Implementation of Fast Operating Microcontroller Based Charge Controller for Photovoltaic Cell

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Abstract *–This paper brings forth a concept of microcontroller based charge controller using PWM technique. This technique can be implemented by fast actuating microcontroller such as ATmega8, Aurdino (ATmega328) and PIC16F877 microcontroller. The microcontroller charges a 12V battery using 80W solar panel. The main feature of the charge controller is dusk to dawn operation; it switches on the load i.e (light) at evening hours and switches off at morning hours. During day, the load is cut off from the battery and the battery is to be recharged from the solar panel. When the battery is fully charged, the charging current becomes "pulsed" interrupted by microcontroller. "Battery Full" will be displayed on the liquid crystal display (LCD). An inbuilt analog to digital converter (ADC) is used to determine voltage level of the battery and the solar panel voltage.*

Keywords- Solar panel, charge controller, battery microcontroller.

INTRODUCTION

As conventional energy (Coal, Nuclear) is depleting day by day, so alternative sources of energy like solar, wind, Bio-gas energy has become the need of the hour. Solar energy can be used to generate power in two-ways; solar thermal conversion and solar electric (photovoltaic) conversion. Solar thermal is employed in heating of fluids to produce steam to drive turbines for large scale centralized generation while solar electric (photovoltaic) which is discussed in this paper, is the direct conversion of sunlight into electricity through photovoltaic cells. PV production becomes double every two years, increasing by an average of 48 percent each year. For this reason, it has become the world's fastest growing energy technology [1].

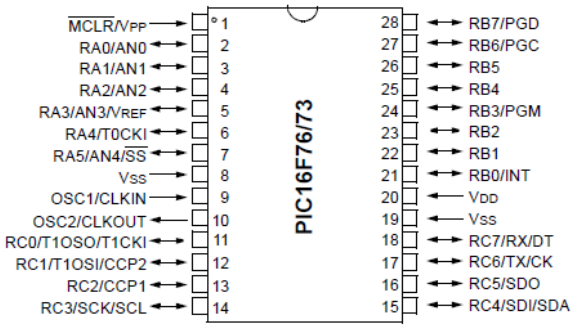
A charge controller is an essential part of PV system that charges batteries. A solar charge controller is similar to the voltage regulator. It regulates the voltage and current that is coming from the solar panels and going to the battery. Most of the batteries are fully charged at 14 to 14.5 volts [2]. On the other hand, battery's life time drastically reduces due to the discharge over the level of 70%-80%; at this discharge level the battery voltage normally goes down to 11.5 volts. Charge controller in a PV system is to keep batteries properly charged and safe for the long term, and to protect it from deep discharging. Charge controllers stop charging a battery when they exceed a set high voltage level, and re-enable charging when battery voltage drops back below that level. Pulse width modulation (PWM) and maximum power point tracker (MPPT) technologies are more electronically sophisticated [2].

SCC (Solar Charge Controller)consists of a voltage regulator, a microcontroller, a crystal oscillator, three MOSFET and LEDs. According to the voltage level at battery terminal, which is set by the microcontroller, it controls the charging of battery from solar panel and hence improves the operational life of a battery.

The aim of this paper is to design and construct a fast actuating microcontroller based charge controller for PV application, capable of charging a 12V battery using 80W solar panel.

CHARGE CONTROLLER BASED ON PIC MICROCONTROLLER

Microcontroller is used for performing various complex tasks. Relatively low cost PlC16F73 series microcontroller is used in this charge controller for the center of coordinating all ongoing system's activity and it is most economical than any other PIC based microcontroller. It is designed in 28 pin DIP package while other microcontroller has greater pins and it has 8-bit RISC CPU. PlC16F73 microcontroller is used here for the charging and discharging control mechanism. It is also used for battery data acquisition task which is the prime requirement. PlC16F73 microcontroller contains 3 or input/output ports which are useful for the development and designing of the charge controller.



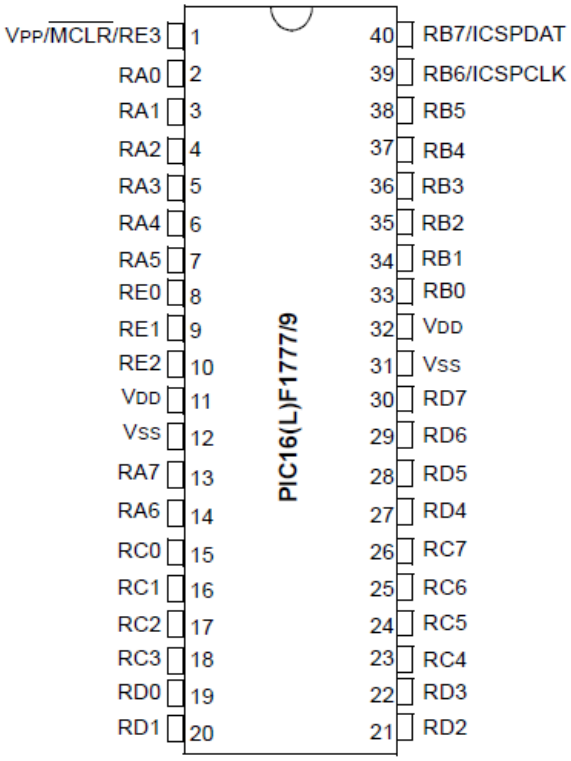
PIC16F1779 is an 8-bit PIC microcontroller that combines the processing power of CIPs and intelligent analog peripherals with a functionality of a microcontroller on a single chip to create a cost effective solution. PIC16F1779 includes many peripherals that are especially useful for switch mode power supply, power management, and medical monitoring applications.

PIC16F1779 provides the following peripherals:

• Fixed Voltage Reference (FVR)
• 10-bit Analog-to-Digital Converter (ADC)
• 5-bit Digital-to-Analog Converter (DAC)
• 10-bit Digital-to-Analog Converter (DAC)
• Op amp
• Programmable Ramp Generator (PRG)
• High-Speed Comparator: High-Speed Comparator modules which can use 5-bit/10-bit DAC references for comparing two analog input voltages. The comparator is designed to operate across the full range of the supply voltage (rail-to rail operation).
• 10-bit Pulse-Width Modulation module (PWM)
• 16-bit Pulse-Width Modulation module (PWM)
• Complementary Output Generator (COG)
• Zero-Cross Detect (ZCD)
• Configurable Logic Cell (CLC)
• Data Signal Modulator (DSM)
• Master Synchronous Serial Port (MSSP)
• Enhanced Universal Synchronous Asynchronous Receiver (EUSART)
• 8-bit Timers
• 16-bit Timers

The implementation of a solar MPPT charger with LED loads system makes use of the following peripherals of PIC16F1779 to achieve optimum performance:

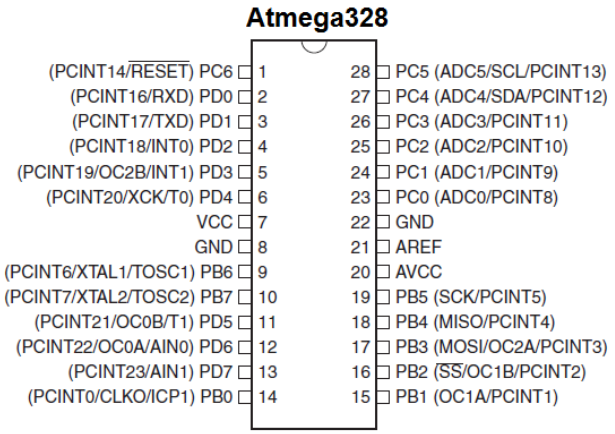
• Analog-to-Digital Converter (ADC)
• Digital-to-Analog Converter (DAC)
• Op amp
• Programmable Ramp Generator (PRG)
• High-Speed Comparator module
• 10-bit Pulse-Width Modulation module (PWM)
• 16-bit Pulse-Width Modulation module
• Complementary Output Generator (COG)
• Data Signal Modulator (DSM)
• 8-bit Timer



When using a DC-DC converter it is essential to have good voltage regulation and transient responses over a wide load current range. Voltage-mode control and current-mode control are the major control strategies. Current-mode control has good dynamic performance and inherent properties, such as short circuit protection. These advantages make current-mode control more suitable for mission-critical applications.[9]

ATmega328P

The Atmel ATmega328P is a low cost, mid-range performance microcontroller. It features a 20 MHz clock, 32 KB flash memory for programming, 2 KB SRAM, and 1 KB of non-volatile EEPROM. The chip runs at 5V DC and contains 14 general digital input/output pins, of which 6 can be used for PWM outputs, and 6 analog input pins. The microcontroller contains one hardware USART serial port, Serial Peripheral Interface Bus (SPI) and Two-Wire Interface (TWI) communication. This microcontroller can be programmed using Atmel's AVR Studio software. The Integrated Development Environment (IDE) allows programming in either C/C++ or assembly code. The ATmega328P requires an external programmer to implement new code. This requires (in the case of a Dual-Inline Package) that the chip be physically removed from a circuit and inserted into the programmer to load a new program into the flash memory.



Arduino (ATmega328)

Arduino is a single-board microcontroller, consisting of an Atmel ATmega328P along with various other components that allow for easy programming and access to various digital and analog pins. The Atmega328P microcontroller is pre-loaded with the Arduino bootloader, allowing this chip to be programmed in the Arduino programming language and eliminating the need for an external programmer. The Arduino Uno is powered either through USB (5V) or an external DC power source (7V – 12V). The board breaks out the 14 digital input/output pins, of which 6 can be used as PWM outputs, and 6 analog input pins. In addition, there is a 16 MHz crystal oscillator, USB connector, and reset button. The Uno incorporates an ATmega8U2 onboard to mediate between the USB and TTL serial communications, allowing programming through USB. The board also provides 5V and 3.3V regulated DC output to power sensors or other low-power systems.

The Uno contains 32 KB (0.5 KB is used for the bootloader) of flash memory to which the program is written, 2 KB SRAM, and 1KB EEPROM (non-volatile storage). The Uno contains one set of hardware UART for serial communication, Serial Peripheral Interface Bus (SPI) communication, and Two-Wire Interface (TWI), also known as Inter-Integrated Circuit (I^2C) communication.

By way of the Arduino bootloader, the ATmega328 can be programmed in the Arduino programming language instead of either AVR's C-like language or its assembly language. The Arduino language is based on the Wiring programming language, and the development environment is based on the Processing IDE. All of these languages and IDE's are free and open source.

The Arduino programming language consists of functions, variables, and mathematical operations that allow the user to interface with sensors and other peripherals through the digital and analog pins utilizing the numerous communication protocols. In addition, many libraries have been written by the Arduino community to interface with various sensors, user interfaces, communications, data logging, and other peripherals [10]

METHOLOGY

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DESIGN

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CONCLUSION

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