WAVE SAMPLING TECHNIQUE
FOR
AC POWER MEASUREMENT

DONE BY

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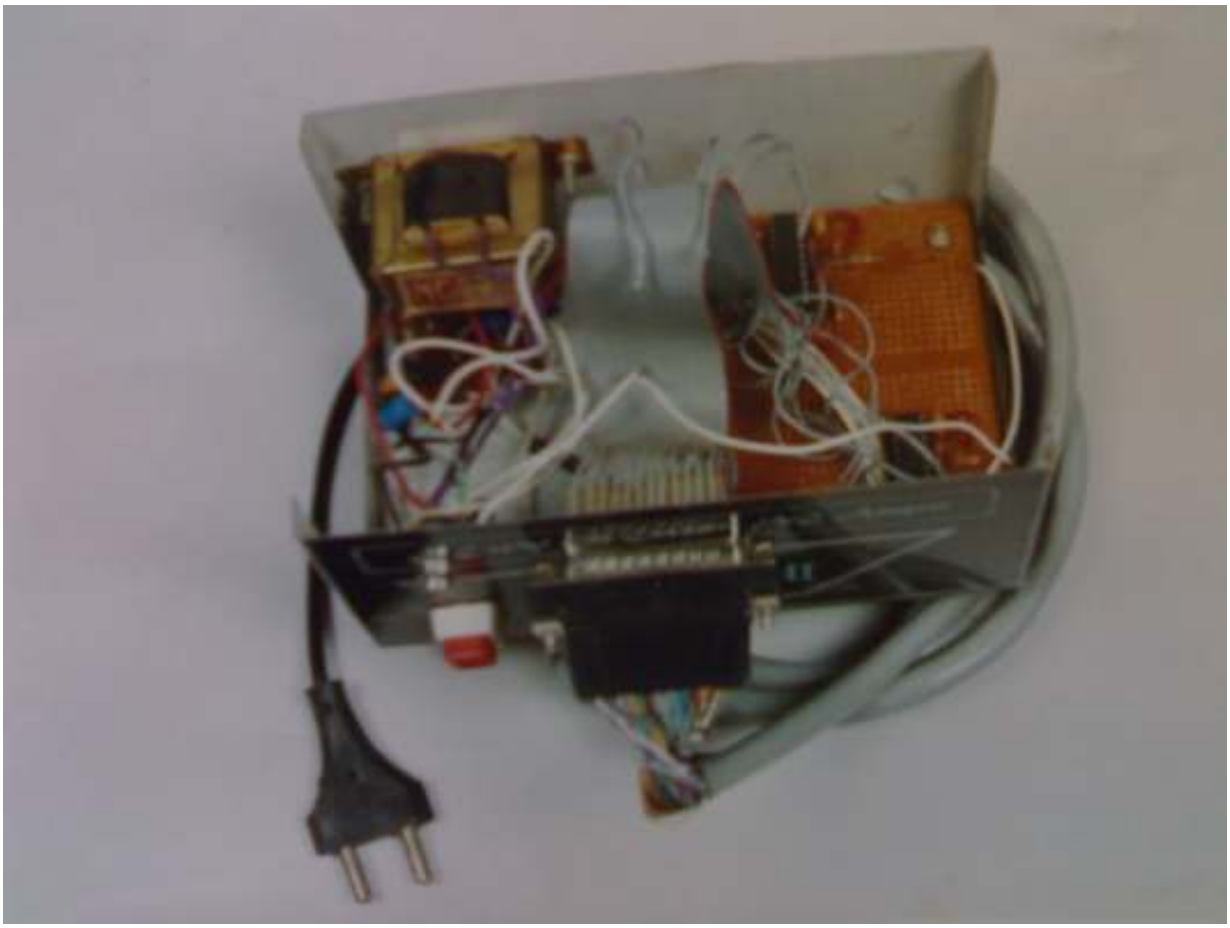
1 Introduction:

The Electrical power is measured in terms of real, reactive, apparent and power factor. The traditionally these parameters are measured by Analog instruments such as electro-dynamometer/induction type instruments. The traditional method of measurement gives the problem of risk in reading, storing data for the future analysis. This can be made easy by using a PC. In this project an attempt is made to overcome the above problems by measuring the electrical parameters using Digital Sampling Technique and the data is processed on the PC.

The following is the actual device:



2 Wave Sampling Technique:

To convert the analog signals to digital signal wave sampling technique is used. Sampling of analog signals should follow the sampling theorem. Fetching the data at a particular instant is known as sampling. Wave sampling converts the continuous signal into discrete waveform. Sampling theorem provides minimum frequency limit of sampling the data to retrieve its original waveform. Sampling theorem states that a signal with the highest frequency ω must be sampled at a minimum rate 2ω frequency to retrieve the original waveform.

3 Power measurement:

Power can be measured by measuring the voltage and the current of a system. Power consumed by the system or delivered by the system is measured in terms of real, reactive, apparent power and power factor.

Real power or active/average power is equal to the power over one cycle. This can be calculated by averaging the powers at the sampling points. This can be given as:

$$\text{Real power} = \{\sum_{i=1}^{i=n} P(i)\}/n$$

$$= \{P(1) + P(2) + P(3) + ……..+P(n)\} / n$$

$$= \{[V(1) * I(1)] + [V(2) * I(2)] + [V(3) * I(3)] + ……+ [V(n) * I(n)]\} / n$$

The product of RMS(Root Mean Square) value of the current and the voltage gives the apparent power in the system. This is given as:

$$\text{Apparent power} = VRMS * IRMS$$

The RMS values are calculated as

$$VRMS = \sqrt{V(1)2 + V(2)2 + V(3)2 + ……. + V(n)2}$$

$$IRMS = \sqrt{I(1)2 + I(2)2 + I(3)2 + …….. + I(N)2}$$

The cosine angle between the voltage and the current or the ratio of real power to the apparent power is known as power factor.

$$\text{The Power Factor(PF)} = \text{Real Power} / \text{Apparent Power} = \cos\Phi$$

The power absorbed by the reactance of the system is known as reactive power. This can be calculated as,

$$\text{Reactive Power} = VRMS * IRMS * \sin\Phi$$

4 Implementation:

The above discussion clearly indicates that the power can be measured by measuring voltage and current. To measure both the voltage and the current two ADCs are used.

4.1 Block diagram:

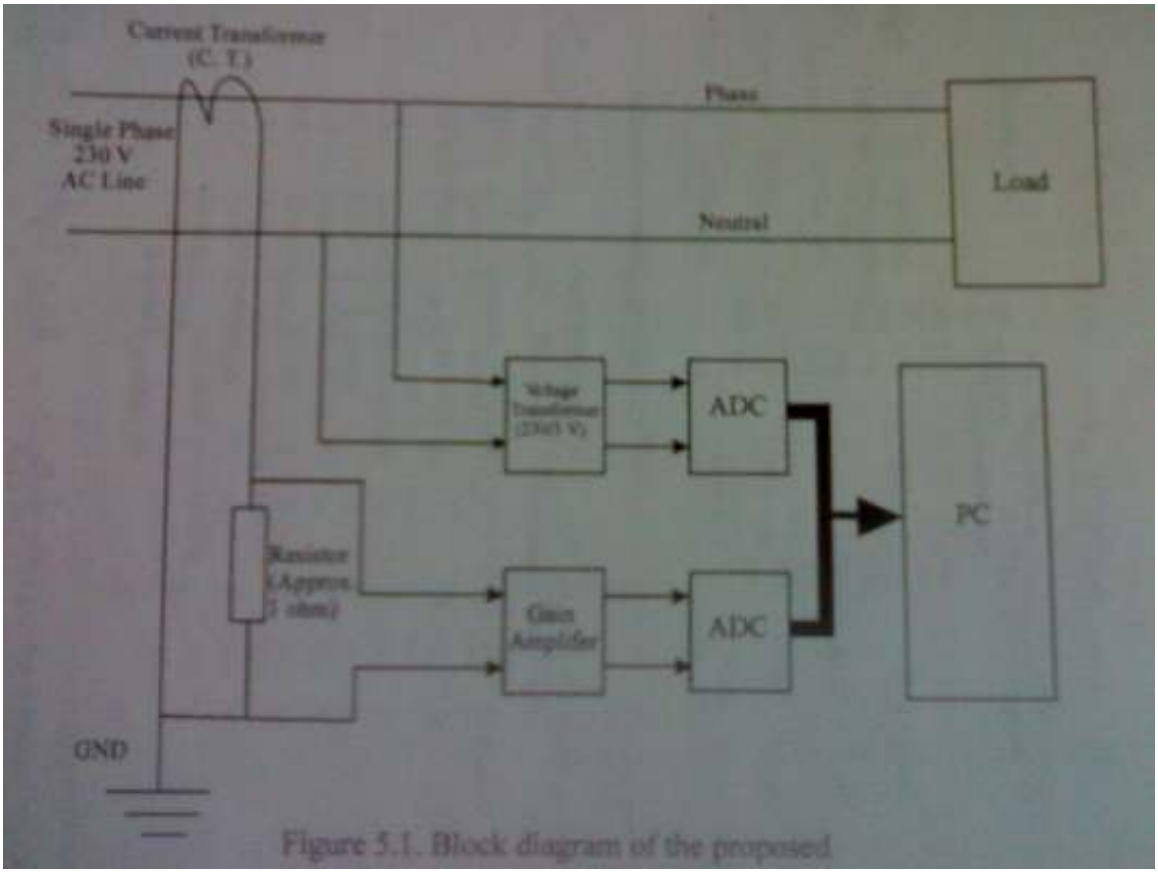


Figure 5.1. Block diagram of the proposed

4.2 Voltage measurement:

The mains supply 230V is step down to 3V by a step down transformer. This reduced voltage signal is directly fed to the ADC1 and the instantaneous voltages are converted into 8 bit values. The converted values are read through the PC's parallel port and are stored in array. Proper mathematical conversion are made in the PC side.

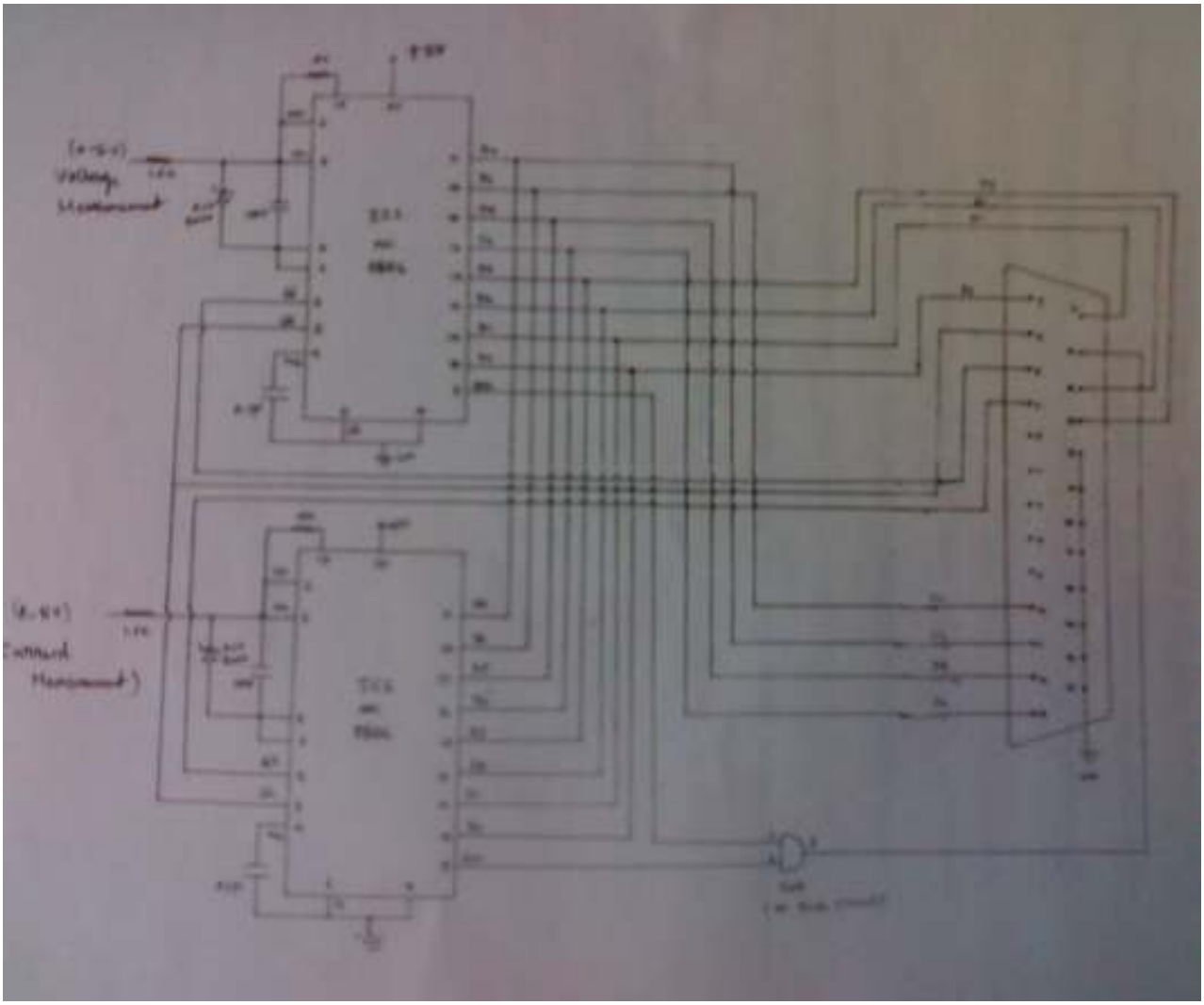
4.3 Current measurement:

The current measuring part uses the Current Transformer (CT) of rated current. Since the CT should be operated at the short circuit condition, approximately 1 ohm resistor is connected at the secondary side to convert the current to voltage. The voltage gain amplifier raises the 0-1V to 0-3V. Then the signal is fed to ADC2 and the proper mathematical conversions are made. The amplification circuit is not shown here. The LM741 op-amp is used as a voltage amplifier.

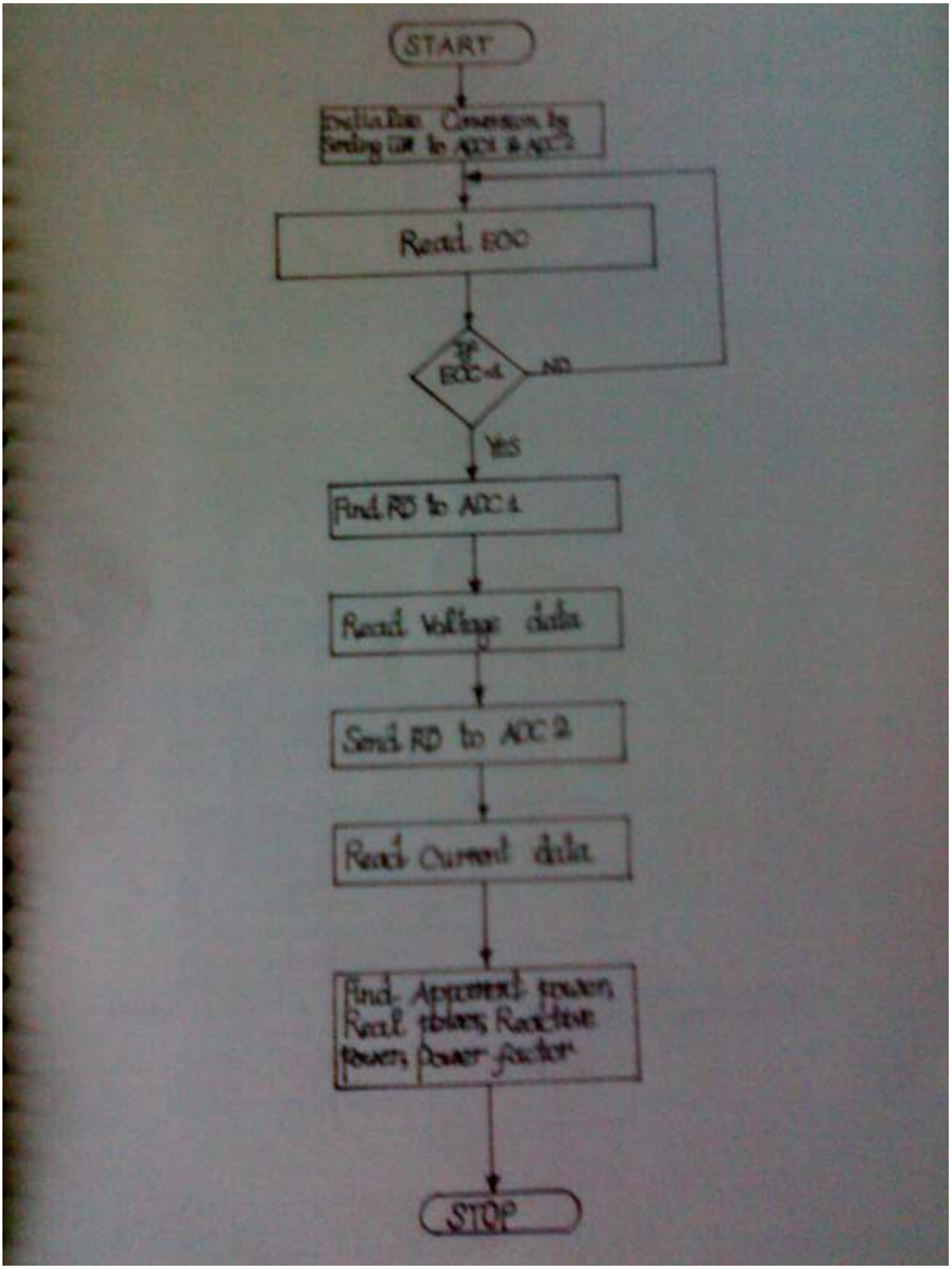
Since the frequency of the power supply is 50Hz the National Semiconductors ADC 804 has been selected. The conversion time for this device is approximately 120 microsecond.

The PC's printer port LPT1 is used to collect the digital data.

4.4 Schematic diagram:

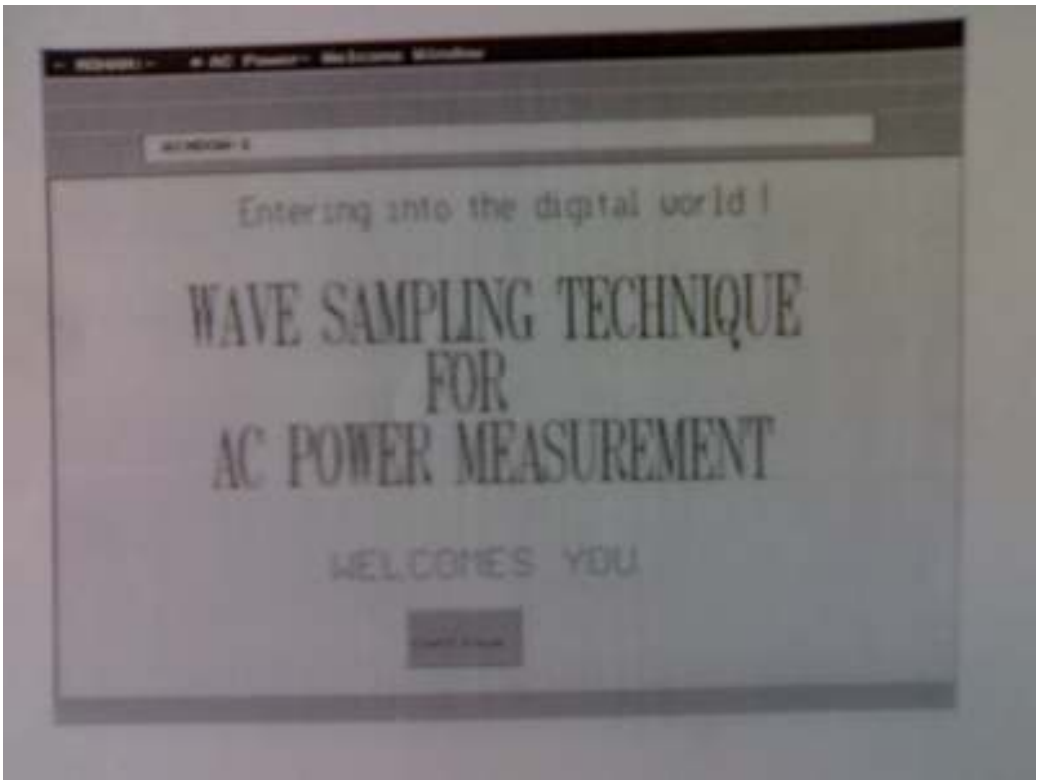


4.5 Flow chart:

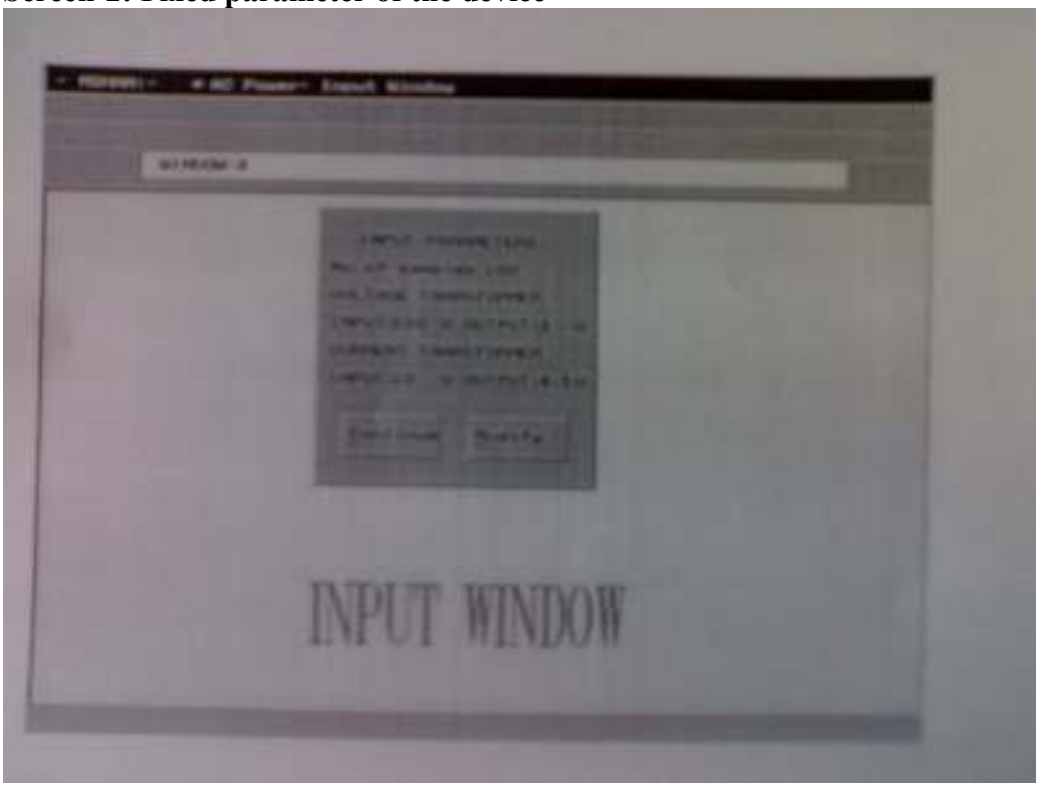


5 Screen shots:

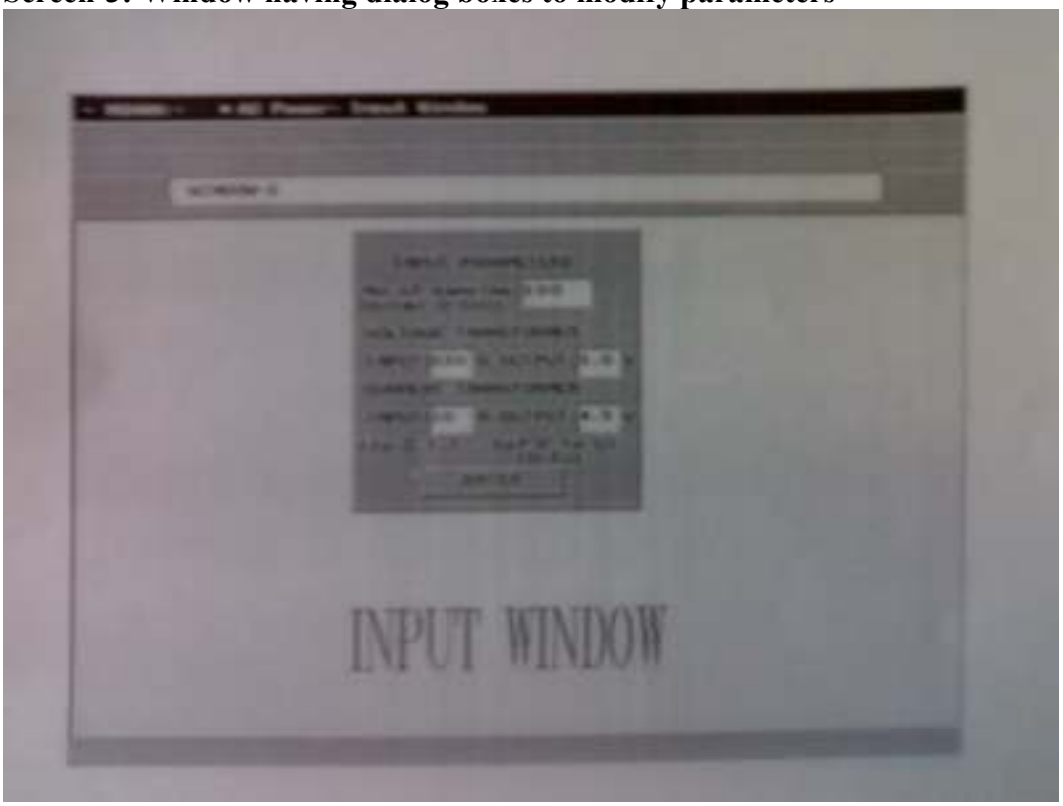
Screen-1: Welcome screen



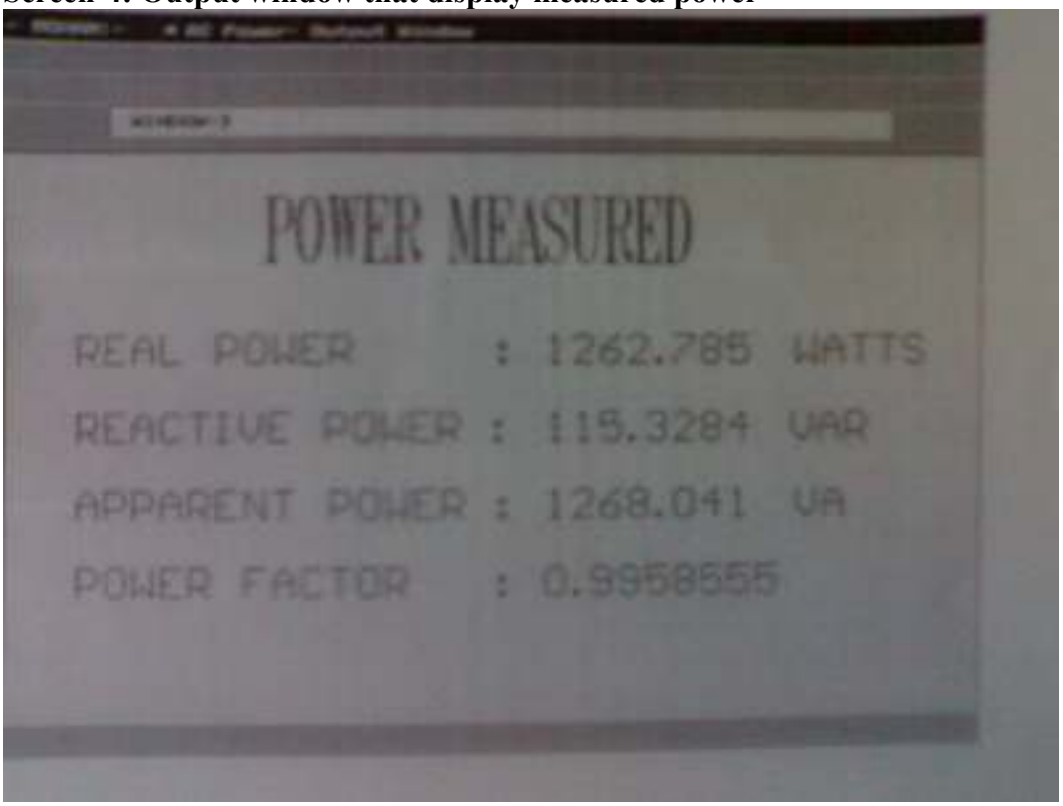
Screen-2: Fixed parameter of the device



Screen-3: Window having dialog boxes to modify parameters



Screen-4: Output window that display measured power



6 Conclusion:

This is not the industry standard project/device. The hardware and software part was wholly designed, developed and implemented by me for learning purpose during 3rd year of my degree course. This gives an idea about basics of wave sampling, data acquisition through PC and C programming to manipulate / interface the new hardware. Also got the basic knowledge of system designing.

References:

1. **"PC based wave sampling technique for load analyzing"**, Prof. S. S. Mone & Prof. U. A. Nuli.
2. **"Electronics for you"**, Jan 1997 & April 2000.
3. **"Fundamentals of Electricity"**, F. E. Evdokimov, Mir Publishers, Moscow.
4. **"The complete reference C++"**, Third Edition, Herbert Schildt, Tata Mc Graw Hill.
5. **"Graphics programming in C"**, Roger T. Stevens, BPB Publications.