DESIGN AND IMPLEMENTATION OF SOLAR POWERED FPGA BASED AUTOMATIC IRRIGATION SYSTEM

[1]Thirumaraiselvan P., [2]Hemachandra G.

[1,2]Adhiparasakthi Engineering College, Melmaruvathur
Email: hemachandra85@gmail.com

ABSTRACT

This paper describes the design of solar powered automatic irrigation system which increases the yield in the irrigation system of rural areas. The main goal is to design and implement a solar power system using field programmable gate array (FPGA). In our project soil moisture sensor is used to detect the moisture level of the soil. Measuring soil moisture is important in agriculture to help farmers to manage their irrigation systems more efficiently. This enables the farmers to use less water to grow a crop, and increase yields and the quality of the crop by better management of soil moisture during critical plant growth stages. As the output of is analog the soil moisture sensor cannot be directly given to the FPGA board. Hence an ADC (Analog to Digital Converter) is used between FPGA and the soil moisture sensor. The motor can be switched on and switched off automatically through FPGA board according to the moisture content levels which are displayed in the PC (Personal Computer) using visual basic coding.

Keywords: FPGA, ADC, photovoltaic array, DTE

I. INTRODUCTION

In the modern world people are interested in using compact equipments. Very large scale integration (VLSI) is the latest technology which steeply reduces the size of equipments. In this project describes the design of solar powered automatic irrigation system which increases the yield in the irrigation system of rural areas. This system was implemented using field programmable gate array (FPGA).

FPGAs are usually slower than application specific integrated circuits (ASICs) but have the advantage of shorter time to market, ability to be re-programmed in the field for errors correction and upgrades, flexibility, and low-cost. Therefore, they combine many advantages of ASICs and digital signal processors (DSPs) [3]. The use of hardware description languages (HDLs) allows FPGAs to be more suitable for different types of designs where errors and components failures can be limited [1]. FPGA is interfaced with the analog to digital converter (ADC) to know the moisture content information of the soil from the moisture sensor. And ADC converts the incoming analog signal of moisture sensor into digital signal to give the information to the FPGA board because FPGA is operated only with the digital signals. The analog to digital conversion operation is done by writing the coding in the VHSIC hardware description language (VHDL). Here the FPAG board is connected to the personal computer through RS232 cable to display the moisture content level information on the monitor.

II. SYSTEM OVERVIEW

Solar powered FPGA based automatic irrigation system is operated by solar power and the entire system is controlled by FPGA board. Here the motor is automatically switched on and according to soil moisture content levels which is detected by the soil moisture sensor. The moisture sensor signals are displayed in the computer. Fig 1 shows solar powered FPGA based automatic irrigation system.

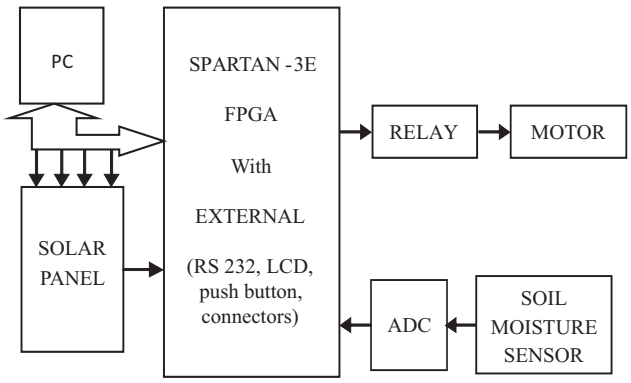

Fig. 1. Solar Powered FPGA based Automatic Irrigation System

III. THE MAIN MODULE OF THE SYSTEM

A. Solar panel

Solar panels (arrays of photovoltaic cells) make use of renewable energy from the sun [4], and are a clean and environmentally sound means of collecting solar energy. Solar power is the conversion of sunlight to electricity. Sunlight can be converted directly into electricity using photovoltaic's (PV) [2].

B. Field Programmable Gate Array

SPARTAN-3E FPGA is used to connect all the blocks of general block diagram. And here FPGA consists of communication ports [8], external memory extension SDRAM modules and external connectors to interface the analog to digital convertor (ADC), relay and personal computer (PC) with FPGA. Fig 2 shows the Xilinx Spartan 3 FPGA board.

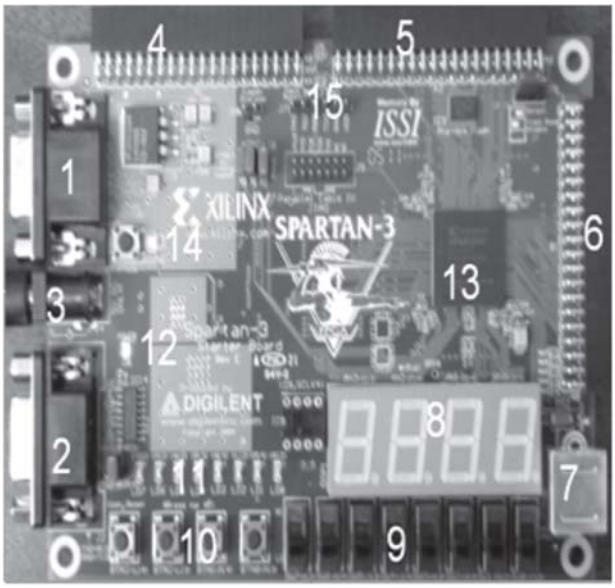

Fig. 2. Xilinx Spartan -3 FPGA board

C. Analog to Digital Converter

Normally the soil moisture sensor gives the analog signals but it cannot be directly given to the FPGA board because FPGA board is operated with the digital signals. So ADC (Analog to Digital Converter) is used between FPGA and the soil moisture sensor. ADC which converts the coming moisture sensor analog signal into digital signals and it is then given to FPGA board. Fig. 3 shows the basic block diagram of A/D converter is as shown below.

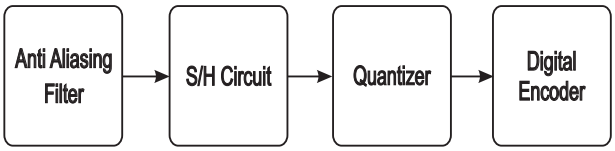

Fig. 3. A/D converter

D. Soil moisture sensor

The Soil Moisture sensor measures the soil moisture's electric resistance and converts it to calibrated readings of soil water suction. The watermark sensor consists of two concentric electrodes embedded in reference granular matrix material. The matrix material is surrounded by protective synthetic membrane and is held in a stainless case. This device is buried in intimate contact with soil, and reaches equilibrium with the soil moisture. The adaptor excites the electrodes with 5V AC current and measures the electrical resistance which decreases with increasing soil moisture. The data logger then converts the resistance to soil moisture units.

E. The module of Relay

Relay is an electromagnetic switch and it is of various types such as SPST, SPDT, DPDT and TPDT. In this paper uses a single pole single throw (SPST) relay that has five pins [5]. Two pins for providing excitation voltage to relay coil. One pin common (COM), One pin normally connected (NC) and one pin normally open (NO).

F. The module of Motor

The two terminals of motor coil connected to the common (COM) and normally open (NO) terminals pins of the relay [6]. The connection is such that motor goes on whenever excitation voltage [9] is provided across the relay coil.

IV. RESULTS AND DISCUSSION

Variable resistance (Trim pot) is connected with the analog to digital converter where the trim pot gives the variable analog values and these values are converted as digital values and it is given to the FPGA. Through FPGA the corresponding digital values are displayed as output values in the system window with the hyper terminal option of windows xp.

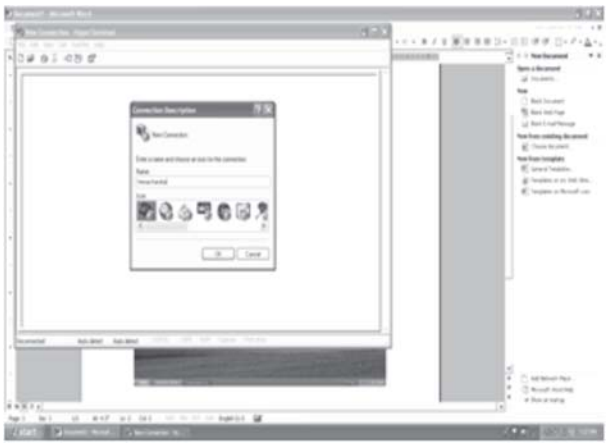

Fig 4. Connection Description

Fig 4 shows how to open connection description window. Initially the start button has to click on the desk top and go to all programs [7] then accessories and communications. In the communication option the hyper terminal will be displayed and clicking the hyper terminal automatically the connection description will be displayed here need to enter name and choose an icon for the connection. Fig 5 shows the how to restore the default values of the hyper terminal. Initially press the start button in the task bar of system window. Then go to all programs, accessories, communications and hyper terminal. Then click on hyper terminal give the file name and choose icon for making new connection in the connection description. The communication port will be displayed in this choose connect using communication port 3 then click on ok. Then com3 properties will be displayed in that press the restore defaults. Automatically the com3 will be restored by default values.

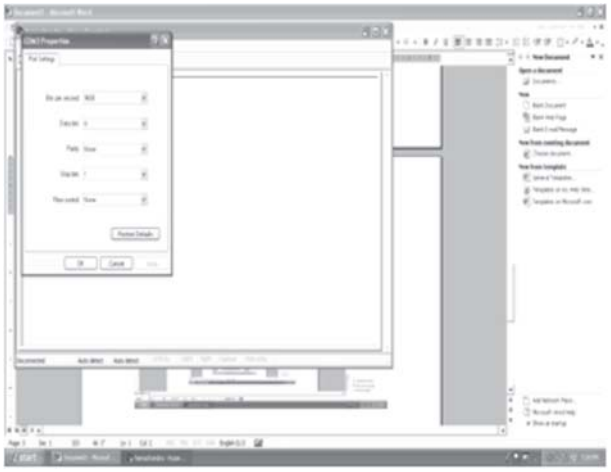

Fig 5. Restoring Defaults

Then Fig. 6 shows the different output values of ADC through FPGA [10] with the variations of trim pot and corresponding digital values are displayed in the hyper terminal window simultaneously. By rotating the trim part adjustment in the kit the corresponding analog to digital converter values are displayed in the hyper terminal window of the personal computer.

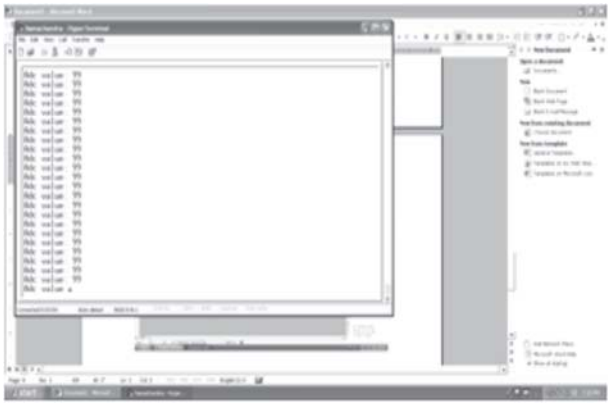

Fig 6. Display of ADC values with Trim Pot variations

V. CONCLUSION AND FUTURE WORK

Solar Powered FPGA Based Automatic Irrigation System was designed and implemented with the detailed study of FPGA and its external communication devices such as analog to digital converter and soil moisture sensors. And the corresponding soil moisture sensor readings are converted to digital values in order give to FPG with the help of analog to digital converter. And the corresponding ADC values are displayed in the personal computer through FPGA with the help of communication ports.

Future work entails in order to make it suitable for large scale irrigation systems the numbers of sensors have to be increased and the sensors need to be place in different places which are different from the length of ground level to get clear information of soil moisture of the land.

REFERENCES

[1] Brehm, T., Rattan, K.S., Hybrid fuzzy logic PID controller.In: Proceedings of the IEEE 1993 National Aerospace and Electronics Conference, NAECON, IEEE, New York, NY, USA, vol. 2, 807813. 1993.

[2] Mohan N, Undeland TM, Robbins WP. Power electronics: converters, applications and design. New York: Wiley; 1995.

[3] Weidong and Yi Qin, "A Simulation Method to PWM Control with C and MATLAB," Electric Transmission, 1st ed., vol. 31, pp.60-62, 2001.

[4] X. Liu, L.A.C. Lopes, An improved perturbation and observation maximum power point tracking algorithm for PV arrays, in: Power Electronics Specialists Conference, PESC 04, 2004, IEEE 35th Annual vol. 3, pp2005_2010, 2004.

[5] Mardav Wala and Don Bouldin, "Integrating and verifying intellectual property blocks using platform express and ModelSim," Midwest Symposium on Circuits and Systems, v 2005, p 758-761, 2005, 2005. IEEE International 48th Midwest Symposium on Circuits and Systems, MWSCAS 2005.

[6] Xianzhong He, "A PWM AC VVVF System Based on S7_200PLC" Machine Tool Electric Apparatus, vol 33, pp.33-34, Jan, 2006.

[7] Kaicheng Yang, "Data Structure(C language)", Publishing House of Electronic Industry, Beijing, pp. 156-162, September, 2008.

[8] Ming-Fa Tsai, Wei-Chieh Hsu, Tai-Wei, Wu Jui-Kum Wang "Design and Implementation of an FPGA-Based Digital Control IC of Maximum-Power- Point-Tracking Charger for Vertical-Axis Wind Turbine Generators," Proceeding of the International Conference on Power Electronics and Drive System, PEDS, 2009.

[9] A.S. Samosir and A.H.M. Yatim, Implementation of new control method based on dynamic evolution control for DC–DC power converter, International Review of Electrical Engineering Journal (February), pp. 1-6 (2009).

[10] Ze Cheng, Hongzhi Yang, Ying Sun, "FPGA-based PV systems fuzzy MPPT control algorithm," the 7th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD'10), 2010.