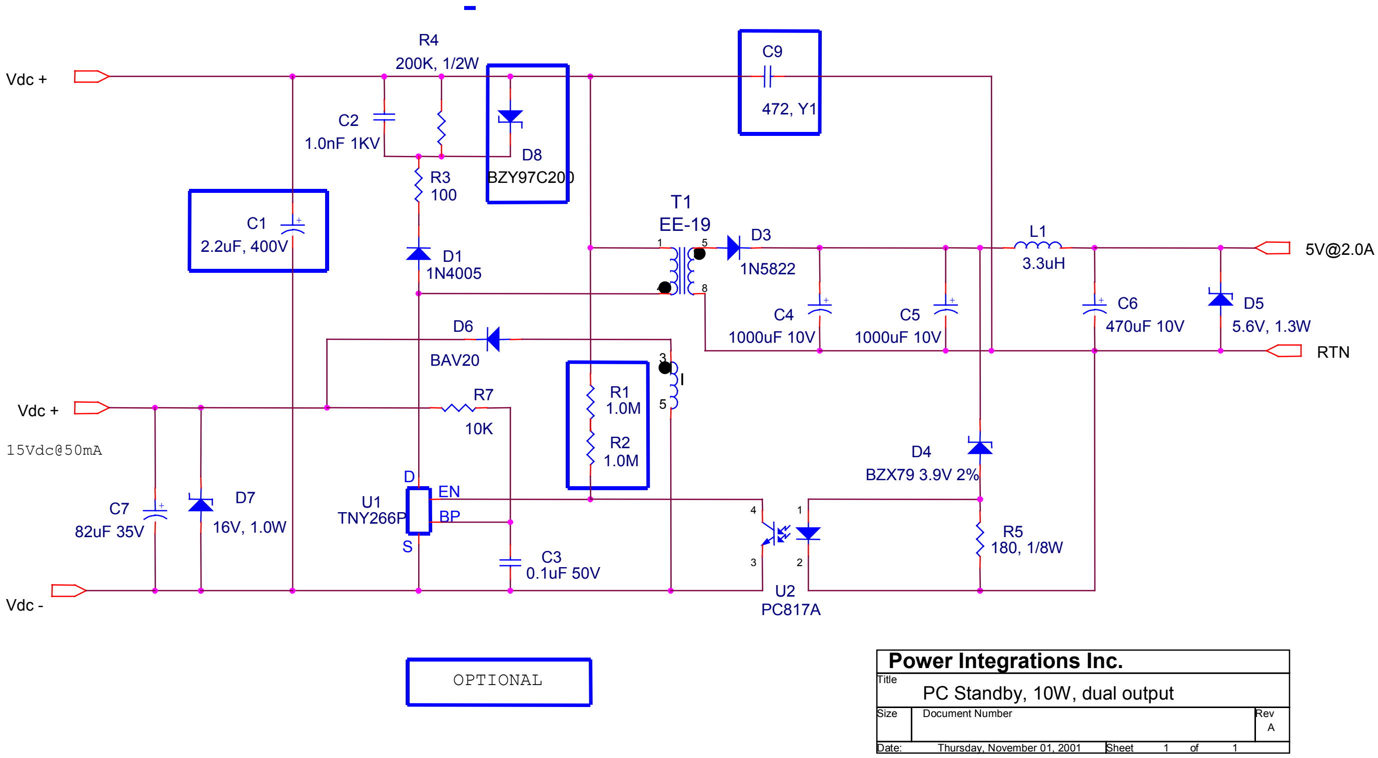
3 Schematic



- D8 is an optional *substitute* for C2 and R4
- R1, R2 implement UV Lockout
- C1 and C9 used only for standalone testing
- D5 is needed only for output OVP

Figure 1 – Schematic

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4 Circuit Description

This is a DC input, dual output Flyback solution for PC - standby applications, with very high light-load efficiency.
1) Capacitor C1 is only necessary when the dc supply is far away from the input. However a 2.2 μF/400 Vdc electrolytic capacitor is recommended when the unit is tested separately.
2) Resistor R1 and R2 implement the UVLO (undervoltage lockout) feature of TNY266P.
3) TinySwitch does not need a bias winding. However by feeding bias current into the device via R7, standby power consumption and efficiency are improved.
4) The built in auto-restart function of TNY266P provides an easy way to implement OVP by just adding a zener diode to the output.
5) Since this circuit will be working together with a PC main power supply, the Y1 capacitor C9 is not implemented on the prototype board. However a Y1 cap is recommended when this unit is tested separately.
6) The specification requires V02 to be within 12 ~ 16 Vdc from 0 to 50 mA while main output 5V is operating from 0 to 2.0 A. The zener diode D7 prevents V02 going too high when VO2 is at 0 load and 5V is loaded. However the standby operation requires 120 mA on 5 V, and no load on V02. In this case, V02 could reach 16 V and increase standby power consumption because of the power dissipation by the zener diode. A 16V 1W, 2% zener diode, or two 0.5W 2% (8.2 V and 7.5 V) zener diode in series is recommended for more voltage margin.

5 PCB Layout

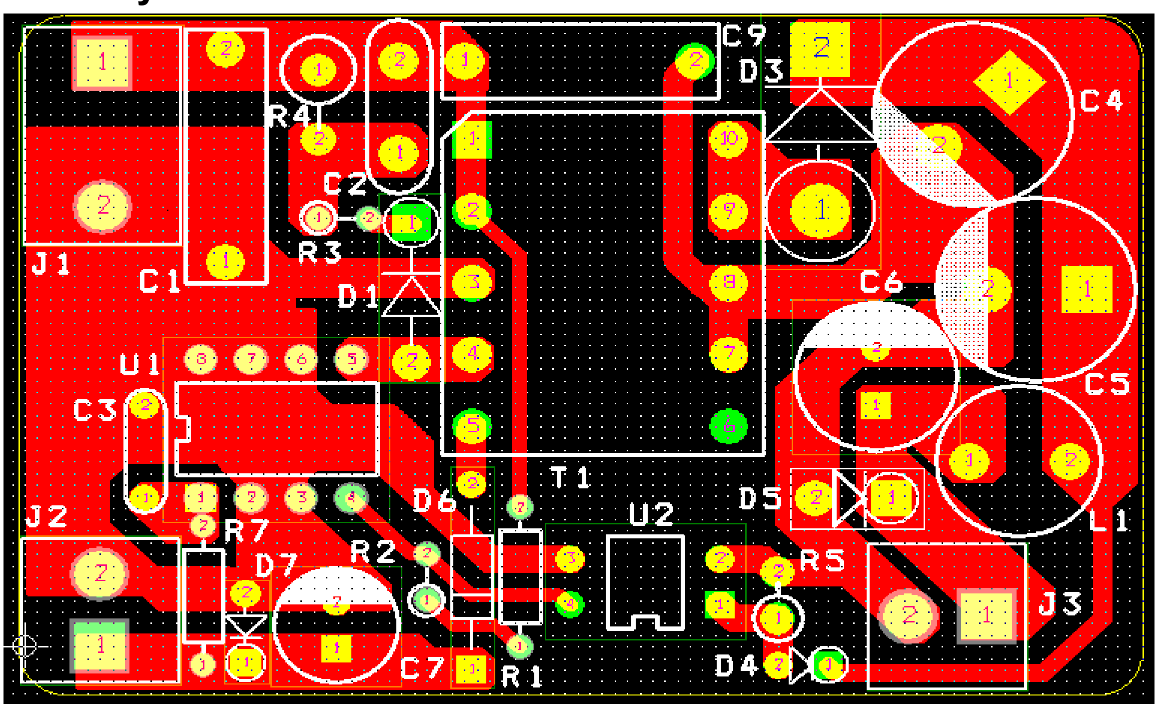

Figure 2 – Printed Circuit Layout

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6 Bill Of Materials

Item	Qty	Reference	Description	P/N	Manufacturer
1	1	* C1	0.01 µF 400V		
2	1	C2	1.0nF 1kV Y-cap		
3	1	C3	0.1µF 50V		
4	2	C4, C5	1000uF 10V		
5	1	C6	470uF 10V		
6	1	C7	82uF 35V		
7	1	* C9	472, Y1		
8	1	D1	1A 600V	1N4005	
9	1	D6	200mA 100V	1N914	
10	1	D3	3A 40V	1N5822	
11	1	* D5	5.6V 1.3W		
12	1	D4	3.9V 2%	BZX79 3.9V 2%	
13	1	D7	16V 2%, 1W		
14	2	* R1, R2	1.0M 1/8W		
15	1	R3	100 1/8W		
16	1	R4	200K 1/2W		
17	1	R5	180 1/8W		
18	1	L1	3.3µH 3.0A		
19	1	T1	Transformer		
20	1	U1	TinySwitch	Tiny266P	PI
21	1	U2	Optocoupler	PC817A	Sharp
22	1		PCB		
23	1	**D8	BZY97C200**		

* Optional components:
- R1 and R2 provide UVLO.
- C1 and C9 are used for standalone testing.
- D5 is used to implement output OVP.

** Optional substitute for R4 and C2. See test results on standby power consumption and cross-regulation.

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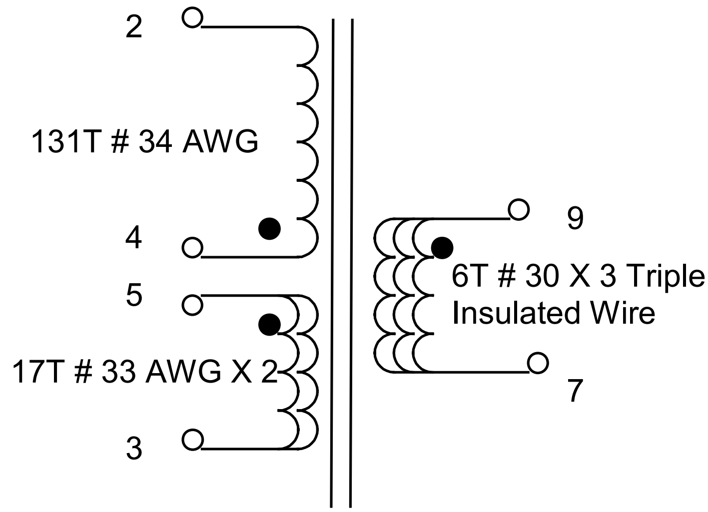
7 Transformer Drawings



7.1 Electrical Specifications

Electrical Strength	1 minute, 60 Hz, from Pins 1-5 to Pins 6-10	3000 VAC
Primary Inductance	With all of the pins open 120 kHz measurement frequency	2250 μH +/-10%
Resonant Frequency	All windings open	1.0 MHz minimum
Primary Leakage Inductance	Pins 3, 5, 7, 9 shorted together, 130 kHz measurement frequency	50 μH maximum

7.2 Materials

Item	Description
[1]	Core: PC40EE19, Gapped for AL of 131 nH/T^2
[2]	Bobbin: EE19, 10 pins
[3]	Magnet Wire: # 33, #34 AWG heavy Nyleze
[4]	Triple Insulated wire: # 30 AWG
[5]	Tape: 3M 1298 Polyester Film (white) 8.6 mm, 0.25mm Thick.
[6]	Tape: 3M 1298 Polyester Film (white) 5.0 mm, 0.25 mm Thick.
[7]	Varnish

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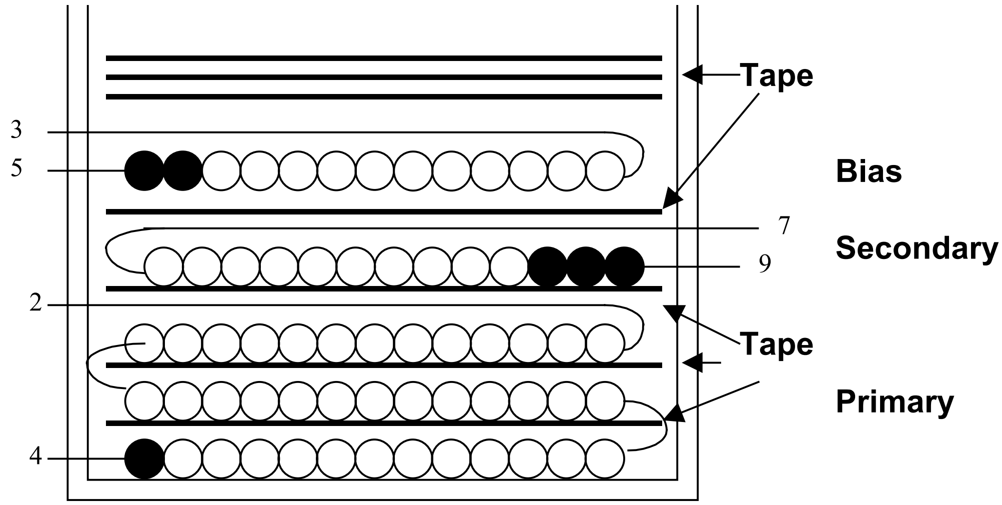
7.3 Transformer Build Diagram



7.4 Transformer Construction

Primary Layer	Start at Pin 4. Wind 44 turns of item [3] from left to right. Apply 1 layer of tape [5] for insulation. Wind another 44 turns in the next layer from right to left. Apply 1 layer of tape [5] for insulation. Wind another 43 turns from left to right Finish on Pin 2.
Insulation	1 Layers of tape [5] for insulation.
Secondary Winding	Start at Pin 9. Wind 6 trifilar turns of item [4] from left to right. Finish at pin 7.
Insulation	1 Layer of tape [5] for insulation.
Aux Layer	Start at Pin 5. Wind 17 bifilar turns of item [3] from left to right. Finish on Pin 3.
Final Assembly	Assemble and secure core halves. Put 3 layers of item [6], Impregnate uniformly (dip varnish) [7] and bake.

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8 Performance Data

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

Two sets of data for standby consumption, and cross-regulation, and efficiency are provided: one using an RCD snubber (as delivered) and a second using a zener snubber (BZY97C200). *All other data were taken with the RCD clamp*.

8.1 Efficiency

The efficiency was tested under a few different conditions.

TEST EQUIPMENT:

POWER LINE METER (EPD)	VAW-2XLP, Electronics Products Design Inc.
ELECTRONIC LOAD	PLZ72W, Kikushi Electronics Corp.
MULTIMETERS	Fluke 77.

8.1.1 Efficiency vs. input voltage at full load

Figure 3 shows efficiency vs. input voltage by using *RCD clamp*.
Figure 4 shows efficiency vs. input voltage by using *Zener clamp*.

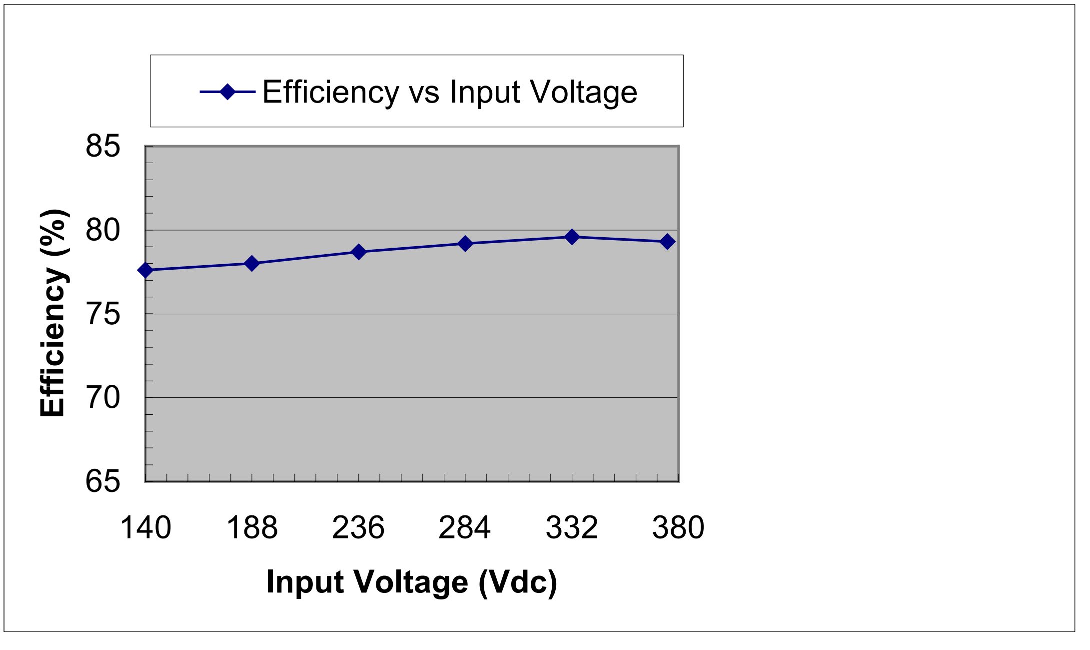

Figure 3 – Efficiency vs Input Voltage, Full Load—***RCD Clamp***

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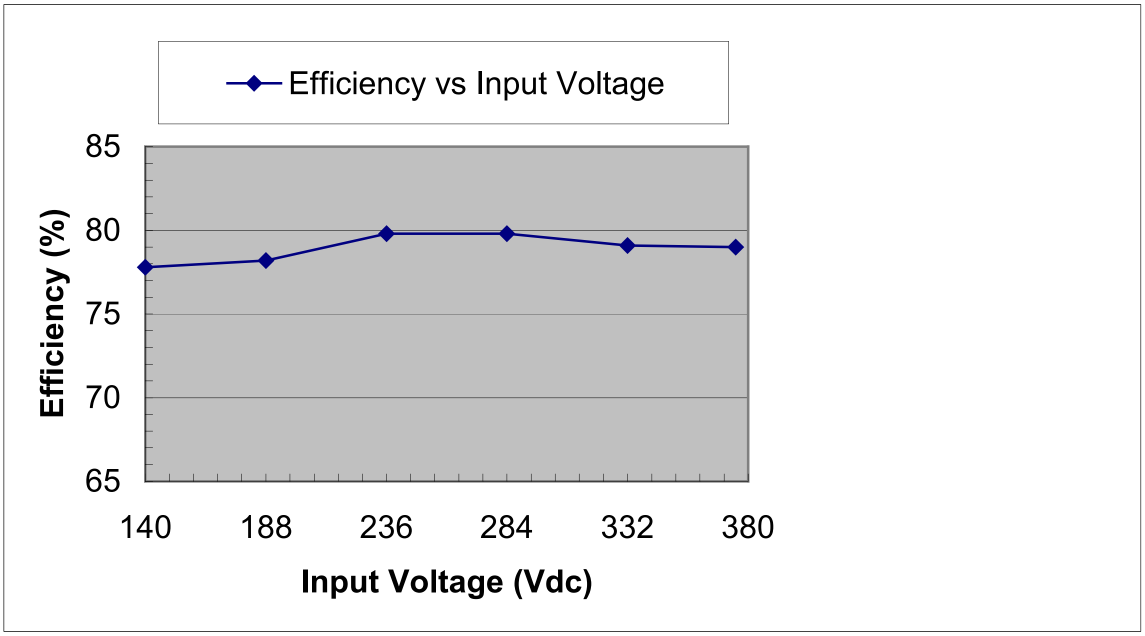

Figure 4 – Efficiency vs. Input Voltage, Full Load--***Zener Clamp***

8.1.2 Efficiency vs. output current at 140 Vdc and 375 Vac

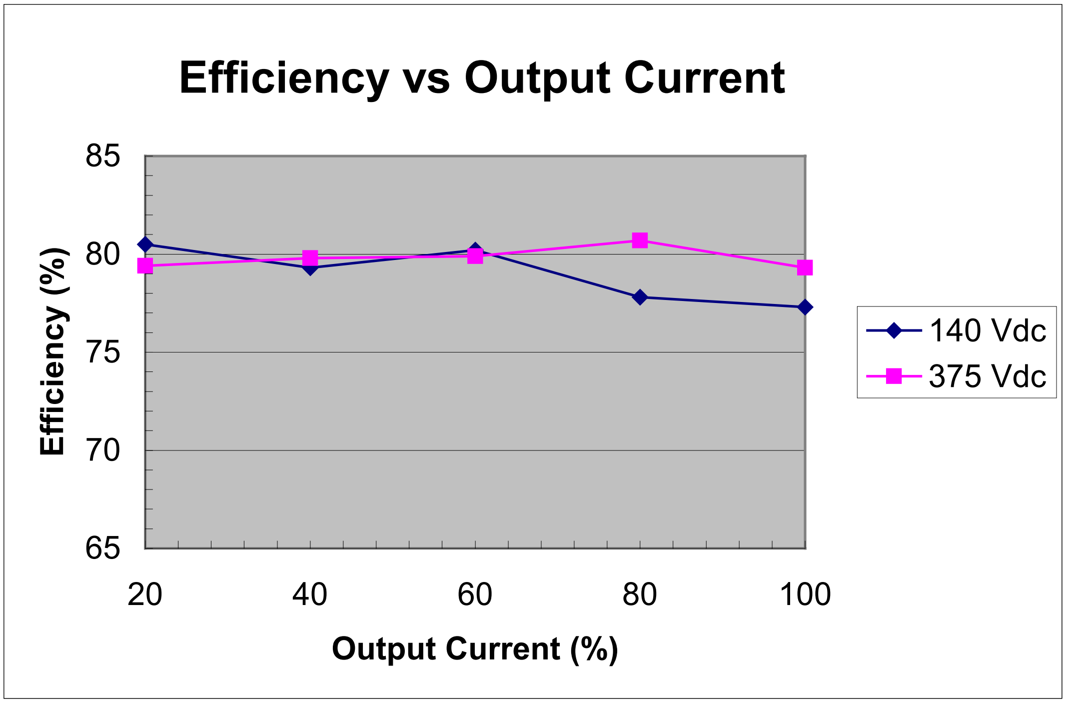

Figure 5 - Efficiency vs. output current at 140 Vdc & 375 Vdc, room temperature

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8.2 Cross Regulation

8.2.1 Worst Case Cross Regulation at 140 Vdc input

Load on 5 V	5 V	15 V (**RCD**)		15 V (**Zener**)	
		0 mA	50 mA	0 mA	50 mA
0 A	4.97 V	14.25 V	12.56 V	14.23	10.86
2.0 A	4.92 V	16.0 V	15.41 V	16.40	15.39

8.2.2 Worst Case Cross Regulation at 375 Vdc input

Load on 5 V	5 V	15 V (**RCD**)		15 V (**Zener**)	
		0 mA	50 mA	0 mA	50 mA
0 A	4.95 V	14.30 V	12.32 V	14.32	10.82
2.0 A	4.92 V	16.03 V	15.43 V	16.30	15.41

8.3 TNY266 Thermal Performance

The TNY266 temperature was measured at 220 Vdc input, full load. Ambient temperature is at 50°C, open frame, no airflow.

Test Result:

90°C.

8.4 Standby Power Consumption

Standby power consumption was measured at 115 Vac (325 Vdc). The dc bus was generated by a (2 A, 600 V) bridge rectifier and a 100µF, 400 Vdc capacitor. The load conditions:

5 V 120mA
15 V Floating (no load)

	Standby Power	15V output (no load)
RCD Clamp	900 mW	15.21V
Zener Clamp	780 mW	15.89

Note:
These results include the power dissipation caused by the 2 A bridge and a 100µF bulk capacitor (about 20 mW).

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8.5 Output Ripple & Noise measurement results

Electronic load was used during this test. Due to the test was done without the main PC power supply a 4.7 nF, 250 Vac Y cap was placed between primary and secondary.

A modified oscilloscope test probe was utilized in order to reduce spurious signals due to pickup. Details of the probe modification are provided below:

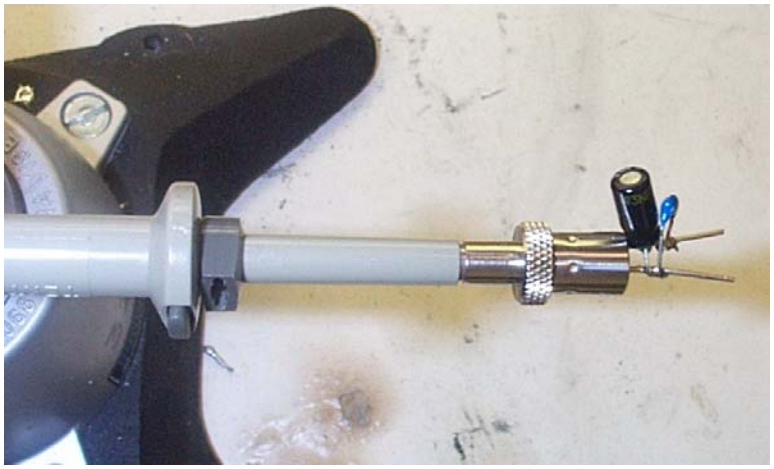

Figure 6 - Oscilloscope Probe with Probe Master 5125BA BNC Adapte

8.5.1 Output Ripple & Noise of 5Vdc

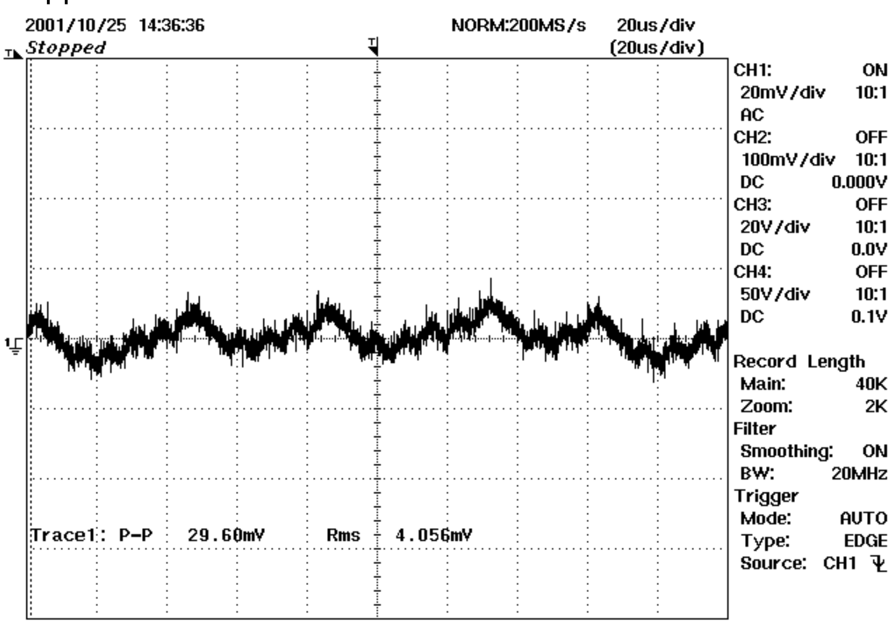

Figure 7 – Full load at 140 Vdc input

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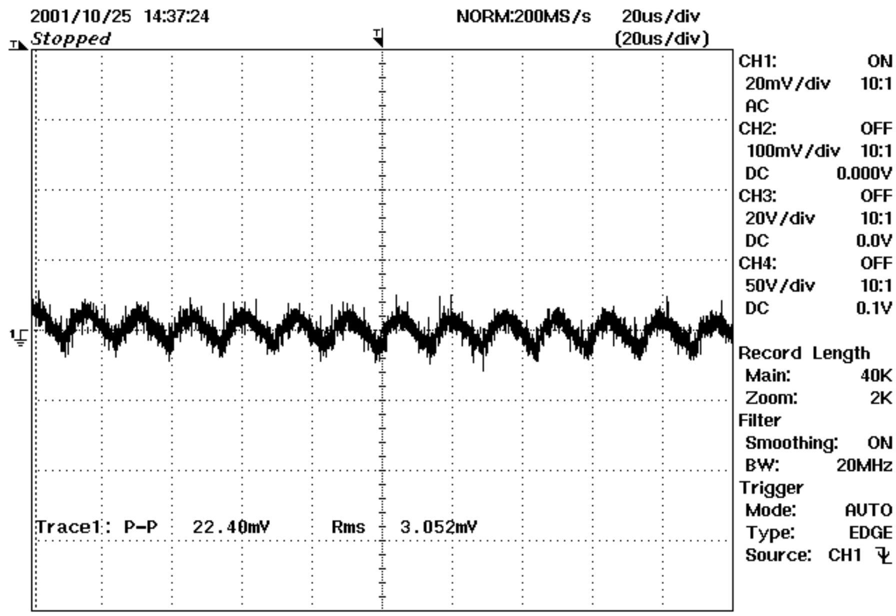

Figure 8 – Full load at 375 Vdc input

8.5.2 Output Low Frequency Ripple & Noise of 15 Vdc output

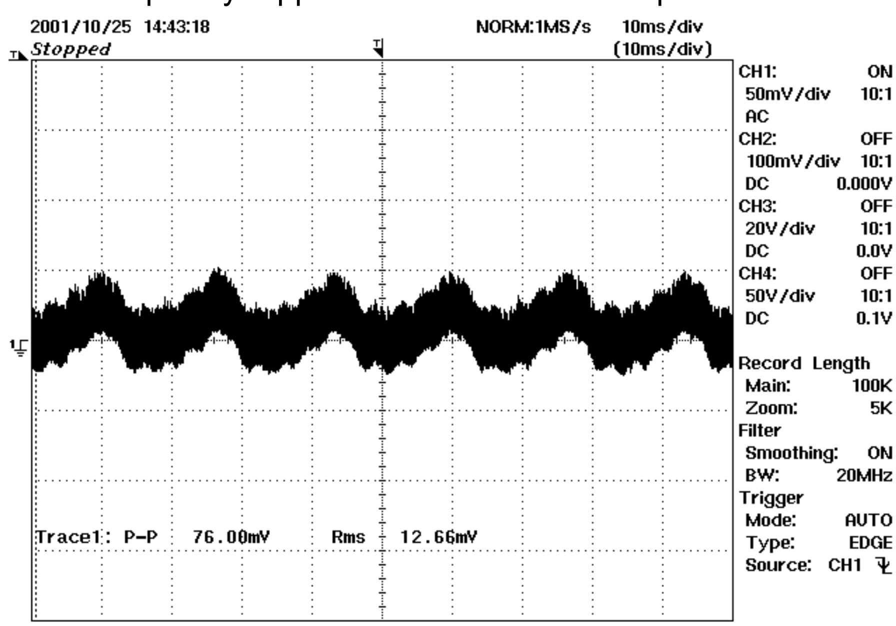

Figure 9 – Full load at 140 Vdc input

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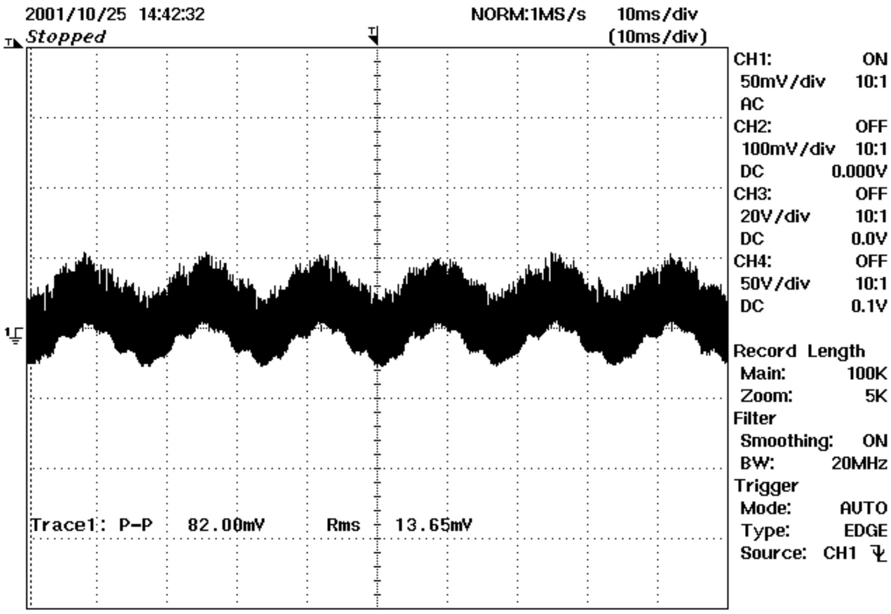

Figure 10 – Full load at 375 Vdc input

8.5.3 Output High Frequency Ripple & Noise of 15 Vdc

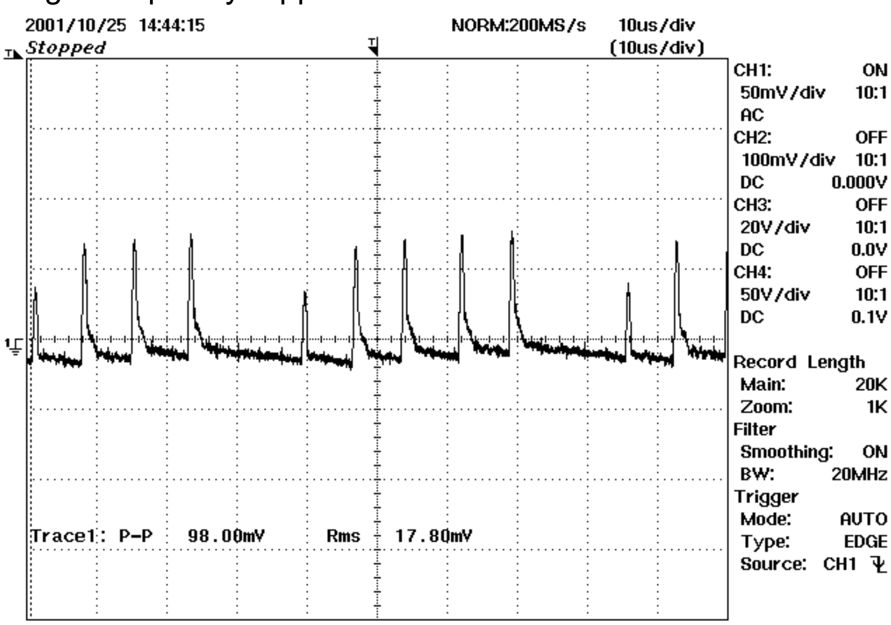

Figure 11 – Full load at 140 Vdc input

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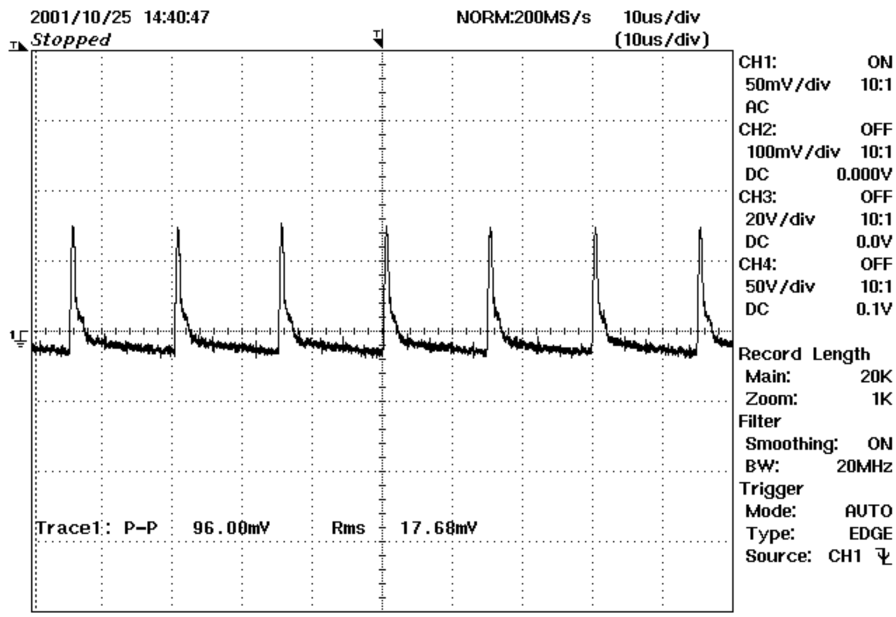

Figure 12 – Full load at 375 Vdc input

8.6 Output Voltage Over Shoot

The on/off control of TinySwitch II eliminates overshoot as shown below. The electronic load was used during the test. The results were taken at 375 Vdc input, no load and full load.

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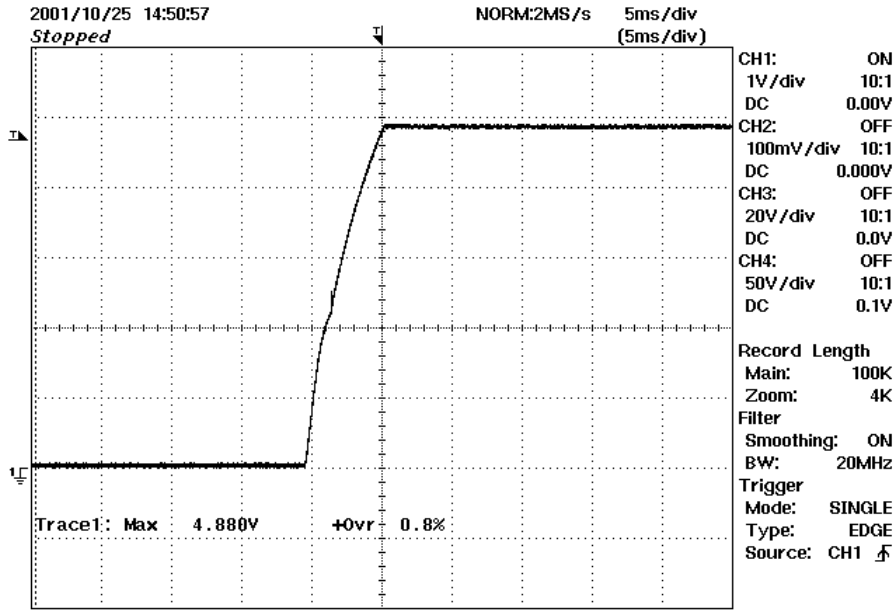

Figure 13 – 2.0 A at 375 Vdc

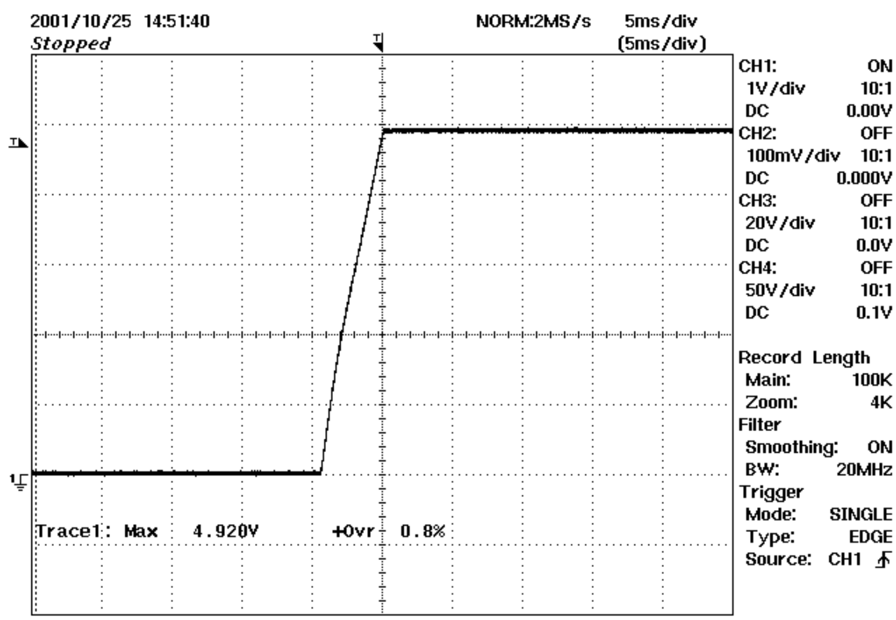

Figure 14 – 0 A at 375 Vdc

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8.7 5 V Output Voltage Hold up

The electronic load was used during this test. The results were taken at 140 Vdc input, full load – 2.0 A. No glitch.

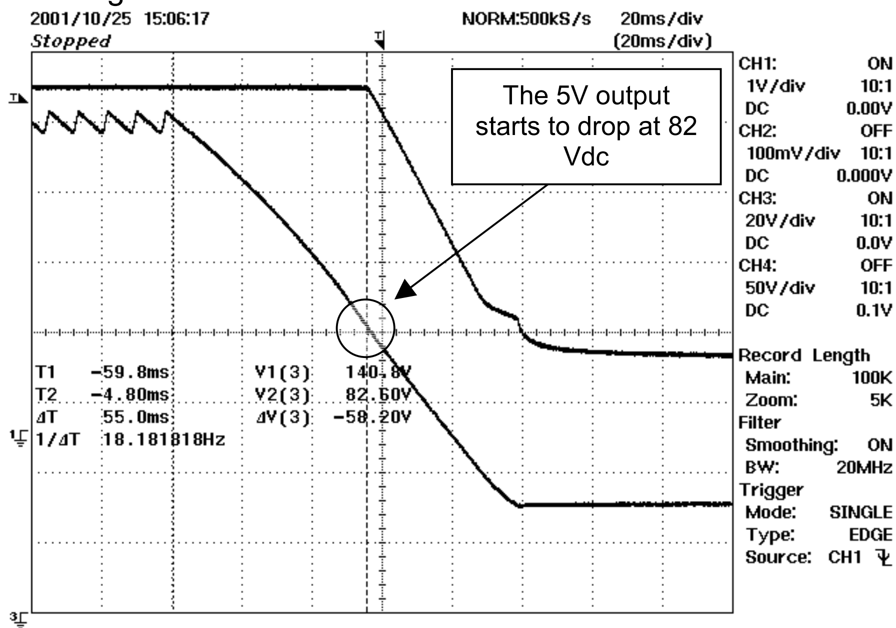

Figure 15 – 5 Vdc Output hold up at 140 Vdc, full load - 2.0 A

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9 Conducted EMI

Conducted EMI measured with output return connected to a main PC power supply (from Liteon) secondary ground, which is connected to PE of LISN. The input dc bus was obtained from the main PC supply (by taking out the PFC switch). The test was performed at both 115Vac and 230Vac, full load.

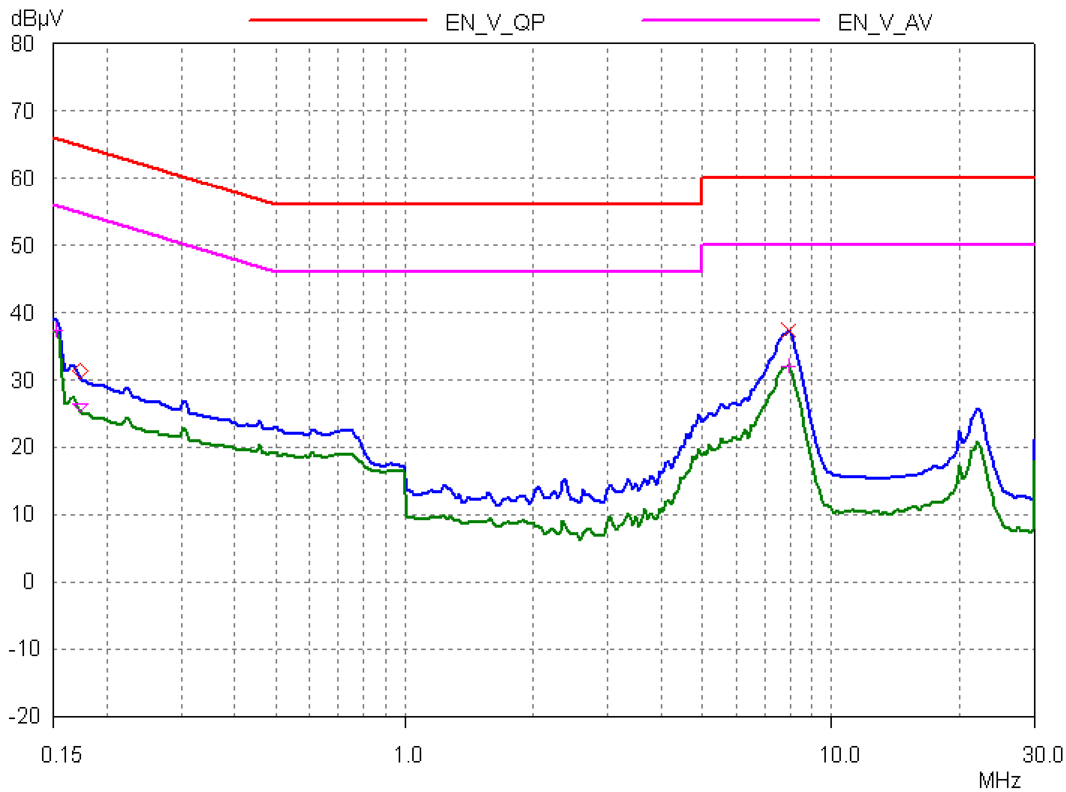

Figure 16 - Conducted EMI at 115 $V_{AC,}$ Full Load, using PC Main PSU EMI filter

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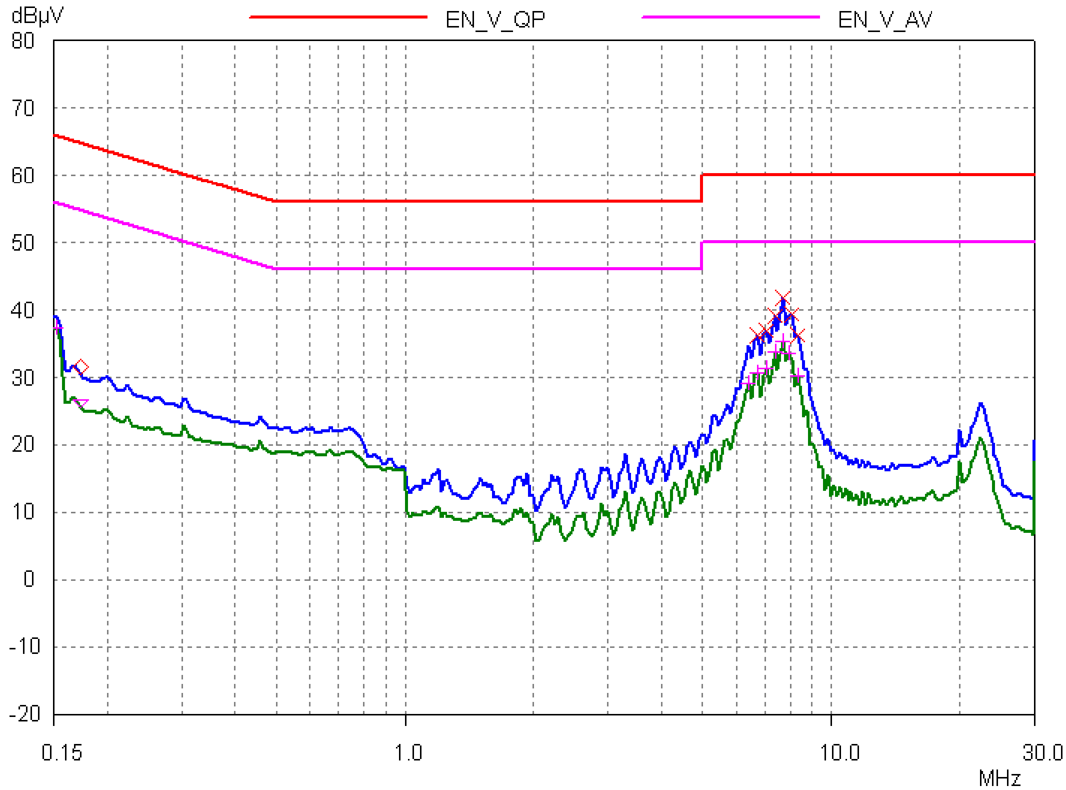

Figure 17 - Conducted EMI at 230 VAC, Full Load

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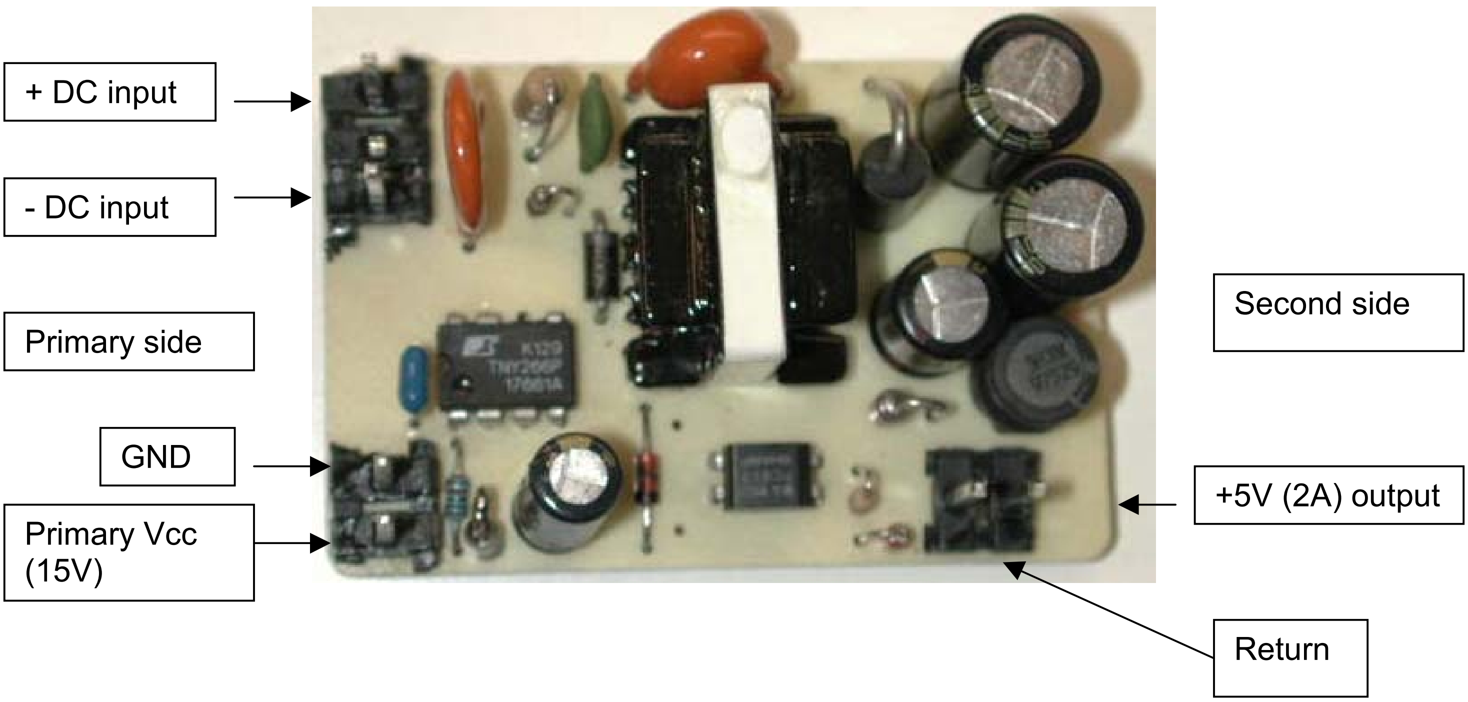
10 Top view of completed prototype



Revision History

Date	Author	Revision	Description & changes
26-Oct-01	YG	0.1	First draft
4-Nov-01	YG/JC	1.0	First release

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