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Operation of a Single Phase Bidirectional Inverter with Buck/Boost MPPTS using PV and Wind Module

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***Abstract*: The proposed project is focused on integration and operation of a single-phase bidirectional inverter with two buck/boost maximum power point trackers (MPPTs) for dc-distribution applications. In a dc-distribution system, a bidirectional inverter is required to control the power flow between dc bus and ac grid, and to regulate the dc bus to a certain range of voltages. A drop regulation mechanism according to the inverter inductor current levels to reduce capacitor size, balance power flow, and accommodate load variation is proposed. Since the photovoltaic (PV) array voltage can vary from 0 to 600 V, especially with thin-film PV panels, the MPPT topology is formed with buck and boost converters to operate at the dc-bus voltage around 380 V, reducing the voltage stress of its followed inverter. Along with the PV module, the wind module is proposed. Additionally, the controller can online check the input configuration of the two MPPTs, equally distribute the PV-array output current to the two MPPTs in parallel operation, and switch control laws to smooth out mode transition. A comparison between the conventional boost MPPT and the proposed buck/boost MPPT integrated with a PV inverter is also presented.**

Keyword: MPPT, matlab, PVmodule, buck boost converter.

I. INTRODUCTION

An embedded system is a computer system designed to perform a few dedicated functions often with real time computing constraints. It is embedded as a part of complete device often including hardware and mechanical parts. Then by contract, a general purpose computer, such as personal computer, is designed to be flexible and to meet a wide range of end user needs. Embedded system control may devices in common used today. Embedded system is control by one or more main processing cores that are typically either microcontroller or digital signal processor. The key characteristic, however, is being dedicated to handle a particular task, which may require very powerful processor. In general, embedded system is not a strictly definable term, as most system have some elements of extensibility and programmability. For ex, hand held computer share some element with embedded system such as the operating system and microprocessor which power them, but they allow different application to be loaded and peripherals to be connected. Maximum Power Point Tracking is algorithm that included in charge controllers used for extracting maximum available power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point' (or peak power voltage). Maximum power varies with solar radiation, ambient temperature and **solar cell** temperature. The major principle of MPPT is to extract the maximum available power from PV module by making them to operate at the most efficient voltage (maximum power point). MPPT check output of PV module, compares it to the battery voltage then fixes what is the best power that PV module can produce to charge the battery and converts it to best voltage to get maximum current into battery. It can also supply to a DC load, which is connected directly to the battery.

MPPT is most effective under the condition Cold weather, cloudy or hazy days: Normally, PV module works better at cold temperatures The term duty cycle describes the proportion of 'on' time to the regular interval or 'period' of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on. A optimal duty cycle is the best time that an entity spends in an active state as a fraction of the total time under consideration. In a periodic event, duty cycle is the ratio of the duration of the event to the total period.

Optimal duty cycle

where,

$$D = \frac{\tau}{T}$$

τ is the duration that the function is active.

T is the period of the function.

II. PHOTOVOLTAIC CELLS AND WIND MODULE

Maximum power point tracking for a Photovoltaic Cell. AT89S52 is the microcontroller used here, this acts as the heart of the project. Other components like Solar Panel (Photovoltaic Cell),Wind Module, DC-DC booster, Super Capacitor, Inverter, Voltage Sense, Analog to digital converter. The Photovoltaic Cell allows direct convertion of light energy from Sun's rays into electricity by the way of generation and transport inside a semiconductor material, of positive and negative electric charges, through the action of light. The material has two regions, one exhibiting an excess of electrons, the other an electron deficit, respectively referred as N-type doped, and P-type doped. Here the excess electrons from the N-material diffuse into the P-material. The initially N-doped region becomes positive charged, and the P-doped region becomes negative charged. An electric field is thus set up between them, tending to force electrons back into the N-region, and holes back into the P-region. A junction has been set up. By placing metallic contacts on the N and P regions, a diode is obtained. When the junction is illuminated, photons having an energy equal to, or higher than the width of the forbidden band or band gap, yield their energy to the atoms, each photon causing an electron to move from the valence band to the conduction band, leaving behind it in turn a hole, also able to move around the material giving a rise to an electron-hole pair.

When a load is positioned t the cell's terminals, Electrons from the N-region will migrate back to the holes in the p region, by way of the outside connection, giving rise to a potential difference: an electric current passes.

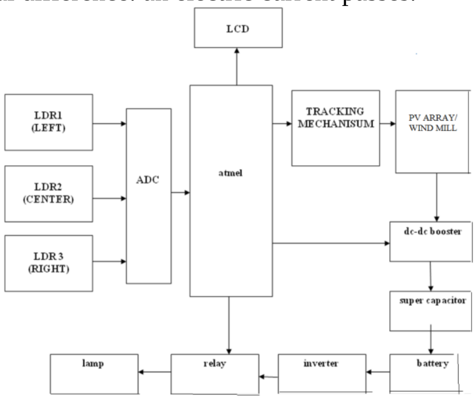

Fig. 1. Block diagram.

[1]. A windmill is a machine that converts the energy of wind into rotational energy by means of vanes called sails or blades. The reason for the name "windmill" is that the devices originally were developed for milling grain for food production; the name stuck when in the course of history, windmill machinery was adapted to supply power for many industrial and agricultural needs other than milling. The majority of modern windmills take the form of wind turbines used to generate electricity, or wind pumps used to pump water, either for land drainage or to extract groundwater.

[2]. Wind is a form of solar energy and is a result of the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and the rotation of the earth and are modified by bodies of water, vegetation, and differences in terrain. Humans use this wind flow, or motion energy, for many purposes: sailing, flying a kite, and even generating electricity.

[3]. The terms wind energy or wind power describe the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity.

III. ATMEL MICROCONTROLLER AT89S52

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry- standard 80C51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

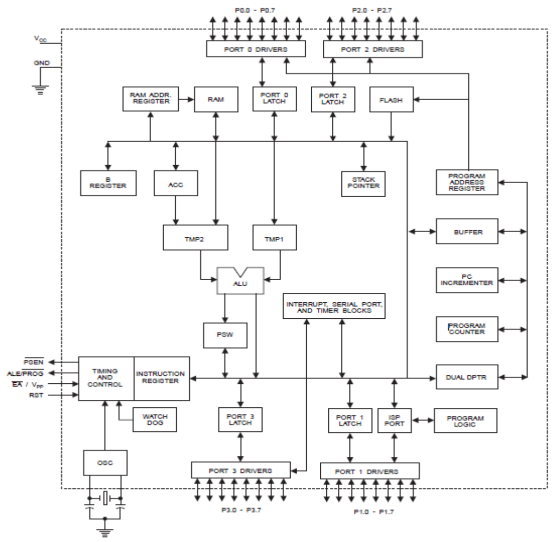

Fig. 2. Internal Block Diagram

IV. PIN DIAGRAM AND MEMORY ORGANISATION

There are three memory blocks in each of the PIC16F87X MCUs. The Program Memory and Data Memory have separate buses so that concurrent access can occur and is detailed in this section. The EEPROM data memory block is detailed in Section 4.0. Additional information on device memory may be found in the PIC microcontroller Mid-Range Reference Manual, (DS33023).

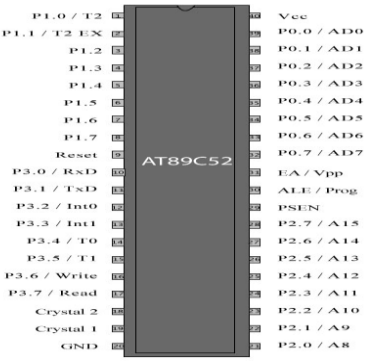

Fig.3. Pin Diagram.

V. CONCLUSION

A single-phase bidirectional inverter with two buck/boost MPPTs has been Designed and implemented. The inverter controls the power flow between dc bus and ac grid, and regulates the dc bus to a certain range of voltages. A drop regulation mechanism according to the inductor current levels has been proposed to balance the power flow and accommodate load variation. Since the PV-array voltage can vary from 0 to 600 V, the MPPT topology is formed with buck and boost converters to operate at the dc-bus voltage around 380 V, reducing the voltage stress of its followed inverter. Additionally, the controller can online check the input configuration of the MPPTs, equally distribute the PV-array output current to the two MPPTs in parallel operation, and switch control laws to smooth out mode transition. Integration and operation of the overall inverter system have been discussed in detail, which contributes to dc-distribution applications significantly.

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