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Design of a Smart Low Cost Mini Ups for PC's

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ABSTRACT*: Digital equipment such as telecommunication, computers systems and instruments use microprocessors that operate at high frequencies allowing them to carry billions of operations per second. A disturbance in the electrical supply lasting just a few milliseconds can affect millions of basic operations. The result may be malfunctioning and loss of data with dangerous or costly consequences (e.g. loss of production). That is why many loads, called sensitive or critical loads, require a supply that is protected. Many manufacturers of sensitive equipment specify very strict tolerances, much stricter than those in the distribution system for the supply of their equipment, one example being Computer Business Equipment Manufacturer's Association for computer equipment against distribution system disturbances. The design of this uninterrupted power supply (UPS) for personal computer (PC) is necessitated due to a need for enhanced portability in the design of personal computer desktop workstations. Apart from its original functionality as a backup source of power, this design incorporates the unit within the system unit casing, thereby reducing the number of system components available. Also, the embedding of this unit removes the untidiness of connecting wires and makes the whole computer act like a laptop. Not to be left out is the choice of Arduino as an important part of the circuitry. This has eliminated the weight and space-consuming components that make up an original design. The singular use of this Arduino places the UPS under the class of an advanced technology device.*

KEYWORDS: Arduino, Uninterrupted Power Supply, Personal Computer, Automation, Power Electronics.

I. INTRODUCTION

An uninterruptible power supply, commonly called a UPS is a device that has the ability to convert and control direct current (DC) energy to alternating current (AC) energy. It uses a conventional battery of 12V rating as the input source and by the action of the inverter circuitry; it produces an alternating voltage which is sent to the load. This particular UPS is designed for a small scale load like a personal computer and hence only a basic power rate is generated by the UPS. Many believe that because an inverter is operating from a nominal 12V battery and it cannot deliver as much output as a normal mains power outlet, it's relatively safe. This is not usually true. Even a low power inverter rated at a mere 60watts has an output which is potentially fatal if you

Become its load. Such an inverter can have a typical output of 350mA at 230V. This is above ten (10) times the current level connected to cause fatal fibrillation and stop your heart. Generally, uninterrupted power supply (UPS) can be grouped by source or method of functionality. [1]By Source: Here we have a voltage source (DC) for its operation or a current source (DC). The current source however is used for very high power consumption devices hence this design is a voltage source UPS. [2] By Functionality: Amongst others here is the single tracked and dual-tract UPS. The single-tract UPS feeds the load continuously from the rectified DC supply directly. This type of UPS is disadvantaged because a fault in the rectification stage leads to a complete system failure. The dual tract acts like the single tract but it has a bypass that sources from the mains supply. Hence the battery is used only as backup and does not run all the time unlike the single track. This design is a dual track methodology. For an ideal UPS, basic functionality is needed Being a backup utility, a UPS must ensure that there is no break in the power supply at any point in time unless major faults like fuse cuts are experienced. An ideal UPS must provide the battery with an adequate charge so as to maintain the optimum conversion rate to AC when needed. It must also ensure overcharge protection to prevent the battery from being damaged. All forms of surges and undesired waveforms that may emanate from inverted source voltage are to be filtered and well suited to the output level. Must be sensitive to maintain stability when the battery safe voltage is being exceeded. It must also provide an overload protection for the entire unit.

Many embedded devices provide a rich GUI-based user experience; use file systems, multiprocessing, and multi-threading; and include networking. An operating system (OS) can provide these features to support the rapid development of application programs [1, 2]. In charging a battery of the personal computer (PC), a cheap, unattended, unregulated charger can destroy a battery by overcharging it. A temperature compensated charger is also highly recommended [3]. Thus most power supplies have a PWM controller based on the well-known TL494 [4] or equivalent chips (for instance KA7500). TL494 features two error amplifiers, but most power supplies only use one of these. A PWM controller featuring two error amplifiers is recommended in some design because one controls the output voltage and the other controls the output current.

However, after careful consideration of any existing design of the UPS and some embedded systems, this particular design incorporated the following methodology upgrades: The battery charging unit is basically handled by the micro-controller which detects in split microseconds the point at which the safe battery (voltage at which operating the battery to generate alternating voltage is not safe) is being exceeded. This causes the system to shut down in order to prevent damage to the battery. Also handled by the Arduino is the overcharge protection. The controller disengages the battery at

full charge voltage. Application software interfaced via the USB (Universal Serial Bus) port of the computer motherboard maintains a constant check link between the operating system and the UPS. To enhance compactness, 2-pole relays and switches are used to eliminate duplication of components. Very simple and readily available components are sourced making the device commercially viable. For clarity and neatness of presentation, the article is outlined into five (5) sections. The First Section gives a general introduction of a UPS and smart embedded systems. Review of system components used for this system design is presented in Section Two. In Section Three, we outline the design and implementation procedures. Section Four presents the experimental results and discussion of the results. In Section Five, we conclude the work with some recommendations. Finally, the references are presented at the end of the paper.

II. BRIEF BACKGROUND WORK

If a power failure occurs not only the ac power goes out but also the 24 volt dc supply and thus the complete automation system as well costly downtime ANF undefined system states can be the result. This smart UPS module prevents the scenario by providing reliable, and also offers detection and fluctuation of current flow by implementing Arduino features. When companies do not have reliable solutions for the continuing operations of their equipment, they lose their money, if a websites goes down due to blackout. Data may occur error when electric noise penetrate of file server in fact network file servers that are constantly writing to disk are particularly susceptible to power related problems This led to the development of Smart UPS with advanced power protection solutions such has spike also referred to as an impulse, a spike is an instantaneous, dramatic increase in voltage. A spike can enter electronic through AC, network, serial or phone lines and damage or destroy components.

- Cause: Spikes are typically caused by a nearby lightning been knocked out in a storm or as the result of a car accident.
- Effect: Catastrophic damage to hardware occurs. Data will be lost.

III. SYSTEM COMPONENTS

This section discusses the basic theory of components used for this work. Though, we will be more focused on the heart of the system design and its peripherals while we leave other basic electronic components:

1. Arduino Nano Board.
2. Nano pluguino.
3. LED plug.
4. Relays.
5. Button Plug.
6. LCD backpack.
7. 12V lead-acid battery.
8. Adaptor.
9. Potential transformer.

IV. LITERATURE SURVEY

Digital equipment such as computers, telecommunication systems and instruments use microprocessors that operate at high frequencies allowing them to carry out millions or even billions of operations per second. A disturbance in the electrical supply lasting just a few milliseconds can affect thousands or millions of basic operations. The result may be malfunctioning and loss of data with dangerous or costly consequences (e.g. loss of production). That is why many loads, called sensitive or critical loads, require a supply that is protected. Many manufacturers of sensitive equipment specify very strict tolerances, much stricter than those in the distribution system for the supply of their equipment, one example being Computer Business Equipment Manufacturer's Association for computer equipment against distribution system disturbance.

Abstract safeguarding our home appliances has become an issue when dealing with an advancement and growth of an economy. This research focuses on the controlling of home appliances remotely when the user is away from the house. The system is Short Message Service (SMS) based and uses wireless technology to revolutionize the standards of living. It provides ideal solution to certain problems faced by home owners in daily life. Due to its wireless nature, it is more adaptable and cost-effective. The research is divided into two.

There is a consequence of inherent problems in the sectors of generation, transmission and distribution. Systematic failure has resulted in incessant power cuts, blackouts and unhealthy mains which have adversely affected offices, businesses and homes. The country now generates less than 25 % installed capacity. Most homes can be without electricity for days and the alternatives to lighting are the traditional candle light, kerosene lamps, petrol/diesel generators or an inverter, if it is affordable.

The first three are carbon emitters, run the risk of fire hazard, and in the case of the generator, noise polluter as well, all contributing to respiratory problems and environmental degradation. In order to reduce carbon footprints as well as mitigate climate change, the whole world is gradually switching to renewable energy for alternative energy supply in an effort to diminish total reliance on fossil fuels this work is one of several contributions intended to tackle the problem of blackouts, especially in rural settings, where the grid is nonexistent. With the development and availability of low-priced, very efficient DC LED bulbs, a household can be conveniently lit with these bulbs from a battery charged by a solar panel during the day.

This paper describes the author's experiences using a low-cost system-on-a-chip (SoC) embedded computer system and a commercial real-time operating system (RTOS) in the laboratory component of an undergraduate embedded system design class. The target hardware is a small low-cost X 86 SoC computer systems that has a wide range of I/O features. For software development, a popular commercial hard RTOS is used that has been designed for use in embedded devices. This course covers both hardware and software topics in embedded systems and the course culminate in a final team-based design project. A full set of course a material including a textbook with laboratory tutorials, instructor slides, and code examples have been developed and is available online in electronic form.

V. GAPS IN THE LITERATURE

- From the literature review carried it is found that Microcontroller is used only for the battery indication and display purpose.

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- Hence microcontroller in SMART UPS is used also to detect the fluctuation in the current.
- Auto backup is normally not implemented in most of the existing UPS; hence it is a feature of SMART UPS.
- The display indication in existing UPS displays only the energy stored in battery, and this is improved to display the duration which the system can run in "Smart UPS".
- A real time battery backup, which backups when low battery mode is identified in the smart ups, which is not a feature of existing UPS.

VI. SYSTEM DESIGN AND IMPLEMENTATION

This section will discuss the design procedure and the real time implementation of the system. The working principle of the smart embedded PC uninterruptible power supply unit is visually explained in the schematic block diagram shown in Fig. 1. The inverter block, which is the central block in the design, does the inversion of a 12V DC to a 220V AC. This block provides the backup power supply unit for the load in the case of power outage. The DC supply block is needed in order to charge the battery since the rechargeable batteries are not charged by AC voltages. Though not schematically shown, this block also powers various circuit components which would be extensively discussed in later sub-sections of this section. The switching circuit block does the automatic switching from AC mains to inverted DC power. The Arduino block comprises a single Arduino chip used for both interfacing with a conventional personal computer (software control) and for other circuit components control (hardware control). This system enables the automatic shutdown of the personal computer when the battery level falls below a designated safe voltage value. This occurs only when there is a power outage.

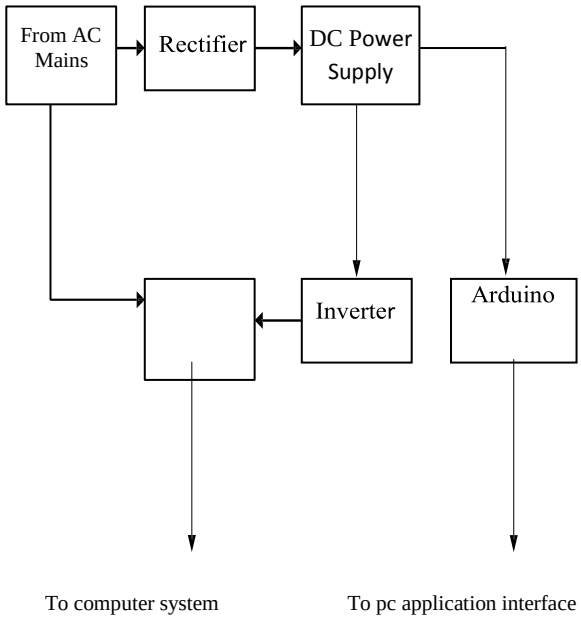

Fig. 1: Complete Block Diagram of Smart Embedded PC UPS

VII. HARDWARE INTEGRATION AND SOFTWARE IMPLEMENTATION

This section discusses the basic theory of components used for this work. Though, we will be more focused on the heart of the system design and its peripherals while we leave other basic electronic components.

1. Hardware

Hardware component includes.

- **Arduino Nano Board:** The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.0) or ATmega168 (Arduino Nano 2.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.

Switching Circuit

- **LCD display:** A liquid crystal display (LCD) is a thin, flat display device made up of any number of colour or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.
- **12V lead-acid battery:** Battery provides back up power source for the load when mains are shut.
- **Relays:** Relays are electromechanical devices or solid state devices which operate in response to a signal which may be voltage, current, temperature etc. Electromagnetic relays operate due to magnetic fields.
- **Step-up transformer:** A step-up transformer is the direct opposite of a step-down transformer. There are many turns on the secondary winding than in the primary winding in the step up transformer. Thus the voltage supplied in the secondary transformer is greater than the one supplied across the primary winding.

2. Software

- Software such as arduino code to Arduino Nano board to implement all the features of intelligent UPS. Mission is to achieve features like current fluctuation, Battery indication, Auto-shutdown, Short circuit sensing.

VIII. PROCEDURAL FLOW

The control module offers a series of flow to determine various conditions of operation. A summarized flowchart of the procedural flow of the control module of a conventional computer system unit is shown in Fig. 2. Specifications had to be sought to ensure that no undue outputs or designs were gotten or made respectively.

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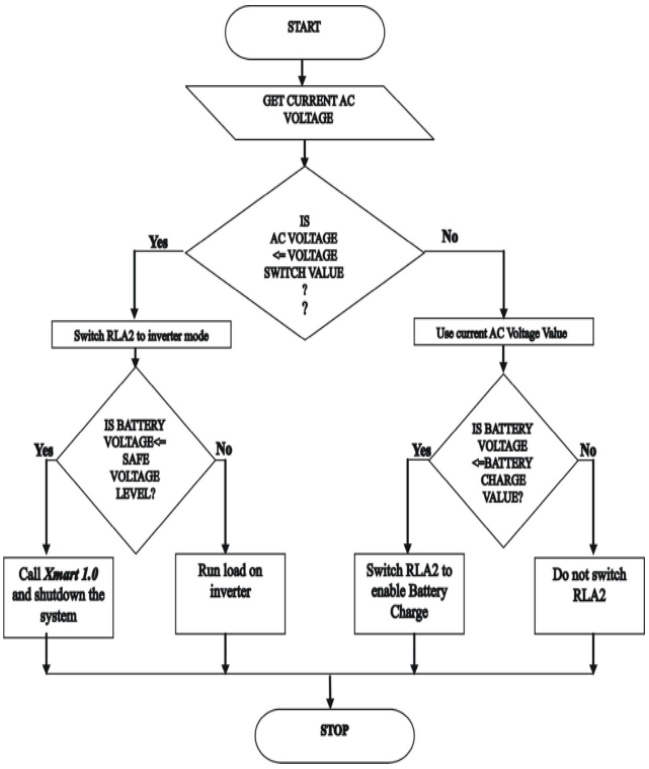

Fig. 2: Summarized flowchart of the procedural flow of the control module of a conventional computer system unit

IX. RESULTS

Snap shots of results obtained

Fig 9.1:

As we switch on the system UPS LCD indicates battery normal (Bat Nor) then we can able to run the system by using UPS when there is no power, if there is no current fluctuations then LCD will indicate current normal(Cur Nor), as shown in fig 9.1.

Fig 9.2:

When there is a current fluctuation in the circuit then the LCD will indicate Cur Flx as shown in fig 9.2.

Fig 9.3:

Fig 9.4:

When the UPS battery level is below the threshold level to run the system then LCD will indicate that the UPS battery level is less than the threshold level, and mains down as shown in the fig 9.3 and fig 9.4.

Auto shut down of the system

- To prevent the computer switching off suddenly and to prevent damaging of its internal components a feature of Auto-Shutdown has been added.
- UPS would be a 12v lead-acid battery charged from a wall-wart that can supply enough power to keep the Arduino running.
- If the mains power fails the Arduino will notice - until the battery is discharged enough so the voltage falls too low. But that won't be allowed to happen.
- Arduino can easily test whether there is mains power available. When it detects a failure of mains power it can go into auto shutdown routine.

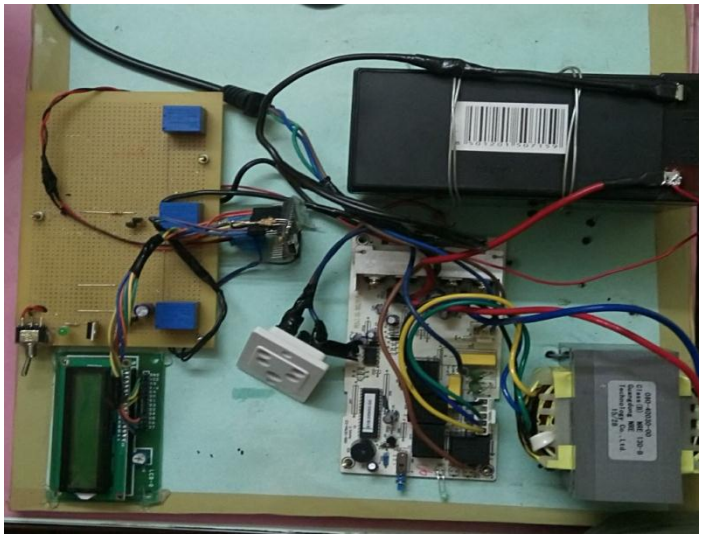

Fig 6.5: Entire model of smart UPS

Disadvantages of existing UPS

- Sags and surges.
- Brownouts.
- Impulses.
- Outage.

Advantages of smart UPS

- An Arduino which can detect fluctuation and current flow.
- Low cost.
- Auto shutdown.
- Real-time battery backup.

X. CONCLUSIONS

It can be concluded that the sole aim of carrying out the design, analysis and implementation of a smart embedded personal computer uninterrupted power supply system was achieved, in that the aim was to develop a cheap, affordable, reliable and efficient smart embedded system, which was successfully realized at the end of the design process. The whole concept of the system cuts across the hardware implementation and software implementation. The power module generated an output that conveniently powers a personal computer and the control module do the master channeling of device outputs and inputs though they are controlled mainly by the assembly code on which the microcontroller runs on. However similar implementation existed before now and was called internal UPS. Unique to this design however is the principle behind the control of the module, whereby a 5V microcontroller has to read a source of 12V (DC).

Various UPS types are appropriate for different uses, and no single UPS type is ideal for all applications. The intent of this paper is to contrast the advantages and disadvantages of the various UPS topologies on the market today. Significant differences in UPS designs offer theoretical and practical advantages for different purposes. Nevertheless, the basic quality of design implementation and manufactured quality are often dominant in determining the ultimate performance achieved in the customer application.

Businesses today invest large sums of money in their IT infrastructure, as well as the power required to keep it functioning. They count on this investment to keep them productive and competitive. Leaving that infrastructure defenseless against electrical dips, spikes and interruptions, therefore, is a bad idea. A well-built power protection solution, featuring high-quality, highly efficient UPS hardware, can help keep your business applications available, your power costs manageable and your data safe. By familiarizing themselves with the basics of what a UPS does and how to choose the right one for their needs, data centre operators can ensure that mission-critical systems always have the clean, reliable electricity they need to drive long term success.

This design is a dual track methodology. In SMART UPS, basic functionality provided is a backup utility, a UPS must ensure that there is no break in the power supply at any point in time unless major faults like fuse cuts are experienced, this also provide the battery with an adequate charge so as to maintain the optimum conversion rate to AC when needed and also ensure overcharge protection to prevent the battery from being damaged. It is sensitive to maintain stability when the battery safe voltage is being exceeded. It must also provide an overload protection for the entire unit.

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