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HARDWARE IMPLEMENTATION OF MPPT ALGORITHMS FOR SOLAR SYSTEM

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ABSTRACT

To improve the performance of the solar system under the varying environmental condition we implement to MPPT algorithm on a single circuit. In this module, we include two MPPT algorithms that are Perturb and Observe, Incremental Conductance to extract maximum power from the solar module. The programs for the execution of this algorithm are stored in the microcontroller and the microcontroller decides which algorithm is operated. Also, a DC-DC boost converter is used to step up the output voltage of the solar module. MOSFET is used as a switching component in the DC-DC boost converter which is controlled by the microcontroller. Also regulating IC, transistor, inductor, capacitor, current transducer, and resistors are used. The PV voltage, bus voltage, and MPPT output voltage along with the name of the algorithm are is displayed on the LCD.

Keywords: Solar System, Maximum Power Point Tracking (MPPT), Photovoltaic (PV).

I. INTRODUCTION

In the running world, there is huge increasing demand for energy sources and they are depleting at a very fast rate, therefore it is necessary to use renewable energy resources. Solar energy has many advantages over other nonrenewable energy sources. Solar energy is indeed not just a good possibility for the future, but already a profitable and promising solution for present energy needs. However, the challenge is not only to generate energy using a solar system but also to increase the performance and efficiency of the overall process. But, the disadvantage of the solar system is that the output power is decreased due to environmental effects such as solar irradiation, temperature, etc. To overcome this drawback, we use the concept of Maximum power point tracking is used.

In this project, the output of the solar panel is given to the microcontroller. The execution programs or algorithms are stored in the microcontroller and according to the selection of the algorithm the PWM pulse is given to the boost converter and it gives the tracks the maximum power as shown in figure 1.

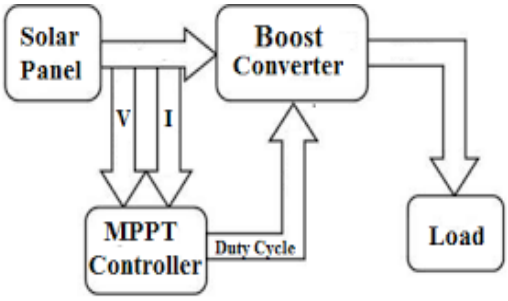

Figure 1: Block diagram of MPPT working

In this module, we use perturbation and observation (P&O) and Incremental conductance (I&C) algorithm are used. In the case of perturbation and observation algorithm operating essentially on the perturbation of the system by increasing or decreasing the duty cycle at each cycle of MPPT and observing the array terminal voltage and current to detect the maximum point of the PV curve see the flow chart in figure 2. As shown in the flow chart in figure 3. this algorithm continuously observes the ΔP/ΔV. If ΔP/ΔV=0 means the algorithm catches the maximum power point, but still the algorithm observes the system ΔV and ΔI. If they have any changes then repeat the procedure to catch the MPP. The incremental conductance name come from the term ΔV/ΔI.

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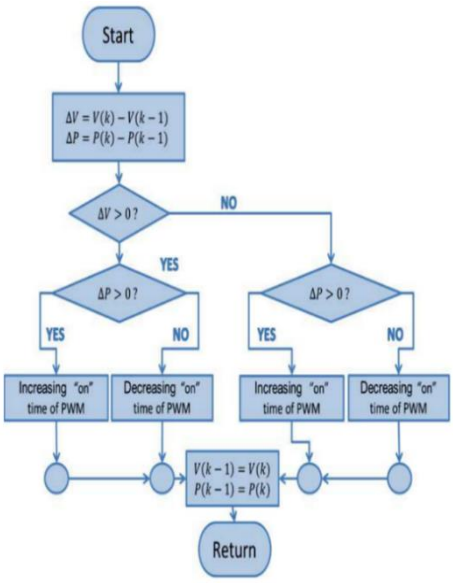

Figure 2: I and C algorithm

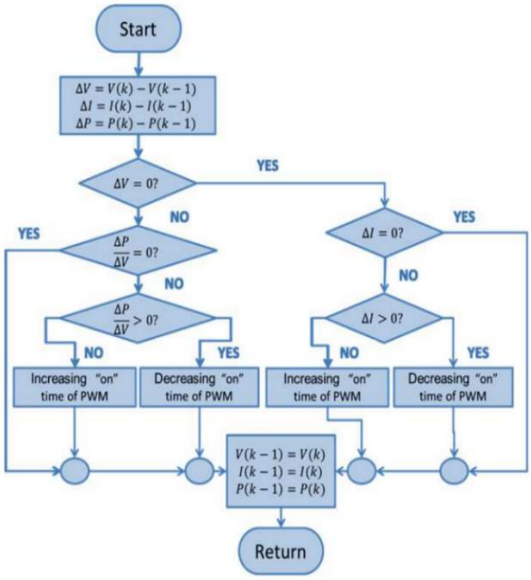

Figure 3: P and O algorithm

II. METHODOLOGY

Figure 4. shows the overall circuit diagram of the hardware implementation of the two MPPT algorithm on a single circuit. The solar module output is given to the microcontroller and it decides whether the MPPT algorithm concept is used or not, but the output of the solar module (11.7V to 12V in our case) is high for the microcontroller. Therefore, the solar module output is first given to the voltage divider circuit the voltage divider circuit converts this output to readable (5v) for the microcontroller. Like that there is three voltage divider circuits are used for PV, Battery, or bus, and MPPT output or boost converter output. The output of this three-voltage divider circuit should not exceed above 5V so that the microcontroller read it.

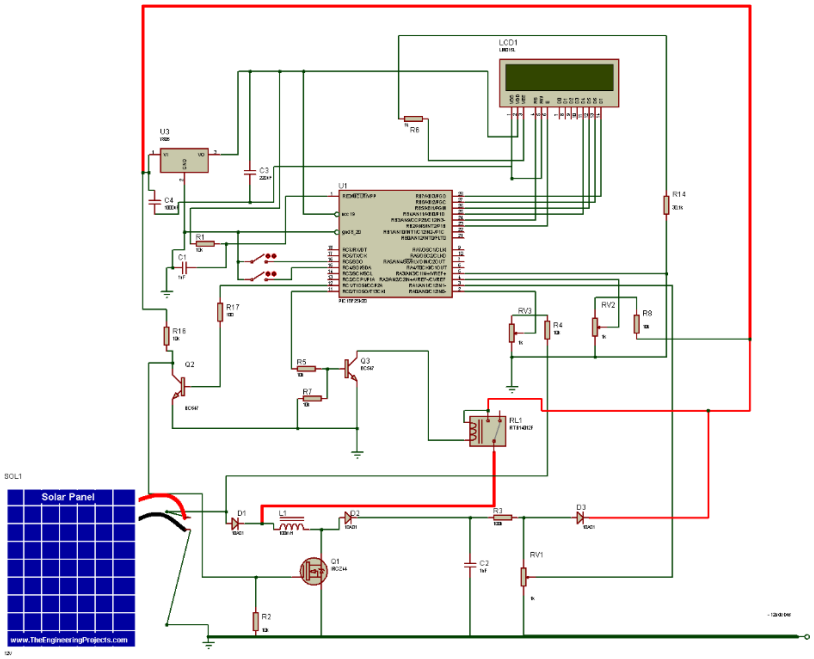

Figure 4: Circuit diagram

To operate the microcontroller, we required 5V therefore by using the voltage regulator IC (7805) convert 12V from bus to 5V. Now, the microcontroller starts consuming the voltage which for the load on the regulator to increase which may cause the microcontroller reset. To avoid this the capacitor is used to store the 5V, if the circuit required excessive voltage, then this stored voltage in the capacitor is used. When the microcontroller is going on it is mandatory to reset it for that a resistor and ceramic capacitor are used which are connected to the

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microcontroller. Then it is on and checks whether the solar module voltage is sufficient or not. If its voltage is sufficient which is between 12V to 14V then no need for the algorithm this voltage is directly given to load through the relay circuit. If the solar module voltage is below the range (12V to 14V) then the microcontroller checks the switch position (For changing the algorithm). And according to the switch position the microcontroller gives the triggering signal to the MOSFET. But MOSFET required 7V for the turn-on, therefore, the microcontroller feeds the 5V output to the transistor and the transistor starts switching MOSFET with 12V. We use the external switch for changing the algorithm manually.

III. MODELING AND ANALYSIS

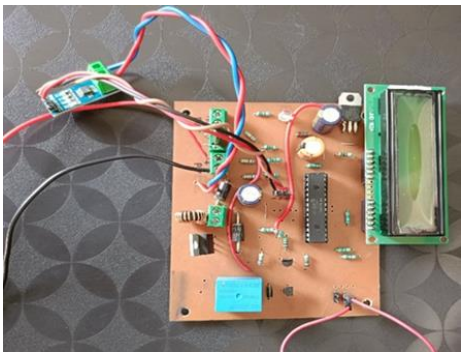

Figure 5: Experimental prototype

Table 1. P and O algorithm results in different condition

Sr no.	Component Name	Rating	Quantity	Price in Rs.
1	Solar panel	12V, 20W	1	900
2	Microcontroller (PIC 16F886)	-	1	300
3	Regulator IC (LM7805)	5V	1	20
3	Transistor (BC5478)	6V, 0.5W	2	20
4	Diode	8A	4	40
5	MOSFET (IRFZ44N)	55V, 25A	1	25
6	Inductor	100mH	1	75
7	Current Transducer	30A	1	150
8	LCD display (16cm *2cm)	12V	1	250
9	Resistor	1K	5	20
10	Resistor	10K	8	32
11	Resistor	100K	2	8
12	Capacitor	1000uF	2	50
13	Capacitor	470uF	1	25
14	Connector	-	4	40
15	Relay (SPDT)	12V	1	30

IV. RESULTS AND DISCUSSION

The module is tested and the following results are obtained from the P&O and I&C algorithm as shown in tables 2 and 3 respectively. It is observed that when the solar panel voltage decreases due to the atmospheric condition and the solar irradiation then the MPPT algorithm changes the duty cycle and keeps the switching frequency constant and increases the MPPT output voltage that is improving the performance of the solar system in the varying atmospheric condition.

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Table 2. P and O algorithm results in different condition

Solar o/p voltage at different atmospheric conditions	Duty cycle in %	Frequency in Khz	The output voltage of MPPT in volts
9	30	5	13.5
9.5	28	5	14.2
9.3	29	5	14.3
9.1	29	5	14.2
10	28	5	14.2
10.6	27	5	13.9
10.9	27	5	13.7
11.2	26	5	14.2
10.9	27	5	14
11.6	26	5	15.2
12.9	25	5	14.9
13.6	24	5	14.1
12.8	25	5	13.9
12.3	26	5	13.8
14	24	5	13.6
14.8	24	5	13.5
15.6	23	5	13.8

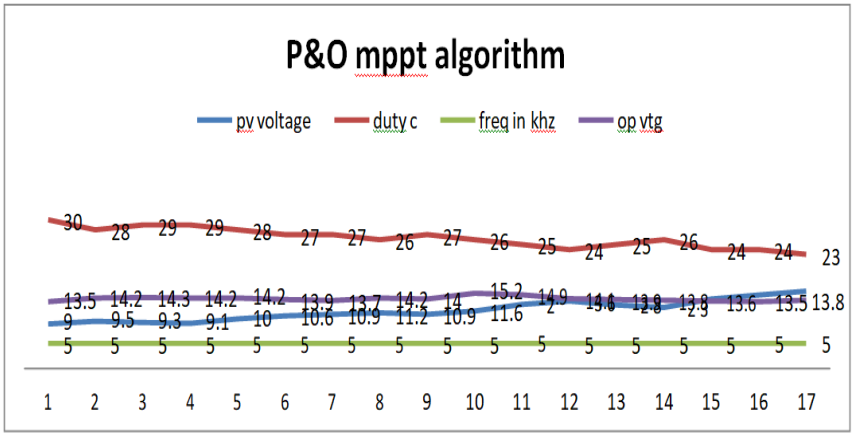

Figure 6: P and O algorithm simulation result

Table 3. I and C algorithm output at different condition

Solar o/p voltage at different atmospheric conditions	Duty cycle in %	Frequency in Khz	The output voltage of MPPT in volts
9	36	1	13.7
9.5	34	1	13.8
9.3	35	1	13.7
9.1	35	1	13.6

10	33	1	13.7
10.6	32	1	13.6
10.9	31	1	13.7
11.2	30	1	13.6
10.9	31	1	13.7
11.6	30	1	13.8
12.9	28	1	13.7
13.6	25	1	13.6
12.8	28	1	13.6
12.3	29	1	13.8
14	24	1	13.6
14.8	24	1	13.7
15.6	23	1	13.6

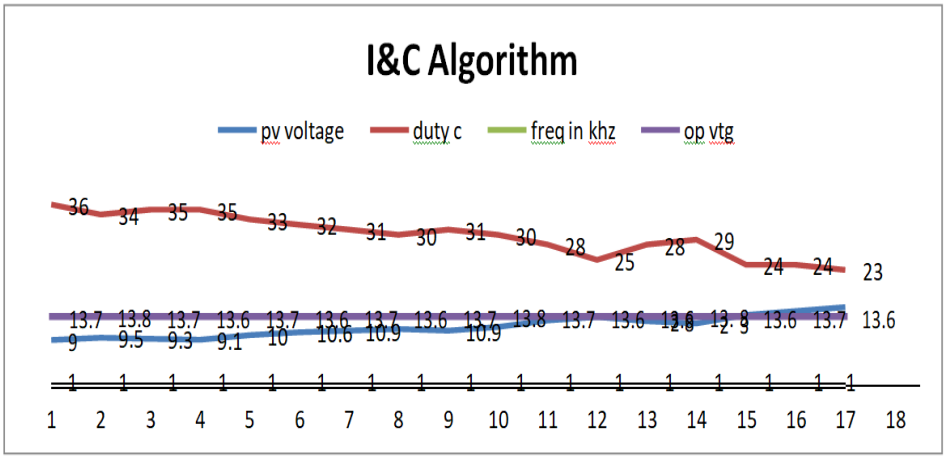

Figure 7: I and C algorithm simulation result

V. CONCLUSION

In this paper, a low-cost, low-power consumption MPPT system with two algorithms is implemented and tested. The system consists of high efficiency, Boost-type DC/DC converter and a microcontroller-based unit that controls the duty cycle for DC/DC converter directly from the Solar Panel output power measurements. Experimental results show that the proposed MPPT control system always follows the maximum power point under varying solar characteristics. The proposed control unit was implemented on the PIC-Microcontroller board based on the 16f886 microcontroller since it permits easy system modifications.

By observing the above table, it can be concluded that the P&O MPPT technique gives increased output compared to I&C with a combination of the BOOST converter. The harmonic quantity is also reduced with P&O. The efficiency of the system has also improved with P&O. Hence the PV generation system is proved to be more advantageous with P&O. Also, it is found that the I&C method tracking the peak power under fast varying atmospheric conditions. So, according to the atmospheric condition we can use both the algorithm alternately just by changing the switch position manually.

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