Microcontroller Based Load Protection

Jatin Sharma[1], Kanya Hage[2], Anurag Mohan [3]
[1, 2, 3] Dept of Electrical Engineering
[1, 2, 3] AISSMS IOIT Pune, Maharashtra

Abstract*- With the advent of non-linear loads, consumer electronics are becoming highly susceptible to power distortions and harmonics. These irregularities in voltage and current waveforms cause a number of problems. This has huge economic and social repercussions. Power outages and blackouts in metros affect health facilities which may interfere with medical treatments thereby losses in productivity and ultimately money. Mitigation of such anomalies is of the utmost importance in our modern times. This paper attempts to deal with the same. A prototype power protective device has been proposed by referring and analyzing existing technologies in the same field. Proper hardware selection has been done to ensure economy. The model has been built on the basis of simulations run on the Proteus 8 software. The model aims to attain considerable accuracy.*

Keywords- Microprocessor, power converter, current sensor, relay and contactor, harmonics

I. INTRODUCTION

This report present a cost effective microcontroller driven power protection and control device. We have aimed for the device to control and stabilize variable input voltage to tolerable levels. Our goal is to maintain terminal voltage of industrial or domestic (electrical/electronic) machines to the required adequate voltage levels in spite of variations, protect them from over/under voltages. The system is also aimed at saving energy, improving power factor and thereby improving performance and longevity of loads.

Most of the uninterruptible power supply units are expensive and don't provide the mitigation in case of under voltage or overvoltage. Some power supply systems may also be not computationally efficient.

For solving these issues we use Arduino Uno for its great computational abilities and robustness. The Arduino Uno acts as a regulatory unit for the system. Using various voltage and current sensing devices microcontroller detects and monitors the device for its voltage and current variations. The system can then be programmed to only allow a certain range of voltage and current to flow in the circuit of the device thereby shielding the device from surges or sags.

II

A. Literature Reviews

1. Microprocessor based Power Supply

Tanvir , Satwinder and Kahlon [1] proposed a system which was reliable & intelligent, one that wouldn't damage the device even if it runs out of specifications or mishandled by user. Microcontroller used was 89CS8252 of the 8051 family. The system used interrupt driven keyboard so that it doesn't waste time on scanning keys. The system uses hardware which can be scaled as per user requirements. Each pin of the microcontroller can be configured bi-directional which eliminates the use of external digital read/write ports. Every 250mS the system looks for an error. Logs are stored in nonvolatile EEPROM so that they can be checked even after power failure.

However the system output voltage is not programmable and the dc voltage has to kept above the battery DC level.

2. Microcontroller based power supply control system

Rumrill[2] proposed a microcontroller based power supply with an intelligent communications port for connection to PC's. He made programmed the microprocessor not only to handle the communication protocols but also to take care of the floating point math required for the scaling of units and also the power supplies interlock functions which will in turn reduce the number of relays required. He proposed a modular pc board for each major function. This system uses each to understand ASCII commands. For safety optical isolation was used. The proposed system used a MOTOROLA 6809 microprocessor and an RS422 for serial communication which uses voltage difference in the twisted pair cables rather than the voltage level in them. Handshaking was decided not to be used in the system so that simple cables could be used. The components automatically acknowledge the transfer after each command or store acknowledgement for later queries. The PC boards consists of 2 PIA with 16 bit port as TTL inputs. The EPROM is programmed with the address of each interlock switch. DAC's used Optical isolation.

However the microprocessor used by this system is quite expensive due to its robust nature.

3. Microprocessor Based Single Stage Power Supply using Fly-Back Converter for LED Lightings

[3]KYU, Won and Kyung proposed a power supply for LED system using the FLY BACK convertor. This system provides better efficiency and regulates the output power for LED loads using PWM and PFM control. LEDs have been growing rapidly due to their long life time and high efficiency but they require a power supply unit for AC to DC conversion and current control. This system proposed power control of LED instead of current control. This type of control provides a better efficiency and higher power factor due to FLY BACK convertor. A multi-vibrator is used for initial build up after which the microcontroller controls the fly back convertor completely by means of pulse width modulation and PFM switching signals.

B. Problem Statement

Electrical power is one of the main driving forces behind an industry, especially for industrial machineries. The main objective behind power supplies is to provide uninterrupted power input to consumers. However power instabilities which are inherent to all power supplies are a major cause of economic loss and harm to industrial machines. Investors feel insecure to come to a country with constant power failures and voltage fluctuations. Hence there is a pressing need to stabilize the power supply to machines. Our work is to provide a step in addressing this issue. The project will benefit consumers who use loads that are sensitive to variations in power supply.

C. *Objectives*

1. To design control unit which shuts off supply in case of overvoltage or under voltage.
2. To program the control unit for allowing only a specific range of voltages and current through a device.
3. To design needful mitigation techniques for providing supply under fault conditions.

D. Methodology

The control unit uses voltage and current sensing devices which use Hall effect sensors for monitoring the respective parameters. The control unit can then be programmed for either switching off the supply or employing compensation using a contactor/ relay as a switch.

III. BLOCK DIAGRAM

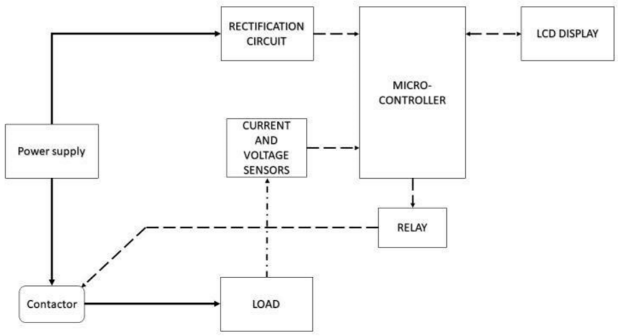


Fig.1

IV. HARDWARE SELECTION

A. Converter circuit

This circuit converts AC to 12 volts DC for the use of microcontroller and relay. The circuit uses a transformer to step down the working voltage and then a bridge rectifier (W10) to convert ac into pulsating DC. This pulsating dc is the fine-tuned using filter (resistor and capacitor) circuit and finally given to voltage regulator which supplies the constant voltage output for use.

A.1 Bridge rectifier W10- (Fig.A.1) Ratings-Voltage range 50V TO 1000 V

Current 1.5 A

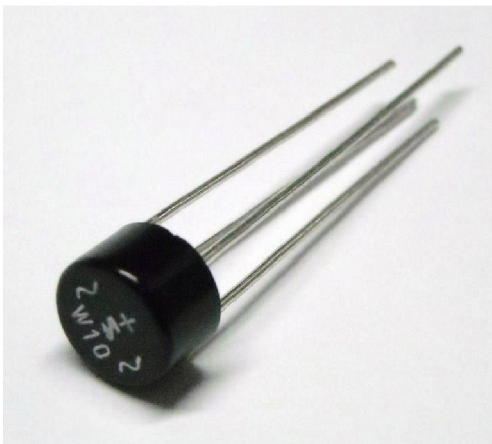


Fig.A.1 Bridge Rectifier (W10)

A.2 Transformer- Primary voltage of 240V Secondary voltage of 12 V

Current drain of
500Ma

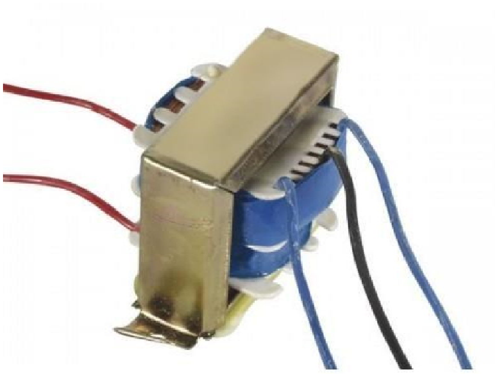


Fig.A.2 Stepdown Transformer

A.3 Filter circuit

Lastly this circuit uses resistors and capacitors of different ratings to fine tune the pulsating DC whose output is then given to the 7812 voltage regulator which gives constant voltage output.

B. *Current and Voltage Sensors*

The sensors identify the current and voltage levels from the load and send it to the micro controller for necessary action. Here we have used ACS 712 Hall Effect sensor for getting the value of current in the load circuit

Fig.B.1 Current Sensor (ACS 712, 05B)

C. *Microcontroller*

Houses the main control circuit. Senses the input from the voltage and current level detectors and sends signals. Here we are using Arduino Uno microcontroller for its superior robustness and high speed computational abilities.

Fig.C.1 Arduino Uno

D. Relay and Contactor Circuit

To effect the switching on/off of supply to output load. The ratings of relay and contactor will be decided according to the load which is supplied.

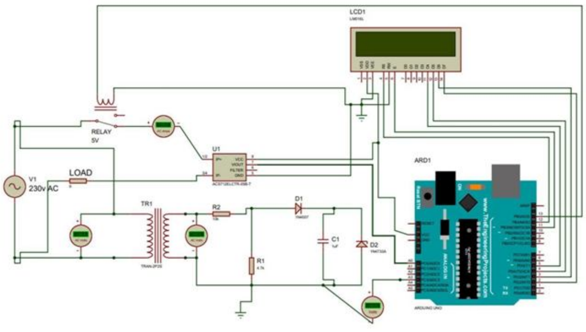
Fig.D.1 Relay (7.5 Amps)

E. LCD Display

Displays the status whether the supply is within range or not. Here we will be using a Blue on white (16x2) LCD.

V. SOFTWARE SIMULATIONS

Simulations were performed on the Proteus software



VI. FUTURE SCOPE

- Ability to analyse power quality parameters such as THD and TSD.
- Harmonic Distortion analysis for each harmonic component in load current.
- Operating temperature sensing capabilities.
- AI capabilities (ability to learn and correct faults)

VII. RESULTS

The following readings were recorded across a resistive load and the accuracy of current sensor and voltage divider circuit was checked.

Voltage across load (volts)	Microcontroller voltage reading (volts)
173.00	173.33
194.40	194.56
214.11	215.00
231.50	231.59
251	248

Ammeter reading from load circuit (amps.)	Current reading in microcontroller (amps.)
0	0.04
0.8	0.83
1.6	1.6
2.38	2.37
4.60	4.66

Based on the above readings from current sensor and the voltage divider circuit the microcontroller was programmed to operate the relay which disconnected the load from supply. Hence, protection was established.

VIII. CONCLUSION

We now deduce that power supply can be monitored more effectively.It is possible to detect the load voltage and current for preventive measures and mitigation. The system provides protection against overvoltage and under voltage also necessary mitigation techniques against voltage sags and swells. Arduino can be programmed for different voltage ranges depending upon the type of load. Also the system is highly inexpensive and efficient.

IX. ACKNOWLEDGMENT

I express my sincerest of gratitude towards the project guide Mrs. Shubhangi Landge, also our GFM for her valuable guidance and constant support throughout.

I take this opportunity to especially thank Prof. P Mahajan for his tirelessly assisting with the component setup, and all the lab attendants for their cooperation

.

Also I thank our HOD of Electrical department and the principal.

Lastly I am thankful to those who have directly or indirectly supported in the completion.

REFERENCES

[1] Tanvir Singh Mundra , Er. Satwinder Singh Sachdeva and K.S. Kahlon "Microcontroller Based Power Supply " M/S Pulse Engineering, D-153, Industrial Area Phase-8, SAS Nagar Mohali, Punjab, India Department Computer Science Engineering, Rayat Institute of Engineering and IT, Rail Majra Department Computer Science Engineering, Guru Nank dev University Amritsar

[2] R.S. Rumrill "MICROPROCESSOR BASED POWER SUPPLY CONTROL SYSTEM" Alpha Scientific Electronics, Inc. 1868 National Ave. Hayward, CA 94545

[3] Kyu Min Cho1*, Won Seok Oh , Kyung Sang Yoo , Chigak In , Jaeeul Yeon "A Microprocessor Based Single Stage Power Supply Using Fly-Back Converter for LED Lightings" Dept. of Information and Communication Engineering, Yuhan University, South Korea Dept. of Electrical Engineering, Yuhan University, South Korea Dept. of Electrical Engineering, Doowon Technical University College, South Korea 4 PELKOREA, South Korea Fairchild Korea Semiconductor, South Korea

[4] www.arduino.cc/en/Tutorial/HomePage

[5] [www.tutorialspoint.com/Arduino/Arduino-overview