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management

POWER MANAGEMENT SYSTEM FOR HOME APPLIANCES

Nasruldeen.A.Almaeyoufi

Al-jabal Al-gharbi University, Gharian, Libya.

ABSTRACT

The project work reported in this presentation focuses on effective management of power supply to home appliances. This paper described a system that combines mechanism for home appliance protection and management. The system is centrally managed by a microcontroller with LCD interface and push button for user management. Voltage limits and power consumptions by loads are regulated by the system making it very suitable for home use. The software module driving the microcontroller was implemented using C programming language. The power management system provides the users with the ability to create ON/OFF schedules and other user defined requirements.

KEYWORDS : Microcontroller, Lcd, Led, Adc, Pcb

INTRODUCTION

With the recent privatization of the Power Holding Company and subsequently unbundling it into eighteen (18) successor companies of power generation and power distribution, power sector is expected to benefit from a major paradigm shift of constant power supply service. It is worth noting that cost per KWhr of energy will slightly be jacked up initially, consequently there is need for efficient energy management system to manage consumption, reduce cost and protect these home appliances. It is uncommon to find a device that will combine these much desire features in a box. This power management system controls and condition power supply to home or office appliances. It manages effectively power supplied with the following functionalities: Daily time schedule, high and low voltage cutoff, overload cutoff, power ON delay, password authorization operation etc. The front panel contains the LCD interface, three pushbutton switches for entering user define configurations, three LEDs.

The three LEDs serve as monitor for over voltage condition. Daily Time Schedule The daily time scheduler is user define, switching on and off of appliances mains are controlled by what has being predefined earlier by an authorized user. Users can set the time of the day the device should supply power and the time of the day the power supply should be terminated. This is very useful in ensuring all devices are switched off when nobody is at home. This feature also found great usefulness in managing power supplied to refrigerators and freezers as it doesn't have to run continuously. It minimises water dispenser power wastage when no one is available at home to use them. Power ON Delay Power ON delay feature delays the output power supplied when mains power is restored. This guides against transient power damages to home appliances when supplies are restored. Although modern voltage stabilizers have this function in preset mode, this power management device has a 0-100 seconds user defined power on delay function in-built to it. Users have the liberty of choosing any desirable time of delay within the 0-100 seconds range. Voltage Cut-off & Overload Control Included also is high and low voltage cut-off which is user-defined capable. The low voltage cutoff range is between 100 and 220v while the high voltage cut off ranges between 220 and 250v. This high and low voltage cutoff is needed so as to regulate the power being supplied to very sensitive equipment. See Fig.1.0 Overload protection circuit controls the amount of power consumed by managed home appliances. It switches off power to these equipment if consumption gets above the user defined limit. When there is an overload condition the power management device goes into overload protection mode and switches off the output power, the equipment must be removed and reset button pressed before it goes back to normal working condition.

FIG.1: LCD interface of the power management system

FIG.2: User-define Voltage Limit and Overload Protection

CIRCUIT OPERATION

Microcontroller

The heart of the circuit is the PIC18f542 microcontroller which does the necessary processing and it also contains the EEPROM memory which is used to store user data such as the scheduled ON/OFF time, the voltage limits, the power limit etc. Input is accepted through the user operation button, the MCU process it and gives and equivalent information or response which can be displayed on the LCD. It also reads the voltage and current through an in-built 10-bit analogue to digital converter. Time information is gotten from the DS1302 time keeping IC, the IC compares the current time to the pre-stored scheduled ON/OFF time so as to control the output , it also checks the voltage limit too if its lower than the user-defined lower limit or higher than the user-defined upper limit and control the output accordingly. One other function of the MCU is to read the power consumed by the load and compare it with user-defined power limit and controls the output based on if it's an overload or not . The 3 conditions i.e. time schedule, voltage limit and overload are ANDed together to energize an output relay which controls the supply of power to the device. The firmware written in C language allows for the microcontroller to control the activity of other peripherals. LCD Interface Monochrome text Hitachi HD44780 LCD controller was

used for display. A common smaller size of 16×2 was deploy because it is readily available in market. The HD44780 interface supports two modes of operation, 8-bit and 4-bit. The former was used for the project. The PIC18f542 icrocontroller drives the graphic LCD through an 8-bit bus (D0 – D7) and seven control lines. D0 on the microcontroller is connected to D7 on the LCD etc. An additional pin is used to control the backlight.

Ds1302 The DS1302 is a time keeping chip used to ease the microcontroller of the workload of having to keep track of time accurately. It contains some internal volatile memory or registers which increments every seconds and keeps track of seconds, minutes, hours, days, months, years. This implies that the seconds register increments at a frequency of 1HZ and minute register increments every 60 seconds, the hours register increments every 60 minutes and so on. This internal registers content are overwritten whenever the microcontroller sends a time settings to the chip then it continue running the increments afterwards. Whenever the microcontroller needs to display time, it sends a command to the chip and the chip responds by returning packets of bits which contains the time and date information. The communication protocol is synchronous serial communication. Only three wires are required to communicate: CE, I/O (data line), and SCLK (serial clock). The DS1302 has a provision for battery backup input which it makes use of whenever the main supply voltage blackout or brownout. In such case, the power consumption is less than 1uW. The DS1302 uses an external 32.768 kHz crystal to generate clock pulse it needs to run. V-I Transformer and ADC The microcontroller reads voltage using its in-built ADC. This ADC generates a 10-bit number upon reading an analogue voltage within the range of the low and high reference voltage. The lower reference voltage can be set to GND-VSS, GND-Vref, Vref-VSS, VLref-VHref. VSS is the highest voltage a microcontroller ADC can read i.e. Vref cannot be higher than VSS. This implies that if GND-VSS is selected, the ADC generates a value 0-1023(10 bit) with 0-5v analogue voltage. For this project, reading mains voltage which is AC will be difficult because the voltage is on the high side (220V), a voltage transformer is incorporated to step down the voltage to 9v and a diode to rectify and convert to DC. A variable resistor is needed to calibrate the voltage fed into the microcontroller. The voltage transformer is connected parallel to the input mains voltage while the current transformer is connected in series between the input and the output. The principle of current sensing is based on the fact that when current passes through a conductor, an electromagnetic field is generated which is mutually inducted on the secondary conductor and generates an e.m.f in that secondary conductor. So the more the current that passes through the primary conductor the more the e.m.f that is generated in the secondary conductor. This voltage is rectified by diode and calibrated by a variable resistor and read by the microcontroller ADC. This e.m.f generated is dependent on both the mains input voltage and the load resistance, it already contains the power information i.e. the e.m.f varies with varying power consumed by the load. The highest voltage the ADC of a microcontroller can read is 5v and anything above that can damage the microcontroller. For protective measures, a 5.1v zener diode is connected to the two ADC pin used to read the voltage and the current (or power) to protect the microcontroller against extreme high voltage that can occur through power surge and the likes. Power Supply The whole circuit needs 5v to operate except the relay that requires 6v. There are two power options available, namely transformer power supply and switch mode power supply. Transformer power supply is the one that makes use of step-down transformer, rectifier, capacitor and regulator, while a switch mode uses complex DC to DC converting technique to get low voltage out of high voltage and its being used in laptop chargers, phone and PDA chargers DVD, TV, sounds system power supplies etc. After comparing the merits and demerits of both power supplies and the cost of building a transformer power supply to buying a 9v switch mode power supply, the switch mode is found to be preferable because it is cost effective, light weight, small size, better protection against power surge, high power efficiency. A 9v switch mode power supply is J. of Advancement in Engineering and Technology used and then a 7805 voltage regulator to feed 5v to the microcontroller and LCD and other circuits.

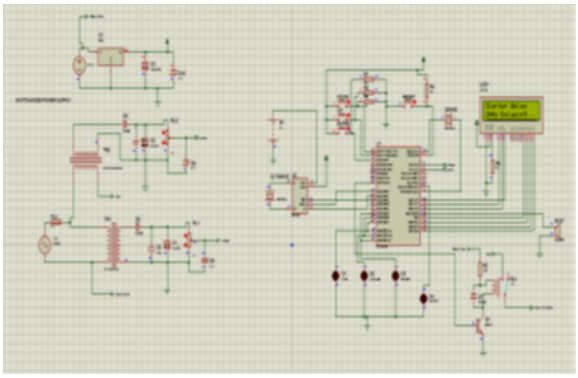

FIG.3 Circuit simulated on Proteus 8

CONCLUSION

In this paper, a low cost home appliances power management system was designed and constructed. The system consist of different modules that are coordinated by the microcontroller. The system provides the users with the ability to set different parameters to protect and regulate voltage and power level. This completely minimizes damages to home appliances. This system is also efficient in managing ON/OFF schedules for high power equipment thereby reducing cost of electricity.

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