# FINAL YEAR PROJECT REPORT

## Design and Implementation of Intelligent uninterruptible power supply (*i*-ups)


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# Design and Implementation of Intelligent uninterruptible power supply (*i*-ups)

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# Abstract

UPS stands for Uninterruptible Power Supply. It is an instrument connected between the electric grid and the consumer, comprising of electric hardware and rechargeable batteries. The aim of the instrument is to supply continuous undisturbed and conditioned power to the critical load. The energy for powering the load comes from the utility, or from the battery upon mains outage. Uninterruptible Power Supply (UPS) are widely used to provide emergency power to critical loads in case of utility mains failure, and as such constitutes an essential element in providing back-up power for computer networks, communication links, biomedical equipment, and industrial processes, among others.

In market local ups designed for just power production using batteries or such types of power sources. They do work but not for all environment. We implement intelligent uninterrupted power supply(*i*-UPS) for multipurpose. It consists of microcontroller based circuit. Mainly four feature of our *i*-UPS. <u>First</u>, it is safe and Improvesbattery life by using temperature sensor. When battery is fully charged and comparator do not trip battery charging then microcontroller will come into work trip the battery charging by temperature sensing because heating hardens the battery and it loses its efficiency and life. <u>Second</u>, we provide two outputs from *i*-UPS, Load-1 and Load-2, Load-1 controls lights, chargers and low power electronics appliances. On the other hand, Load-2 controls the fans and inductor type loads. <u>Third</u> is Energy saving works in the form of battery status. When battery is at its critical situation it switches offLoad-2 and lets the Load-1 on. So we can get lights at low battery status. When main supply is on, automatically Load-1 and Load-2 are connected to main supply. <u>Fourth</u>, we have provided two main energy sourcesLine-1 and Line-2 from different feeders. Microcontroller automatically checks and selects the active Line. If both lines are active then microcontroller will select Line-1 by default setting.

This Intelligent Uninterruptible Power Supply (*i*-UPS) will enable the users to monitor different status of *i*-UPS on LCD. One of the advantage applying microcontroller for the Intelligent Uninterruptible Power Supply (*i*-UPS) is that the system is more reliable and user friendly in functions as compare to the conventional Uninterruptible Power Supply available in the market. At the competition of our project we will be hopefully able to save energy and utilization of energy due to intelligent uninterruptible power supply because of our country facing a large amount of electricity crises so people wants such type of ups like *i*-UPS.

# Dedicated to Our Beloved Parents

# Acknowledgements

We would like to thank Allah, the Almighty at the first place for giving us much courage and strength during the completion of this project and thesis, without the help of whom all His creatures are worthless.

Several people should also be mentioned for their contributions to accomplish our task. We are greatful to our project advisor **Asst. Prof Mr. Farhan Iqbal** and project co-advisor **Lecturer Mr. JAWAD ULLAH** for their kind supervision, help and support. We are also thankful to the lab staff in the Project Lab for their cooperation during this work.

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# Chapter 1.

# Introduction

## 1. Introduction:

UPS stands for Uninterruptible Power Supply. It is an instrument connected between the electric grid and the consumer, comprising of electric hardware and rechargeable batteries. The aim of the instrument is to supply continuous undisturbed and conditioned power to the critical load. The energy for powering the load comes from the utility, or from the battery upon mains outage.

At times, power from a wall socket is neither clean nor uninterruptible. Many abnormalities such as blackouts, brownouts, spikes, surges, and noise can occur. Under the best conditions, power interruptions can be an inconvenience. At their worst, they can cause loss of data in computer systems or damage to electronic equipment. It is the function of an Uninterruptible Power Supply (UPS) to act as a buffer and provide clean, reliable power to vulnerable electronic equipment. The basic concept of a UPS is to store energy during normal operation (through battery charging) and release energy (through DC to AC conversion) during a power failure. UPS systems are traditionally designed using analog components. Today these systems can integrate a microcontroller with AC sine wave generation, offering the many benefits.

As the general population continues to grow, there is an ever-increasing demand for electricity placed on the world's power-generation and distribution facilities. Although significant measures are taken to ensure a reliable supply of electric power, the significant demand for power increases the likelihood that power outages and other electrical disruptions such as brownouts will occur. UPS that currently existed offer users extended periods of backup power during which they can continue to use electronic equipment such as a personal computer. However, this UPS only provide a minimal voltage regulation and filtering for disturbance occurred. Further, most UPS equipped with microcontroller for monitoring and display are much expensive than the standard available UPS in the market as the application of microcontroller will provide a wide range of application in term of programming and hardware controls. The purpose of this project is to design a UPS that manages to act as an emergency power supply to critical load and also equipped with microcontroller programming for UPS monitoring system.

Mobility and versatility have become a must for the fast-paced society today. People can no longer afford to be tied down to a fixed power source location when using their equipment's.

Overcoming the obstacle of fixed power has led to the invention of DC/AC power inverters. While the position of power inverter in the market is relatively well established, there are several features that can be improved upon. A comparison analysis of the different power inverter has been compiled. Aside from the differences in power wattage, cost per wattage, efficiency and harmonic contend, power inverters can be categorized into three groups: square wave, modified sine wave, and pure sine wave. A cost analysis of the different types of inverter shows that sine wave power inverter, though has the best power quality performance, and has a big spike in cost per unit power. Another feature which can be improved is the efficiency of the inverter. The standard sine wave in the market has an average efficiency of 85-90%. Power dissipated due to efficiency flaws will be dissipated as heat and the 10-15% power lost in the will shorten operational life span of inverters. The quality of the output power could also be improved. It is imperative that the output signal be as clean as possible. Distortion in the output signal leads to a less efficient output and in the case of a square wave, which has a lot of unwanted harmonics; it will damage some sensitive equipment's.

In designing any type of power supply, it is important to examine the intended market and place the product in a particular market. Our market will be to design a 300 watts power inverter that will provide optimum pure sine wave performance with minimal cost. In meeting the design requirements, there are several technical challenges that must be overcome. Our single, most difficult constraint will be to produce power at a lower power per unit cost than exists in the market. Our efficiency will be greater than 90 percent. This insures that, with a maximum load, less than 10% of power will be dissipated as heat. The total harmonic distortion will be less than 5 percent.

Generally, an ideal UPS should be able to deliver uninterrupted power while simultaneously providing the necessary power conditioning for the particular power application. Therefore, an ideal UPS should have the following features:

- Regulated sinusoidal output voltage with low total harmonic distortion (THD) independent of the changes in the input voltage or in the load, linear or nonlinear, balanced or unbalanced.
- On-line operation, which means zero switching time from normal to backup mode and vice versa.
- Low THD sinusoidal input current and unity power factor.
- High reliability.
- Bypass as a redundant source of power in the case of internal failure.
- High efficiency.
- Low electromagnetic interference (EMI) and acoustic noise.
- Electric isolation of the battery, output, and input.
- Low maintenance.
- Low cost, weight, and size.

## The Need for Standby Generation:

The need for standby generation arises if the consequences of a failure or disruption of the normal supply are not acceptable. The types of installation in which the need arises seem to be limitless. There are basically four reasons for installing standby generation: safety, security, financial loss and data loss.

- **Safety** Where there is a risk to life or health such as in air traffic control, aviation ground lighting, medical equipment in hospitals, nuclear installations, oil refineries.
- **Security against vandalism, espionage**, or attack Area lighting, communication systems, military installations, etc.
- **Data loss** Situations in which the loss of data may be catastrophic and irretrievable such as data processing and long-term laboratory type of testing or experiment.
- **Financial loss** Critical industrial processes, large financial institutions, etc.

The advances in power electronics during the past three decades have resulted in a great variety of new topologies and control strategies for UPS systems. The research has been focused mainly on improving performance and expanding application areas of UPS systems. The issue of reducing the cost of converters has recently attracted the attention of researcher. Reducing the number of switches provides the most significant cost reduction. Another form of cost reduction is to replace active switches such as IGBTs, MOSFETs, and thyristors with diodes. Not only are diodes more reasonable than the controlled switches, but there is also a cost reduction from eliminating gate drivers for active switches and power supplies for gate drivers. Another way of reducing cost is to develop topologies that employ switches with lower reverse voltage stresses and lower current ratings, which means less silicon and smaller switching losses resulting in lower cost and higher efficiency.

## 1.1 Classification:

UPS systems are classified into three general types: static, rotary, and hybrid static/rotary. In this section, we explain these three categories of the UPS systems.

## 1.2. Basic steps in simple UPS:

- Dc to Ac converter
- Ac to Dc converter

### 1.2.1. On-Line UPS:

On-line UPS systems appeared during the 1970s. They consist of a rectifier/ charger, a battery set, an inverter, and a static switch (bypass). Other names for this configuration are inverter-preferred UPS and double-conversion UPS Figure 1.1 shows the block diagram of a typical on-line UPS. The rectifier/charger continuously supplies the DC bus with power. Its power rating is required to meet 100% of the power demanded by the load as well as the power demanded for charging the battery bank. The batteries are usually sealed lead–acid type. They are rated in order to supply power during the backup time, when the AC line is not available. The duration of this time varies in different applications. The inverter is rated at 100% of the load power since it must supply the load during the normal mode of operation as well as during the backup time.It is always on; hence, there is no transfer time associated with the transition from normal mode to stored energy mode.This is the main advantage of the on-line UPS systems.The static switch provides redundancy of the power source in the case of UPS malfunction or overloading.The AC line and load voltage must be in phase in order to use the static switch.This can be achieved easily by locked-phase control loop.

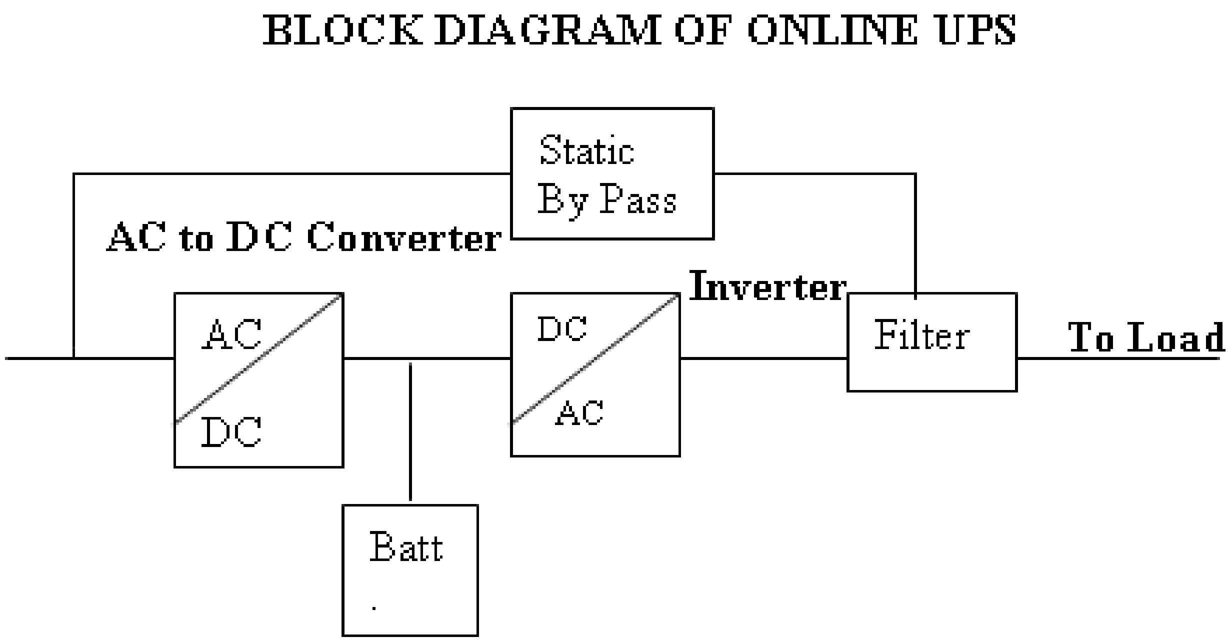


Fig # 1.1

The main important component is inverter, which converts the Dc stored in Battery back into Ac. So by improving the inverter we can improve the efficiency of UPS. There are few problems in inverters available in market, so we will try to overcome these problems, to increase the efficiency of ups.

## 1.3 Design Background:

When designing a UPS system, there are three items that must be considered: cost vs. performance, output waveform and topology.

### Cost vs. Performance:

A UPS system has to be reliable. Money saved on features or performance can be overshadowed by the cost associated with data loss or component failure. So it is important to develop a cost effective solution which satisfies both end user price sensitivity and design robustness.

### Output Waveform:

Some UPS designs use a square wave output instead of a sine wave. This makes the system cheaper to produce. But is this type of waveform really acceptable?

Electrical equipment uses power delivered in the form of a sine wave from local utility companies. When considering alternative waveforms, how differing loads rely on different parts of the standard power company waveform must be examined. Electrical equipment uses power delivered in the form of a sine wave from local utility companies. When considering alternative waveforms, how differing loads rely on different parts of the standard power company waveform must be examined.

For instance, most appliances are always on, thus the power used by the appliance is the RMS value of the sine wave, which is approximately 120 volts. However, equipment such as computers use peak voltage values, which are approximately 170 volts. When a square wave output is used to supply power to computer equipment, the RMS and peak values are equivalent, thus stressing some loads and under-supplying others. So the best output to provide electrical equipment is the output that they are designed to operate with - a sine wave.

## 1.4 Application Markets for UPS Systems:

UPS systems provide for a large number of applications in a variety of industries. Their common applications range from small power rating for personal computer systems to medium power rating for medical facilities, life-support systems, data storage, and emergency equipment, and high power rating for telecommunications, industrial processing, and online management systems. Different considerations should be taken into account for these applications. As an example, a UPS for emergency systems and lighting may support the system for 90-120 minutes. For other applications like computer backup power, a UPS may typically support the system for 15-20 minutes. If power is not restored during that time, the system will be gracefully shut down.

If a longer backup period is considered, a larger battery is required. For process equipment and high power applications, some UPS systems are designed to provide enough time for the secondary power sources, such as diesel generators, to start up.

## 1.5. Components of UPS:

### Mainly UPS consists of:

- DC/DC CONVERTER
- VOLTAGE SOURCE INVERTER (VSI)
- BATTERY CHARGER

### 1.5.1. DC/DC Converters:

Most UPS designs contain a transformer-type DC/DC converter. The transformer provides electrical isolation between the input and output of the converter. The transformer also provides the option to produce multiple voltage levels by changing the turns ratio, or provide multiple voltages by using multiple secondary windings.
Transformer-type DC/DC converters are divided into five basic topologies:

- Forward Converter
- Push-Pull Converter
- Half-Bridge Converter
- Full-Bridge Converter
- Flyback Converter

### 1.5.2. Voltage Source Inverter (VSI):

A single-phase Voltage Source Inverter (VSI) can be defined as a half-bridge and a full-bridge topology. Both topologies are widely used in power supplies and single-phase UPS systems.

- Half-Bridge VSI
- Full-Bridge VSI

### 1.5.3. Battery Charger:

When the AC mains voltage is present, the Offline UPS charges the batteries, and therefore, a battery charger circuit is implemented.
Most battery chargers can be divided into four basic design types, or topologies:

- Linear Chargers
- Switch Mode Chargers
- Ferroresonant Chargers
- SCR Chargers

## 1.6. Introduction of i-UPS:

We implement intelligent uninterrupted power supply (*i*-UPS) for multipurpose. It consists of microcontroller based circuit. Mainly four feature of our *i*-UPS. First, it is safe and Improves battery life by using temperature sensor. When battery is fully charged and comparator do not trip battery charging then microcontroller will come into work trip the battery charging by temperature sensing because heating hardens the battery and it loses its efficiency and life. Second, we provide two outputs from *i*-UPS, Load-1 and Load-2, Load-1 controls lights, chargers and low power electronics appliances. On the other hand, Load-2 controls the fans and inductor type loads. Third is Energy saving works in the form of battery status. When battery is at its critical situation it switches off Load-2 and lets the Load-1 on. So we can get lights at low battery status. When main supply is on, automatically Load-1 and Load-2 are connected to main supply. Fourth, we have provided two main energy sources Line-1 and Line-2 from different feeders. Microcontroller automatically checks and selects the active Line. If both lines are active then microcontroller will select Line-1 by default setting.

This Intelligent Uninterruptible Power Supply (*i*-UPS) will enable the users to monitor different status of *i*-UPS on LCD. One of the advantage applying microcontroller for the Intelligent Uninterruptible Power Supply (*i*-UPS) is that the system is more reliable and user friendly in functions as compare to the conventional Uninterruptible Power Supply available in the market. At the competition of our project we will be hopefully able to save energy and utilization of energy due to intelligent uninterruptible power supply because of our country facing a large amount of electricity crises so people wants such type of ups like *i*-UPS.

### 1.6.1.Objective or Features of our Project:

The main objective of our project is handling and utilization of power with Intelligence. Features and Applications of our work include:

- Improvement of battery life.
- Automatic load control using relays.

- Energy saving in critical battery status.
- Multi input ports for different sources.
- Over Voltage Protection.

### 1.6.2.Project Applications:

- Auto selection of sources
- Auto stop of battery charging
- Continuous Temperature  sensing of battery
- Level(status) of Battery
- Automatic load control
- Display different status by LCD
- Continuity of backup in critical battery

### 1.7.i-UPS Block Diagram:

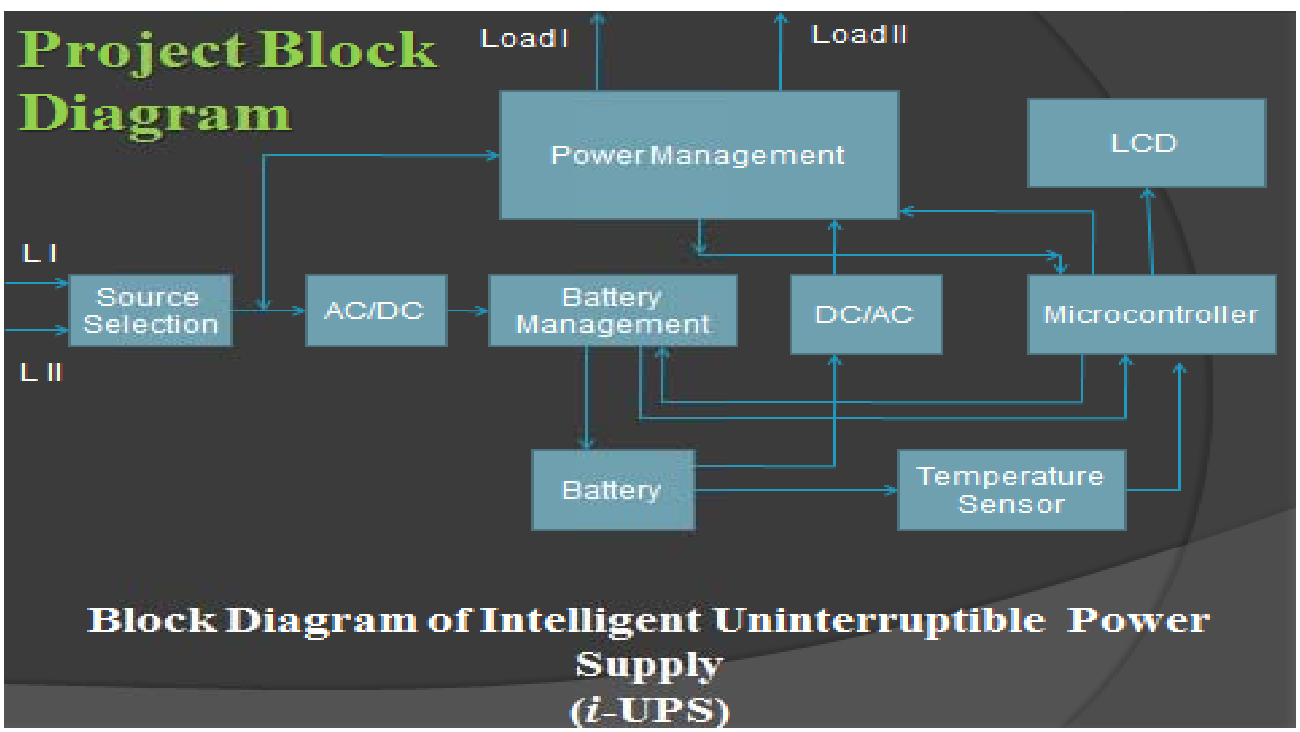


Fig # 1.2

## 1.8.Methodology:

### 1.8.1.Project implementation Steps:

- AC/DC conversion
- DC/AC  Inversion
- Intelligent circuitry
- LCD interfacing

### 1.8.2.Implementation Tools:

- Pic-16F877A microcontroller for Intelligent circuitry
- Pic-16F628A microcontroller for inversion
- Proton Basic for coding
- Simulation Tool used is Proteous
- LCD 4*20 for *i*-UPS status
- LM-35