| | |
|---|---|
| **Title** | ***Engineering Prototype***<br><br>1W PC Standby using TNY267P |
| **Specification** | INPUT: 140 ~ 375 VDC<br>OUTPUT: 5 V @ 0 ~ 2.0A<br>15V @ 50 mA |
| **Customer** | Generic |
| **Application** | PC - Standby |
| **Author** | Y.G. |
| **Document Number** | EPR24 |
| **Date** | 14-Nov-01 |
| **Revision** | First Release |

**Features**

- Low cost solution for PC Standby
- Standby power consumption 770 mW @ 600 mW load
- Operates from 140 Vdc to 375 Vdc @ full load
- Good cross-regulation

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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 TNY267P. 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 770mW at 600 mW out (even if using an RCD snubber) @ 115Vac.

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 slightly 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 $V_{AC}$) | | - | - | 1.0 | W | Measured at 230 Vac to simulate 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** | $\eta$ | | 75 | | % | Measured at full load, 25 °C |
| Conducted EMI | | | | | | Meets CISPR22B / EN55022B |
| Ambient Temperature | $T_{AMB}$ | | | 50 | °C | |
| TNY267 device temperature | | | | 100 | °C | At 50°C ambient, max load, low line |

**- = not specified**

**Table 1 -** Power Supply Specification


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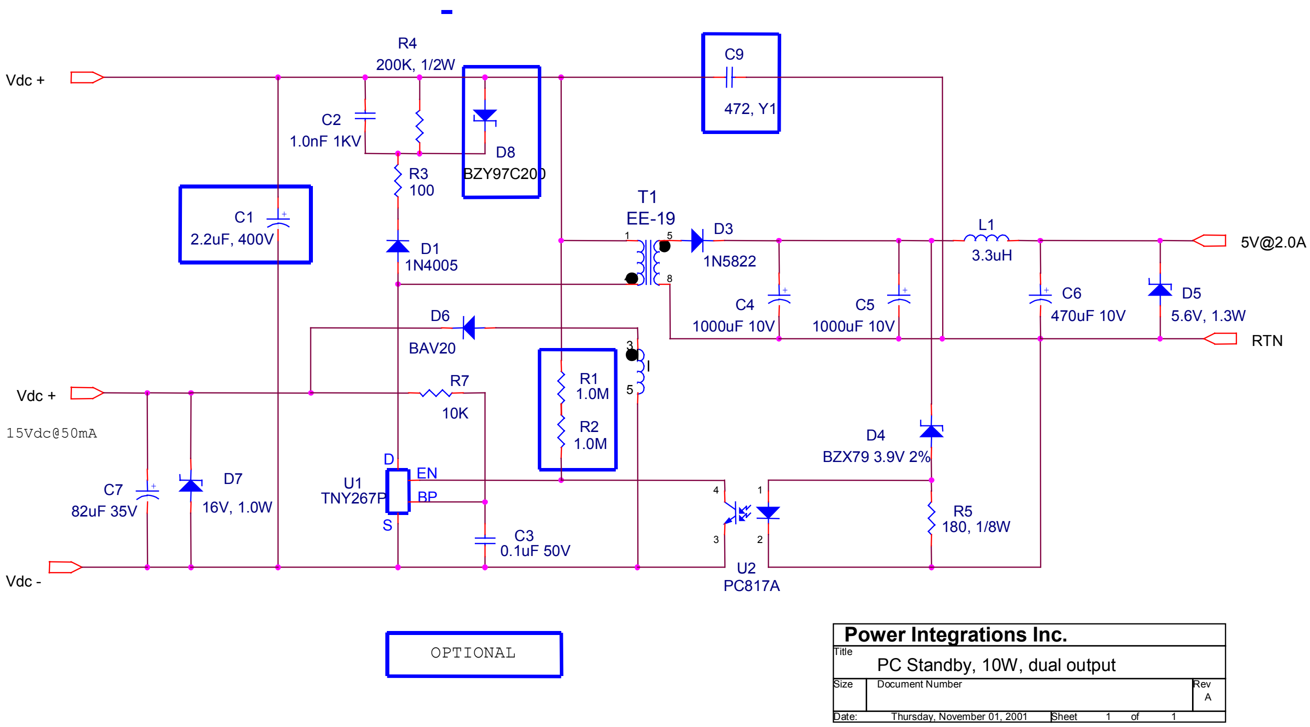
# 3 Schematic




- 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 TNY267P.

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 TNY267P 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

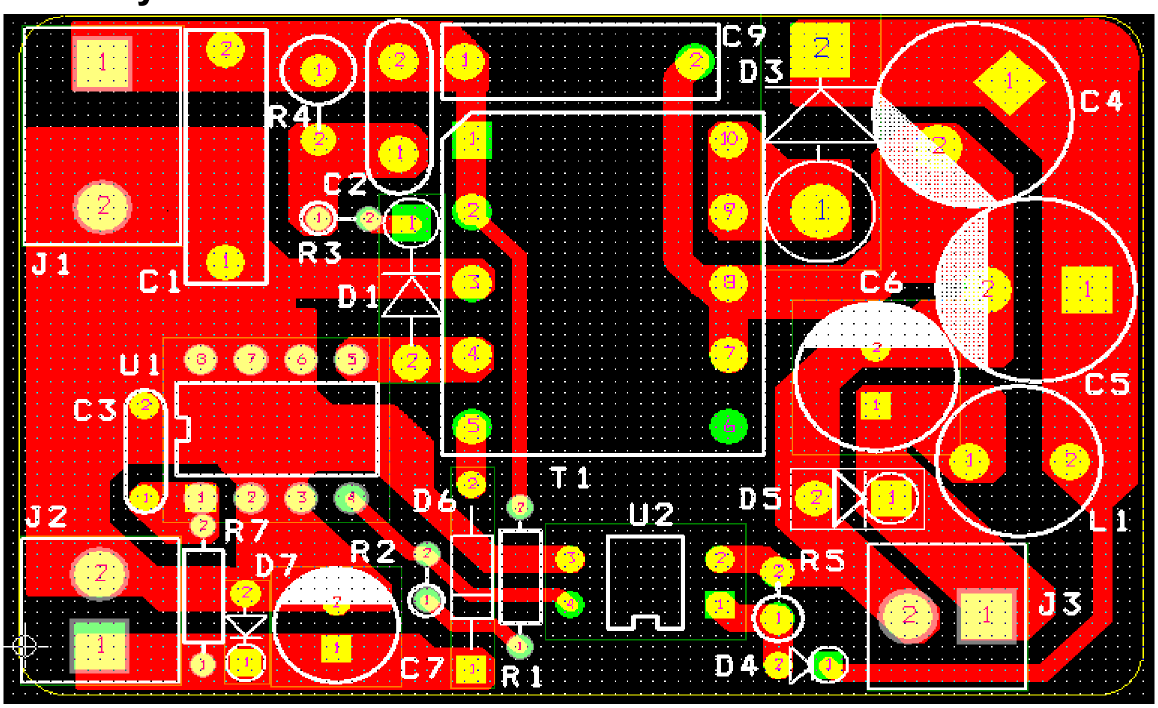


**Figure 2 – Printed Circuit Layout**



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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 | | |
| 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 | 1N4005GP | Diodes |
| 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 | Tiny267P | PI |
| 21 | 1 | U2 | Optocoupler | PC817A | Sharp |
| 22 | 1 | | PCB | | |

- *** Optional**


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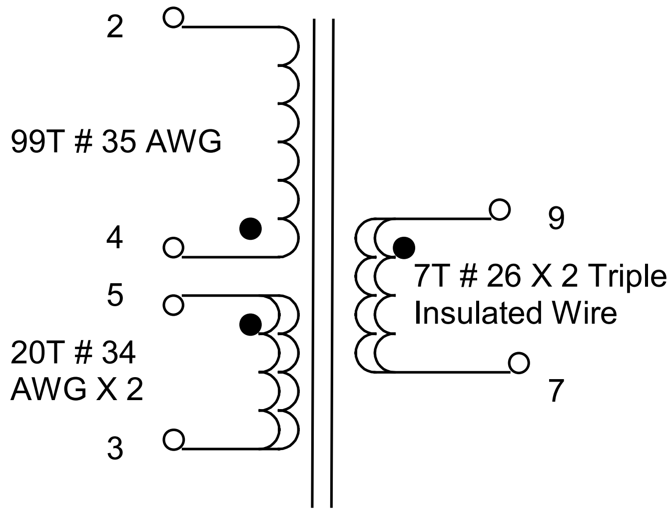
# 7 Transformer Drawings




## *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 | 1353 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 | 30 μH maximum |

## *7.2 Materials*

| Item | Description |
|---|---|
| **[1]** | Core: PC40EE19, Gapped for AL of 138 nH/T$^2$ |
| **[2]** | Bobbin: EE19, 10 pins |
| **[3]** | Magnet Wire: # 35, #34 AWG heavy Nyleze |
| **[4]** | Triple Insulated wire: # 26 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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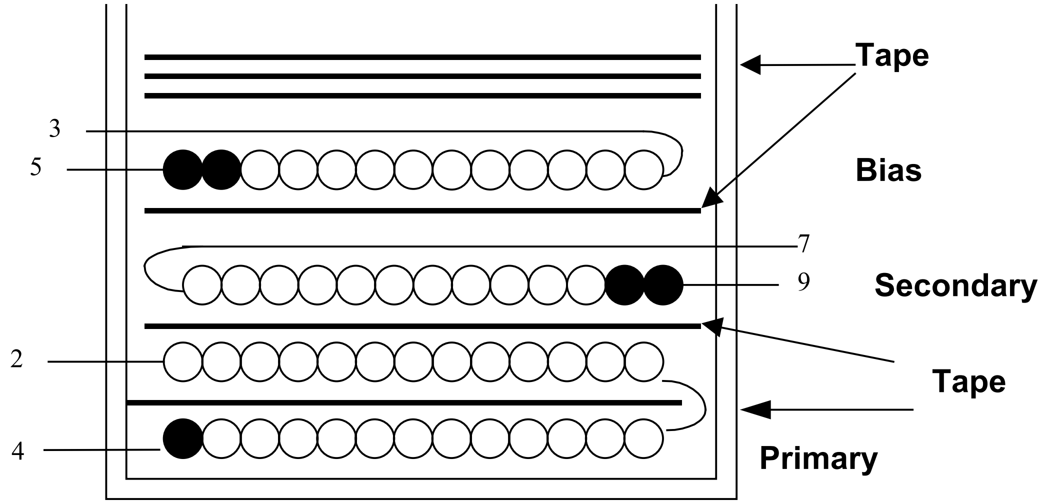
### *7.3 Transformer Build Diagram*




### *7.4 Transformer Construction*

| | |
|---|---|
| **Primary Layer** | Start at Pin 4. Wind 50 turns of item [3] from left to right. Apply 1 layer of tape [5] for insulation. Wind another 49 turns in the next layer from right to left. Finish on Pin 2. |
| **Insulation** | 1 Layers of tape [5] for insulation. |
| **Secondary Winding** | Start at Pin 9. Wind 7 bifilar 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 20 bifilar turns of item [3] from left to right. Finish on Pin 3. |
| **Insulation** | 3 layers of tape [5] for insulation. |
| **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

For comparison, the performance data of zener clamp are also added to efficiency vs. input voltage, cross- regulation, and standby power consumption.

## *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

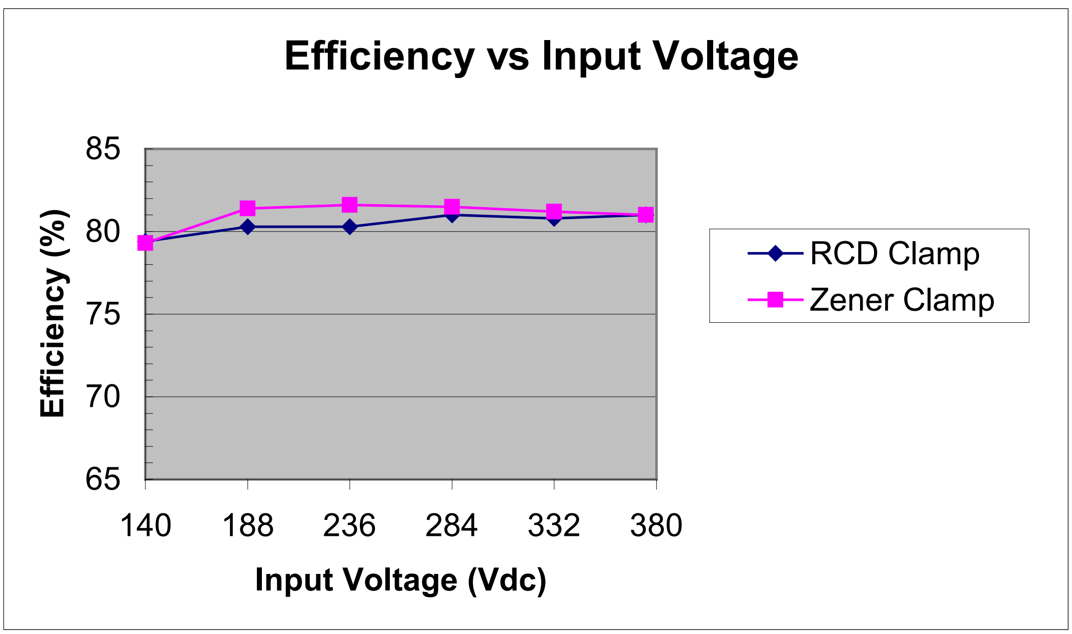


Figure 3 – Efficiency vs Input Voltage, Full Load


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

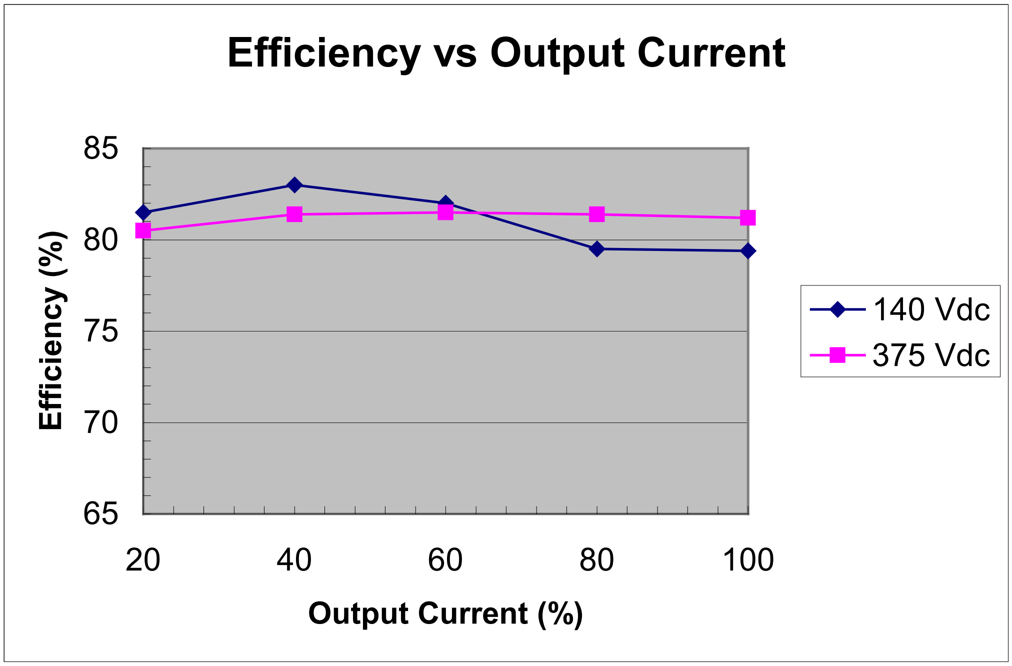


Figure 4 - Efficiency vs. output current at 140 Vdc & 375 Vdc, room temperature

### *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 | 4.96 V | 14.30 V | 12.38 V | 14.33 V | 11.35 V |
| 2.0 A | 4.92 V | 16.0 V | 15.15 V | 16.09 V | 15.16 V |

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 | 4.96 V | 14.33 V | 12.30 V | 14.37 V | 11.30 V |
| 2.0 A | 4.93 V | 16.0 V | 15.17 V | 16.05 V | 15.19 V |


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### *8.3 TNY267 Thermal Performance*

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

**Test Result: 80°C.**

### *8.4 Standby Power Consumption*

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

5 V 120mA
15 V Floating (no load)

**Test Results:**

| | Standby Power | 15V output (no load) |
|---|---|---|
| RCD Clamp | 800 mW | 15.14V |
| Zener Clamp | 770 mW | 15.79 |

Note:
These result include the power consumption dissipated by the 2 A bridge and 100μF bulk capacitor, which is about 20 mW.

### *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 4.7nF, 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 5 - Oscilloscope Probe with Probe Master 5125BA BNC Adapter



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### 8.5.1 Output Ripple & Noise of 5Vdc

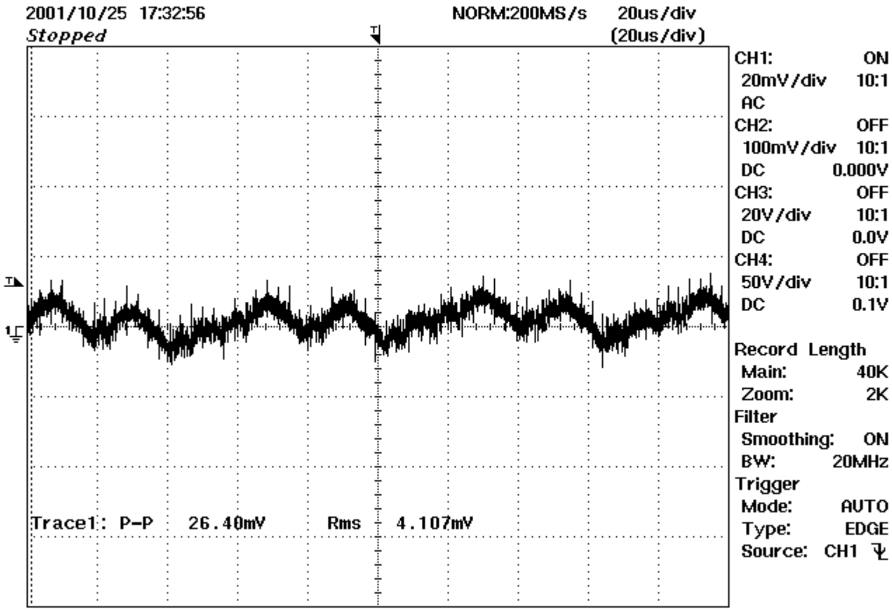


Figure 6 – Full load at 140 Vdc input

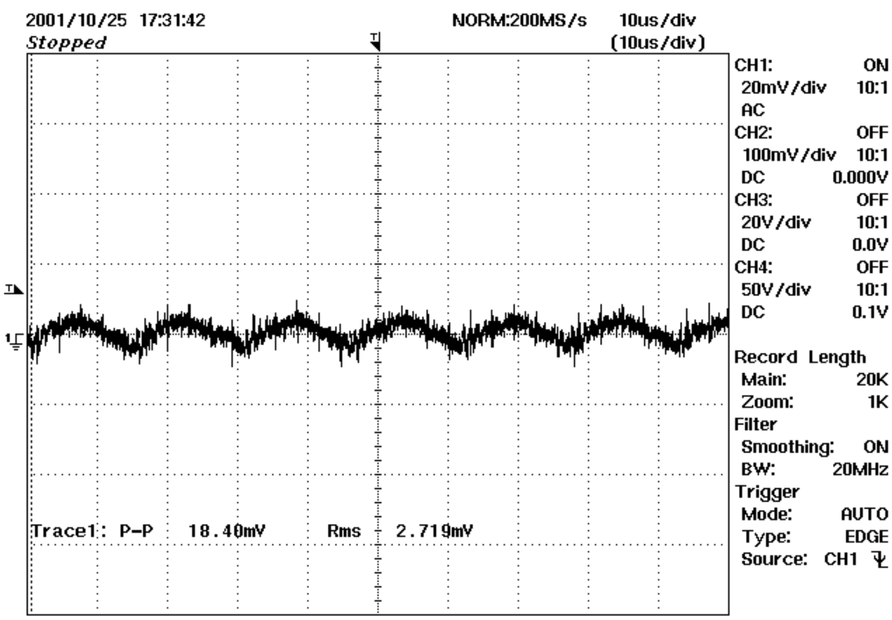


Figure 7 – Full load at 375 Vdc input


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### 8.5.2 Output Low Frequency Ripple & Noise of 15 Vdc

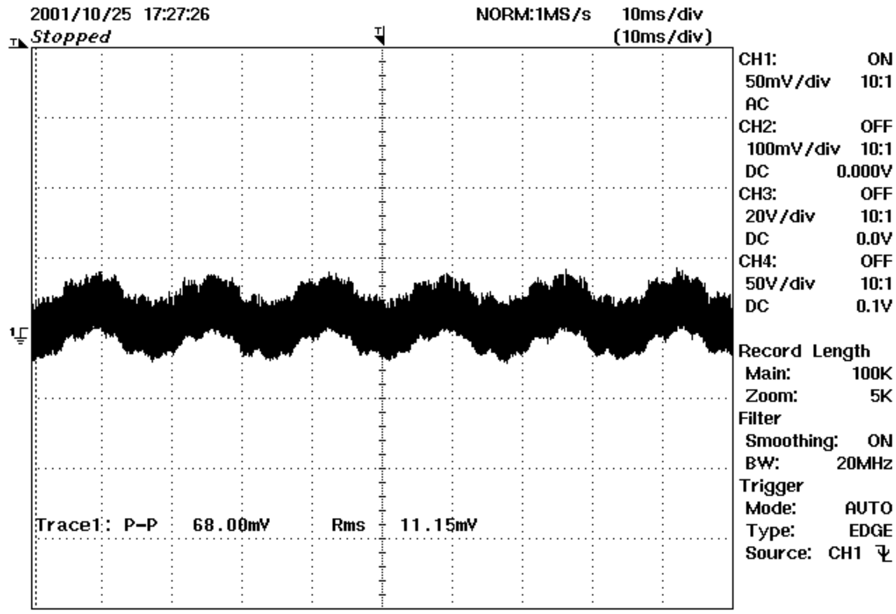


Figure 8 – Full load at 140 Vdc input

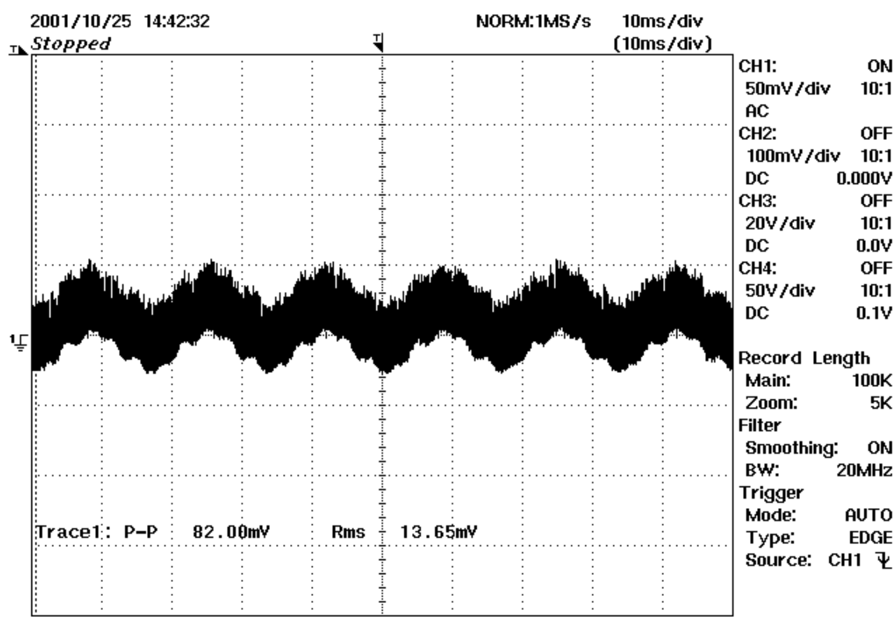


Figure 9 – Full load at 375 Vdc input


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## 8.5.3 Output High Frequency Ripple & Noise of 15 Vdc

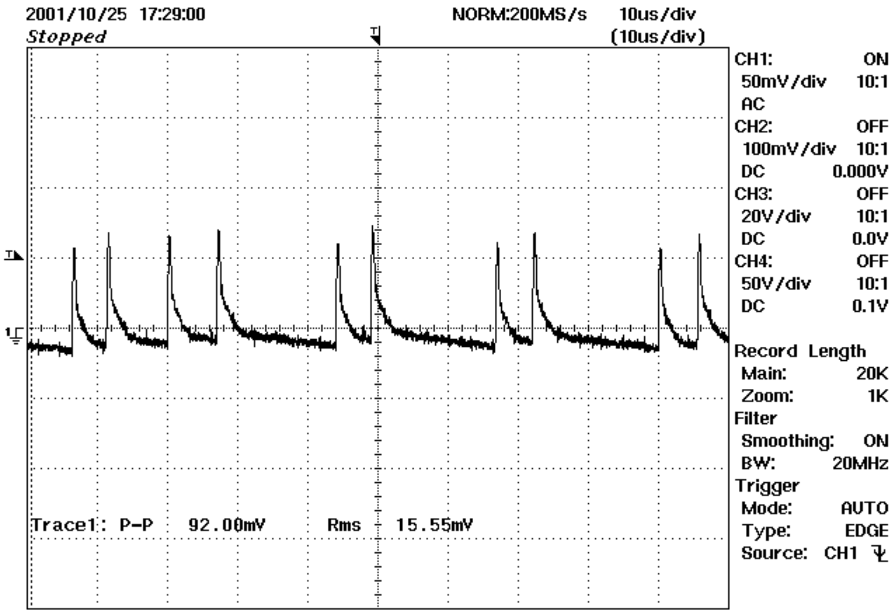


Figure 10 – Full load at 140 Vdc input

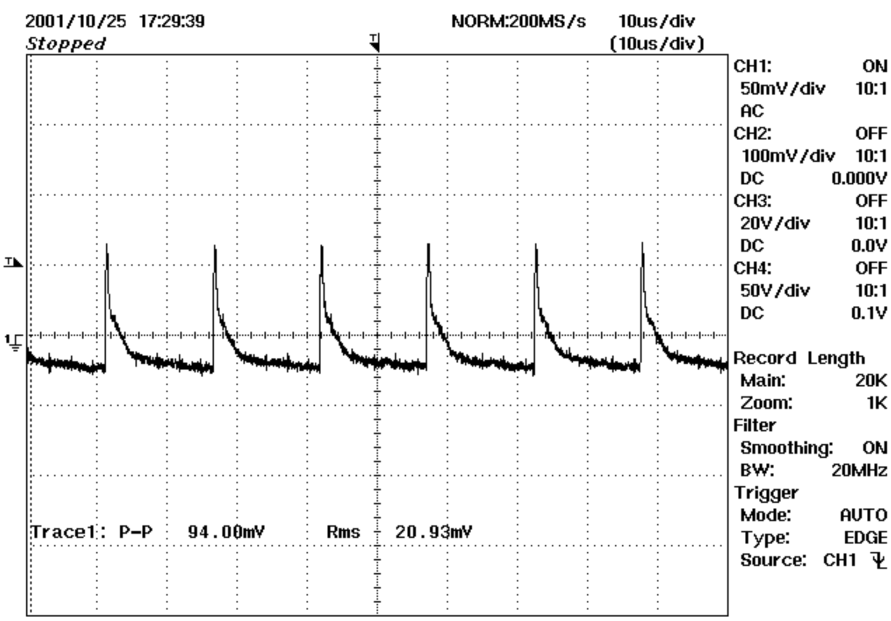


Figure 11 – Full load at 375 Vdc input


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### *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.

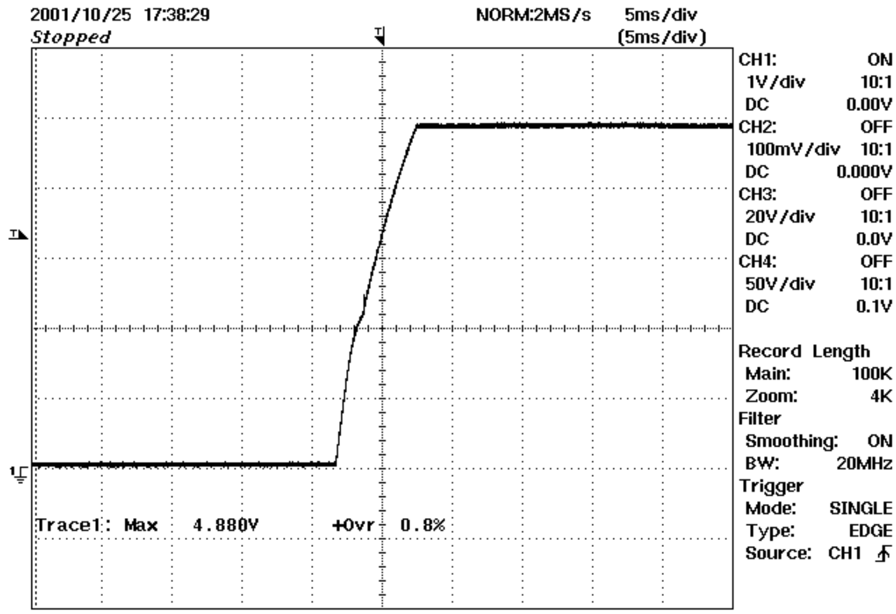


Figure 12 – 2.0 A at 375 Vdc input

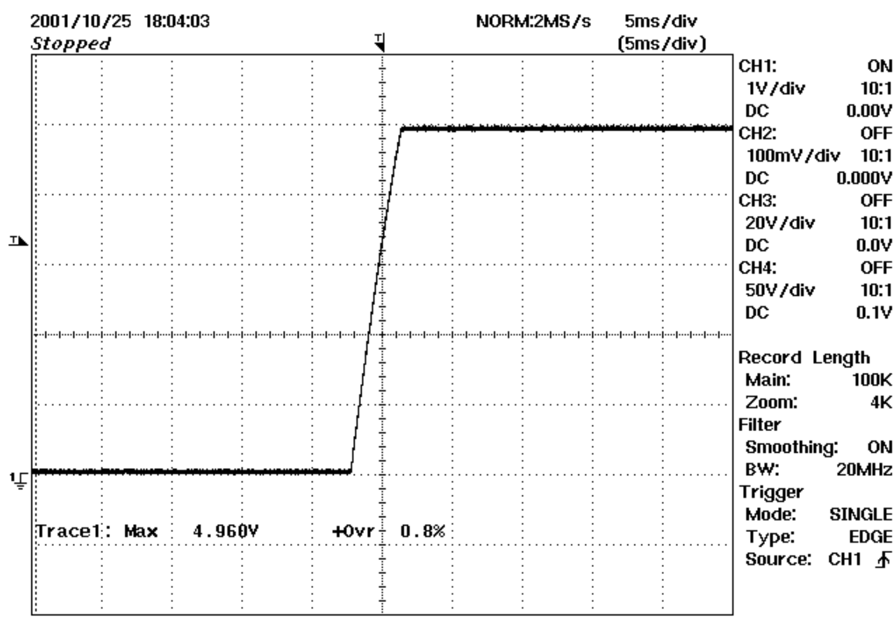


Figure 13 – 0 A at 375 Vdc input


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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.

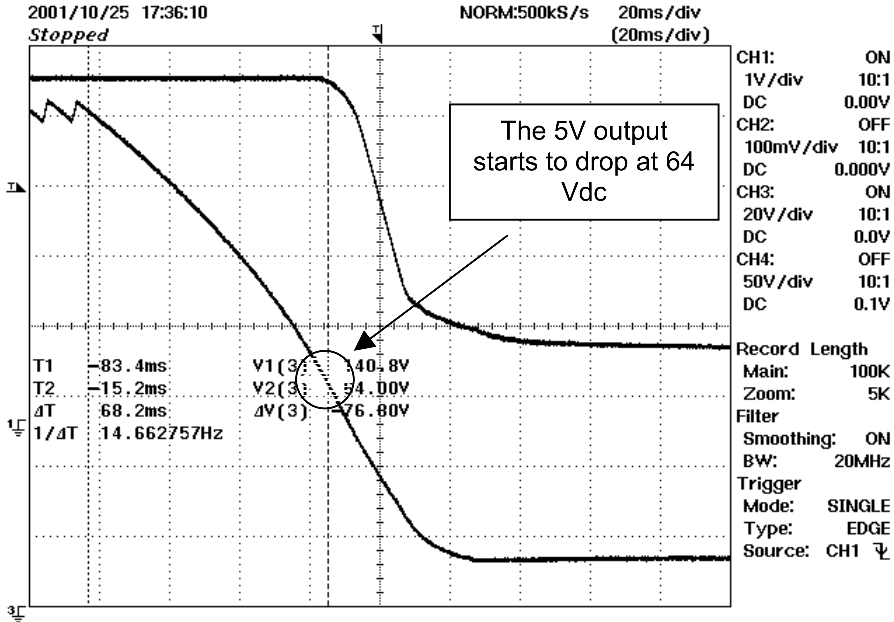


Figure 14 – 5 Vdc Output hold up at 140 Vdc, full load - 2.0 A



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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 115 Vac and 230 Vac, full load.

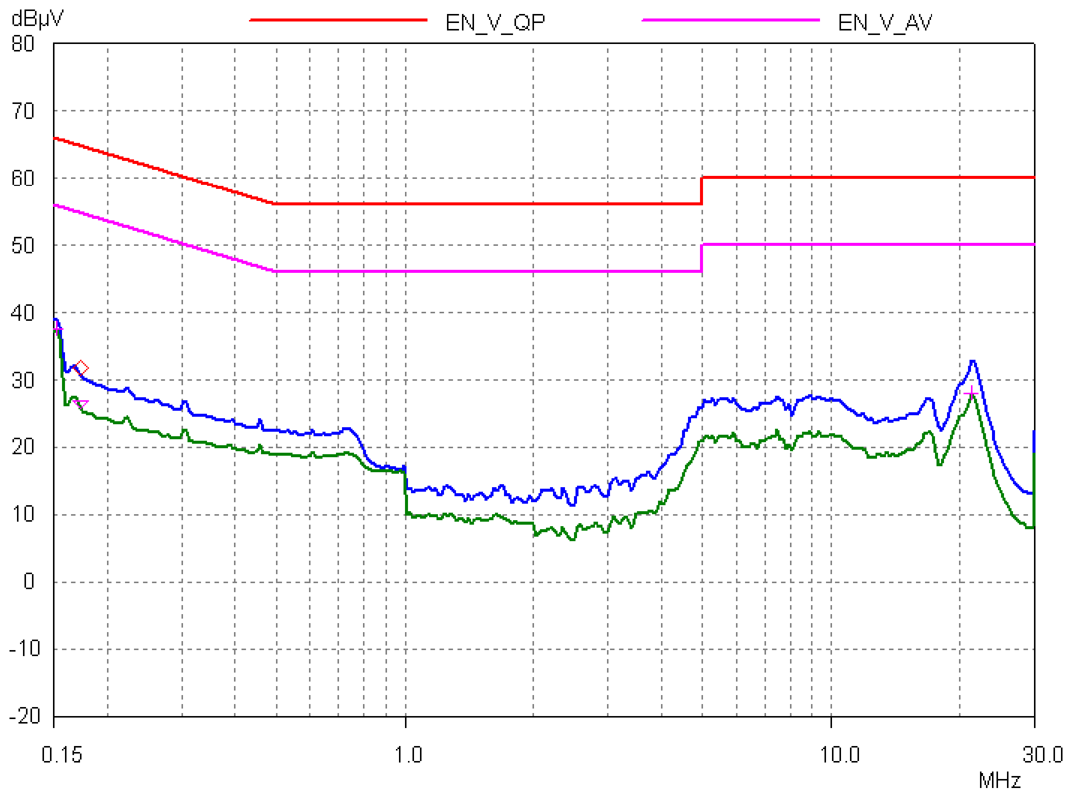


Figure 15 - Conducted EMI at 115 $V_{AC,}$ Full Load


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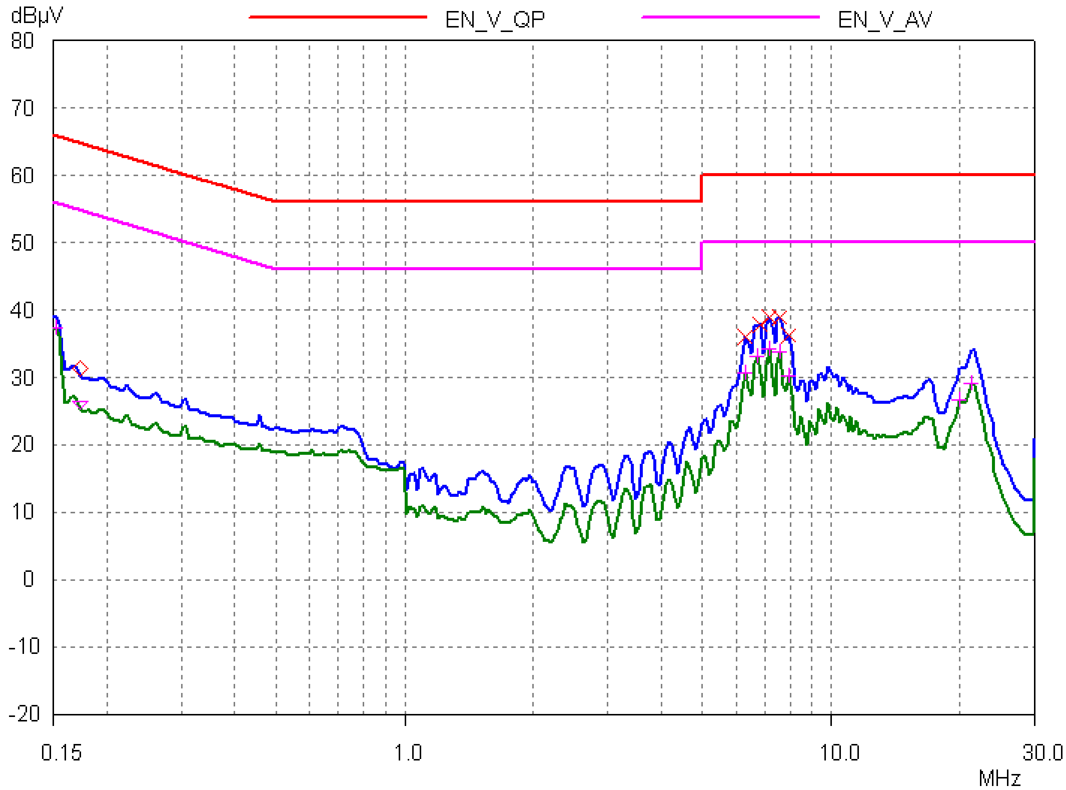


Figure 16 - Conducted EMI at 230 VAC, Full Load



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## 10 Top view of completed prototype


**Revision History**

| Date | Author | Revision | Description & changes |
|---|---|---|---|
| 26-OCT-2001 | YG | 0.1 | First draft |
| 14-Nov-01 | YG/JC | 1.0 | First release |

Filename:



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