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Development of PSOC Microcontroller based Solar Energy Storage System and Electricity Generation System

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Abstract—This paper describes a new PSoC microcontroller based PV (photovoltaic) system. Because the energy from the sun, fluctuates with climate conditions, the impedance of the PV system must be adjusted to match the change in lighting condition. To do this, we employ a PSoC microcontroller which can handle both analog and digital circuits, to reduce the need for additional circuit elements. The PSoC controller is used as a programmable Maximum Power Point Tracking (MPPT) controller. Of all the renewable energy sources, solar energy received the greatest attention in the decade of the 1970s and has been the rub of much emotion and pleasure.

Key words: PSoC. PV Technology, Solar power, wind power

I. INTRODUCTION

The concept of solar and wind energies dates back to nearly 7,000 years ago [1]. However, in the late 1800s the Danes developed the first wind turbines to produce commercial electricity. In the early 1900s small scale wind turbines became more widely used around Europe especially in the rural areas for producing electricity using old car generators and carved rotors. Under current acute power shortage scenario with increasing cost of natural gas, coal and other power generator turbine fuel, there is a very urgent and great need of finding alternate source of energy to generate electricity. There are some natural and eco-friendly source of generating power ,which requires more R&D by using latest technologies to make them more cheap, efficient and easy to use and maintain for technical person . Although solar energy may be used in many markets such as in active and passive space heating and cooling industrial process heating ,desalination and in electric generation.After investments by federal and agencies amounting to several hundred million dollars in the 1970's and all these technologies, only one is in commercial use today. Namely flat plate collectors for water heating .All other remain in various stages of research and development .It now appears that solar electric systems are not expected to make engineering and economic sense as central generating plants of hundreds of mega watts capacities in the foreseeable future [1]. However, at present MPPT requires: (1) additional analog circuits for current and voltage sensing [2-12]; (2) to obtain energy efficiently, it is necessary to know the impedance characteristics of both the PV cell and storage device; (3) To use the maximum power obtained by the MPPT efficiently, a high-speed energy storage device which can accumulate quickly and efficiently the acquirable maximum power which changes according to the climate conditions is needed . To solve these three problems, we employ a PSoC microcontroller for reducing analog circuits and as an intelligent MPPT controller.

"What is PSoC" is an application related review of programmable array systems, the system-on-chip, or PSoC. The hardware and system requirements are explained, hand to hand with practical notes. Description of two examples of embedded wireless systems with digital data modulation follows the theory. The intermittent nature of solar and wind power can be effectively mitigated by using a solar and wind hybrid system. Energy storage on-site (batteries) ensures that power is available when the sun isn't shining or the wind isn't blowing. Pairing solar and wind collection systems at one site can provide diversity protection against the variable natures of both energy sources [2]..

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II. HISTORY

The industrial boom and dot com time during late 90's was paved by major steps in technology and system architecture development. It usually starts with a smart idea. When somebody comes up with a new idea, others try to follow up. By my opinion, the market value of CDMA/GSM cell phones and associated Internet services influenced the R&D direction. The predicted downfall of wireless markets proved to be false. On the contrary, requirements for flexible, cheap, and performing chips with more features are shaking the industry. Design of mixed signal chips for wireless environment is always a challenge.

The wireless buzz, hum, and offsets in high resolution ADCs, DACs, audio amplifiers, and even loudspeakers focused the design to search for different system architecture and solutions. On the other hand, it pointed out the need for hardware verification platform for test and verification. Every simulation program is a very helpful tool for known problems. Sometimes we deal with the unknown. Thinking about "-who can program" the receive diversity switch, the

Fractional-N synthesizer, and a call from a friend searching DSP related ideas brought my attention to PSoC chips from Cypress. After few years, I can tell it was worth of the effort.

III. LITERATURE REVIEW

The literature in the subject areas of this is very widely covered. An excellent textbook for instructional use is *Wind and Solar Power Systems* by Patel (1999) that covers the specific issues in this project in a style appropriate for Industrial Technology students. Sabin (1999) and coworkers have summarized the various standards and benchmarks used in large-scale power quality, and Koval (1999) and coworkers have presented similar finding for rural (small-scale) power quality problems. Taylor (1987) is responsible for some of the early practical work on power quality measurements in wind generation. Kariniotakis and Stavrakakis (1995) have written extensively on simulation problems in wind generator and power grid interactions. Finally, many papers have been written on the electronics regulation/ control aspects of the problem including a recent study by Neris and co-workers (1999) proposing an IGBT (Integrated-Base-Bipolar-Transistor) based regulator. The novel approach of MPPT control algorithms developed from various photovoltaic technologies. Barbosa (1998) and coworkers have described the use of PWM (pulse width- modulation) control schemes to power quality control. Numerous studies have appeared describing the impact of power quality problems caused by PV systems from early work by McNeil (1983) and coworkers in to more recent work by Oliva (1988) and coworkers and most recently by Chowdhury (1999).

Many articles have appeared on the impact of new electronics technologies on power quality management, for example Poisson (1999) and coworkers have described the impact of DSP chips on the problem [10]. The extensive literature on power quality aspects of wind generation includes work by Demoulias and Dokopoulos (1996) on transient power measurement and by Thiringer (1996) on harmonic contamination measurement issues.

Numerous technologies hold promise for harnessing and utilizing the sun's energy. They include: agricultural and architectural technologies, solar lighting, solar thermal, HVAC, solar cookers, electricity generation, solar to petroleum, transportation, and satellites to mention a few. A number of well-known large corporations have launched initiatives to generate their own energy for a variety of reasons, such as reducing energy price volatility, increasing security of supply, decreasing costs or meeting carbon objectives. Example -companies with their own renewable energy generation include IKEA, Google, Toyota, Toshiba, Hertz, FedEx, AT&T, BMW, Renault, VW, Audi and PepsiCo. VW, for example, is investing €1b in offshore wind projects to meet renewable energy objectives and provide a natural hedge against volatile energy prices. That said, a third of respondents expect to meet a greater share of their energy needs through self-generation over the next five years [2].

IV. WHAT IS INSIDE

There is nothing ready-to-work inside, except the downloader, internal RESET circuit, the band gap voltage reference, and the 25MHz clock source. The first generation of programmable array, the PSoC1™, was an 8-bit ASIC micro controller of Harvard architecture. The chip has a set of analog and digital ports for communication with the external world. The digital I/O ports are configurable as inputs/outputs, open collector, or fast digital ports. The analog ports are high impedance inputs or outputs, used for DACs, ADCs, OP amps, or instrumentation amplifiers. The CPU is supported by up to 2K RAM memory, and proprietary technology FLASH memory space.

The device is a multi-purpose dynamically configurable system, programmable on the fly. What does it mean? If you need more gain from the amplifier, you ask for more gain. Then you drop the gain. It is not the class of single purpose dedicated chips, where you get stuck with 0.1k memory, and a single mixed signal functional block.

Fig 1.Psoc kit

Presently, there are three generations of the chip available:
- PSoC1 is ASIC controller of first generation.
- PSoC3 is 8051 version of the above.
(Keil C51)
- PSoC5 (ARM RealView MDK)
The manual selection of building blocks offers
many choices. Let's mention few to get an idea:
- Timers
- Random sequence generator
- PWM, pulse width modulation
- Digital Comms
- Multiplexers
- Digital filters
- Counters
- DTMF dial
- Amplifiers
- DACs
- ADCs
- Infra red communication
With deeper and detailed knowledge of the
internal structure, additional custom functional blocks
can be created.

V. SPECIAL ISSUES OF WIND TURBINES AND PV CELL

As wind does not blow all time nor does the sunshine all time, solar and wind power alone are poor power sources. Hybridizing solar and wind power sources together with the battery storage to cover the periods of time without sun or wind provides realistic form of power generation. This variable feature of wind turbine power generation is different from conventional fossil fuel; nuclear or hydro-based power generation .Wind energy has become the least expensive renewable energy source in existence and has peaked the interest of scientists.

PVs offer added advantages over other renewable energy source in that give off no noise and require practically maintenance. Most industrial use of electricity requires AC power. Wind turbine and PV cells provide DC power. A semiconductor based device known as power inverter is used to convert DC power to AC power. This device has a relatively simple operation that is a vivid illustration of many topics traditionally covered in power electronic classes.

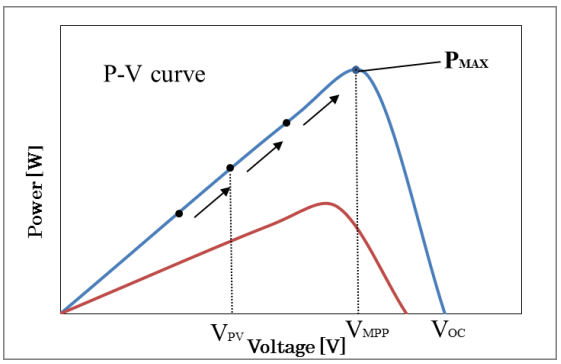

Fig.2 .Power-voltage characteristics of PV [1].

Figure 2 shows the P-V characteristics of a PV cell. The available electric power from the PV cell varies depending on the P-V curve, which is determined by the characteristics of the PV cell. Since the P-V curve is a convex curve, a maximum power point (MAXP) exists, which changes with the intensity of solar irradiation. Therefore, in order to maintain the output power of the PV cell at MAXP even while the solar irradiation is changing, MPPT control is needed [1].

In order to obtain the maximum power from the PV cell as shown in Fig. 1, we need to find and control the maximum power point voltage (VMPP) which may vary depending on the sunlight conditions. To obtain the maximum power, we apply the constant voltage method to find MPPV from the open-circuit voltage (V_{oc}).

VI. METHODOLOGY

Now a days the big problem of electricity, there is no alternate source available in emergency. Thus we are trying to reduce the problems of electric energy by using the natural source like solar power & wind power. The actual proposed system is designed using only solar installation .My research work is energy saving and generation using solar with wind energy installation .In that case refer fig3 in which we implement the generation of electricity using hybrid technology in embedded system.

Establishment of a Wind/PV Hybrid Unit

AS people are much concerned with the fossil fuel exhaustion and the environmental problems caused by the conventional power generation, renewable energy sources and among them photovoltaic panels and wind-generators are now widely used. In this we are using solar panel & wind mill are the main source. Basically from solar cell & wind mill gives the DC voltage output store in the battery & through inverter circuit it gives 230v AC output which can use for building surrounding lights & stair case lights & as well as main load. Under current acute power shortage scenario with increasing cost of natural gas, coal and other power generator turbine fuel, there is a very urgent and great need of finding alternate source of energy to generate electricity.

A] Photovoltaic technology

Photovoltaic is the field of technology and research related to the devices which directly convert sunlight into electricity. The solar cell is the elementary building block of the photovoltaic technology. Solar cells are made of semiconductor materials, such as silicon. One of the properties of semiconductors that makes them most useful is that their conductivity may easily be modified by introducing impurities into their crystal lattice. A solar panel Siemens SM-10 with a rated output power of 10W is used.

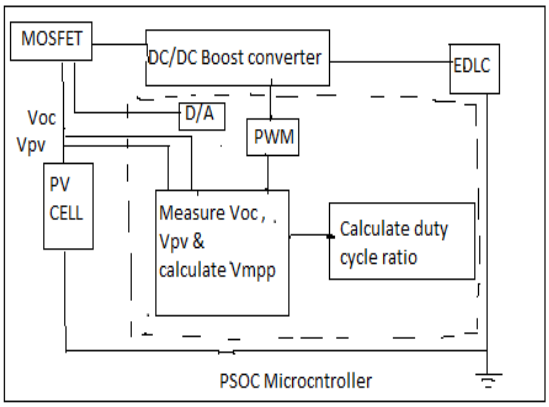

Fig. 3.Proposed system

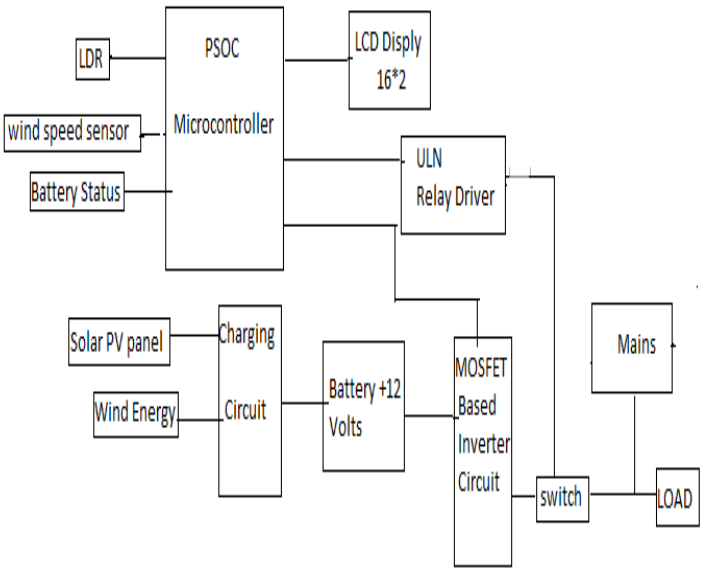

Fig. 4.Basic Block Diagram Of Self electricity Generation using Psoc

B] Wind energy-

Wind power is the conversion of wind energy into a useful form of energy. All renewable energy (except tidal and geothermal power), ultimately comes from the sun . About one or 2 percent of this energy is converted to wind energy (which is about 50-100 times more than the energy converted to biomass by all plants on earth.

C] Battery -

An electrical battery is one or more electrochemical cells that convert stored chemical energy into electrical energy. Here are two types of batteries: primary batteries which are designed to be used once and discarded when they are exhausted, and secondary batteries which are designed to be recharged and used multiple times.

D] PSoC microcontroller-

"PSoC" is an application related review of programmable array systems, the system-on-chip. Cypress's PSoC Creator software is a state-of-the-art, easy-to-use integrated development environment (IDE) that introduces a hardware and software design environment based on classic schematic entry and revolutionary embedded design. The CY8CKIT-030 PSoC 3 Development Kit is based on the PSoC 3 family of devices. PSoC 3 is a Programmable System-on-Chip™ platform for 8- and 16-bit applications. It combines precision analog and digital logic with a high-performance CPU. The following is Psoc kit used in project.

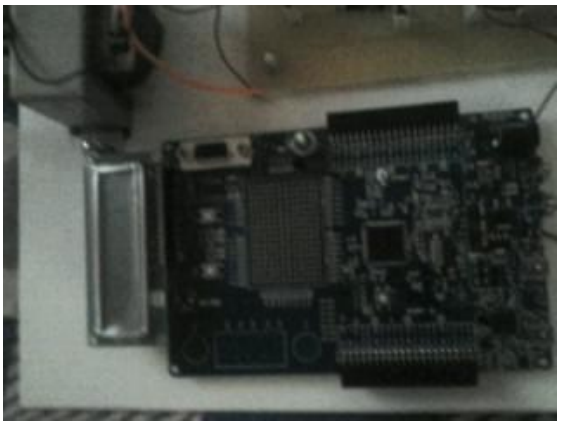

Fig.5.PSoC Kit

E] LCD display-

A liquid crystal display (LCD) is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs). LCs does not emit light directly.

F] LDR-

The main purpose of a light dependent resistor is to change the brightness of a light in different weather conditions. This can easily be explained with the use of a watch. It is the light dependent resistor that allows the watch to know when it has gotten dark, and change the emissions level of the light at that time.

G] Relay driver-

The eight NPN Darlington connected transistors in this family of arrays are ideally suited for interfacing between low logic level digital circuitry (such as TTL, CMOS or PMOS/NMOS) and the higher current/voltage requirements of lamps, relays, printer hammers or other similar loads for a broad range of computer, industrial, and consumer applications.

VII. RESULT

Fig .6.Hardware

PWM waveform-

In order to verify PWM waveform we change the dutu cycle ratio Ton/(Ton+Toff) from 20% to 100%.

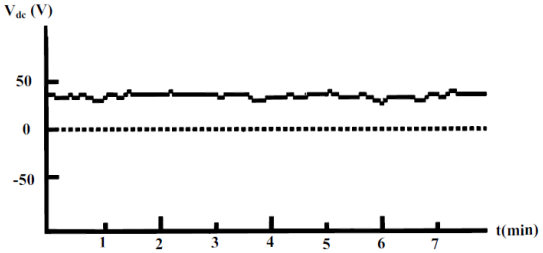

Fig.7.DC voltage generated by hybrid system

The duty cycle ratio is calculated using Psoc microcontroller .In this case Figure 4 shows the DC voltage measured across the 12 volt DC bus where the wind turbine and PV arrays outputs are connected. A slight ripple in power regulation can clearly be seen in expected output.

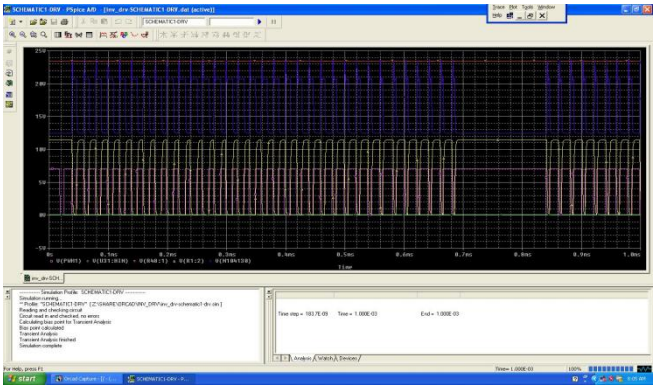

Fig. 8.Inverter output

Fig 8 shows inverter output using Orcad .This is simply inverter output using orcad simulation. In this case we are checking feasibility constraints with the help of Psoc3 kit for applying further applications.

Table I-Solar panel output voltage of proposed system variable with time

Time	Output voltage of solar panel
7 AM	15.3 V
9 AM	17.6 V
11 AM	18.10 V
12 PM	19.9 V
1.30 PM	17.3 V
3 PM	16.47 V
5 PM	14.4V
7 PM	3.4 V
11 PM	0.08 V

Table I gives the information about solar panel output voltage with respect to time. Table shows output voltage in day time at the afternoon solar panel voltage get exceeds as time goes increasing solar panel voltage diminishes.

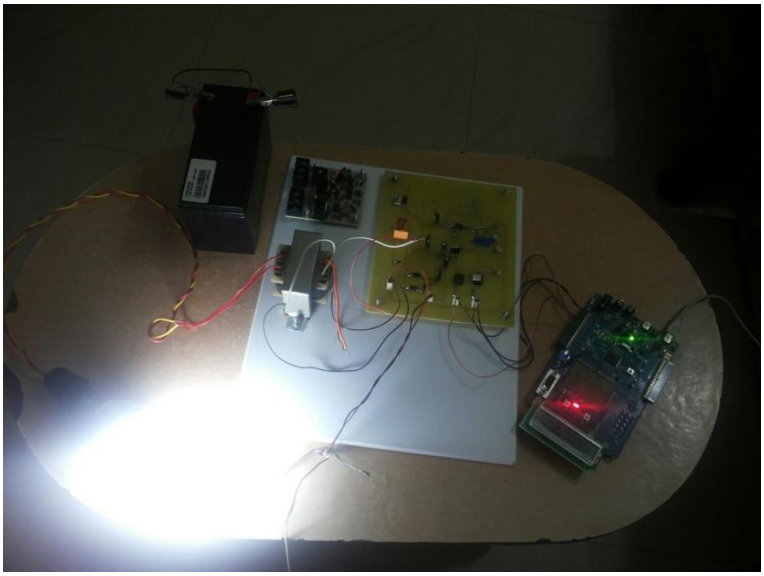

Fig.9.Outcomes

VIII. SOFTWARE SUPPORT AND COMPILERS

The programming language is C or assembly. Both can be used at the same time. An important part of the software development package is basic set of libraries including floating point math, strings, and proprietary libraries. The "Strings" unit is traditionally the weakest part of C. Code from older projects is reusable. Rewriting software libraries from scratch is very time consuming. If you run a project,

the engineering question stands: "how can I get from A to B, without wasting time"? Two compilers are supported. Just recently, a new embedded system C compiler from HI-TECH was released. In order to obtain electrical energy from sun light efficiently, it is necessary to control optimal impedance between the storage device and PV (photovoltaic) cell. One useful impedance control method is called Maximum Power Point Tracking (MPPT). MPPT controls impedance to track the maximum electric power point by sensing the current and voltage from the PV cell [1]. However, at present MPPT requires: (1) additional analog circuits for current and voltage sensing [2-12]; (2) to obtain energy efficiently, it is necessary to know the impedance characteristics of both the PV cell and storage device; (3) To use the maximum power obtained by the MPPT efficiently, a high-speed energy storage device which can accumulate quickly and efficiently the acquirable maximum power which changes according to the climate conditions is needed [8]. To solve these three problems, we employ a PSoC microcontroller for reducing analog circuits and as an intelligent MPPT controller

IX. CONCLUSION

In this case a novel technique for efficiently extracting the maximum output power from the solar panel is presented .It is useful for providing grid quality, reliable power in rural areas where the line voltage is low and insufficient to connected load. In other places, other power sources could be used. For example hybrid combinations of wind power, solar power, geothermal power, hydroelectric power, tidal power, biomass generated power, power from incineration of solid wastes, and many other technologies could be considered depending on local interests and resources. PSoC is an industrial tool, aiming shorter design to market cycle. It targets professional applications and university projects with limited budget, as well. The key elements of this test bed concept presented in this paper are two or more renewable power sources connected to a power grid with complex electrical interactions. The Govt. of India is planning to electrify 18,000 villages by year 2012 through renewable energy systems especially by solar PV systems.

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REFERENCES

[1] Waseda University, Tokyo, Japan "Development of PSoC Microcontroller Based Solar Energy Storage System" SICE Annual Conference 2011 September 13-18, 2011,

[2] Eugene V. Solodovnik, Shengyi Liu, *Senior Member, IEEE*, and Roger A. Dougal, *Senior Member, IEEE "*Power Controller Design for Maximum Power Tracking in Solar Installations" Vol 19, NO. 5, Sep 2004.

[3] Technology White Paper on "Solar Energy Potential on the U.S. Outer Continental Shelf Minerals Management Service Renewable Energy and Alternate Use Program " U.S. Department of the Interior May 2006

[4] R. B. Darla, S. R. Kurode "Continuous Conduction Mode SEPIC Converter for Maximum Power Point Tracking**"** IEEE ACE 2003.

[5] H.S Hung Chung, K.K.Tse"a novel maximum power point tracking technique for a solar panels using a SEPIC or CUK converter." IEEE Trans power Electronic vol.18 no.3 may2003.

[6] W. Lin, H. Matsuo, and Y. Ishizuka, "Performance Characteristics of Buck-Boost Type Two-input DC-DC Converter With an Active Voltage Clamp," IEICE Tech.Rep., Vol. 102, No. 567, 2003, 7 – 13.

[7] J. A. Baroudi, V. D. Dinavahi, and A. M. Knight, "A review of Power Converter Topologies for Wind Generators," Renewable Energy 32, Science Direct, January, 2007, 229 –2385..

[8] M. Sasaki, Y. Sasaki, S. Ito, "System development of a programmable MPPT using PIC" *The Japan Society Applied Electromagnetics and Mechanics*, Vol. 17, No. 2, pp.267-273, 2009.

[9] N. Mutoh, K, Kubota, "PV systems to charge electric energy acquired through MPPT control to EDLCs efficiently and to handle the charged electric power effectively", *34th Annu. Conference IEEE Ind. Electron.*, pp. 2212-2217 Nov. 10-13, 2008

[10] E Koutroulis, K Kalaitzakis, and N C Voulgaris, "Development of a microcontroller-based photovoltaic maximum power point tracking control system," *IEEE Transaction on Power Electronics*, Vol.16, No.1, pp.46-54, Jan. 2001.

[11] T. Noguchi, S. Togashi, and R. Nakamoto, "Short-current pulse based adaptive maximum power point tracking for photovoltaic power generation system," in Proc. IEEE Int. Symp. Ind. Electron., 2000, pp. 157-162.

[12] S. Yuvarajan and S. Xu, "Photo-voltaic power converter with a simple maximum power point tracker," in Proc Int. Symp. Circuits Syst. pp. 399-402.

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