PLC Based ON-Grid System for Home Appliances

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Abstract: This paper describes about the power generation system based on ON-grid solar system using PLC controller. Solar system is used as ON-grid in real time to run the load by the means of Programmable Logic Controller (PLC). This controller has more efficiency which when it used with the solar energy applications. This project deals with the implementation of solar system with ON-grid technology using PLC monitor for home appliances via Crouzet PLC-HMI.

Maximum voltage of 12v, 5A DC power from the solar panel, is converted into A.C through the inverter circuit. The output of the A.C line has maximum power 120v. Through this A.C line we can operate 6W CFL bulb and 12v DC fan, along with DC output, also we can operate F.M radio and DC applications. By this controller, we can calculate the power and it could be distributed to certain load for operating the home equipments.

Introduction

In today’s world many research work is carried out on solar cells, since solar energy consists of photovoltaic cell which comes under advance renewable energy. Now a day’s solar units are widely used in the home appliances, street light and in many real time applications. Electrical Energy is most wanted for day to day life. It is the ultimate factor for both industries and domestic usage. In India more than 80,000 Villages are suffering without electricity, particularly in the state of Tamil Nadu 400 villages are not getting electricity due to insufficient power production and due to economy. Many electrical energy sources are naturally obtained from wind, solar, biodiesel generator etc. The energy is also obtained from coal and minerals [1]. Renewable energy source are most essential in worldwide. Even though more energy is obtained from wind and coal, solar energy is one of the most efficient sources of energy. However this research work, explains in detail about the solar energy to overcome from demand of electricity. This paper deals about the calibration of energy resource where solar energy is used as On-Grid method from which we can use in day time. This method is explained briefly in the following section.

System of Control Panel

1. PLC
2. Inverter Circuit
3. Solar Panel
4. 12-0-12V 2amps Transformer

Block Diagram

Fig.1 Block Diagram of Small On-Grid Solar System
PLC is a versatile and most efficient controller. Many industries and engineers are using only PLC since it is a highly equipped controller. The controller controls both frequency and voltage by using Variable Frequency Driver (VFD) [2, 10]. The above Fig 1. explains the structure of On Grid system. The main role of this circuit is solar panel and inverter.

The solar Photo Voltaic Cell is a cell which produces energy by conversion of light energy into Electric energy. When the solar radiation is high, the wavelength of light also increases from which the DC supply will be generated. The PV cell is a basic module element in each solar Photo Voltaic system. The PV cell consists of number of silicon material which is connected in the form of array [3]. The PV cell consists of many jointly connected solar cells, similarly the PV cell module consists of number of solar cells. Generally, the solar panel produces more than 520W [4].

**Characteristics of PV Cell is determined by two methods [5]**

- **Serial Method**
- **Parallel Method**

**Serial Method**

Fig. 2 V-I characteristic of two similar cells connected in serial

\[ V = V_1 + V_2 \]
\[ I = I_1 = I_2 \]

**Parallel Method**

Assuming that the cell which will be operated at maximum power voltage and current from each cell is

\[ V_M = 0.542V \]
\[ I_M = \left[ \frac{190.5}{M^2} \right] \left[ 6 \times 10^{-4} M^2 \right] = 0.1143A \]

Through by proposed research 10 watts solar panel has used,

Power required for my application is

\[ \frac{power}{cell} = 0.542 \times 0.1143 = 0.062w \]

Number of cell required:

\[ \frac{10w}{0.062w/cell} = 161.29 \]

Number of cell in series

\[ \frac{system\ volts}{voltage/cell} = \frac{21}{0.542} = 38 \]

Number of rows of 44 cell connected in parallel:

\[ \frac{161.25}{44} = 4.24 \]

**Modeling of Inverter Circuit**

**Parts required**

1. 2N3055 Power NPN transistor
2. Capacitor
3. Diode
4. Resistance
5. Transformer
In this modeling of inverter circuit, the circuit is constructed by transformer of 24-0-24v-2Amps, power transistor with 2 -resistance, 2 -diode and 2 -Capacitor with proper interconnection.

From this circuit we will be able to produce maximum 120V 20W of current.

2N3055 is intended for power switching circuits, series and shunt regulators, high fidelity amplifiers and output stages. By interchanging the transformer & power transistor with capacity of 24V-0-24V -15Amps and power MOSFET respectively, we will be able to produce 230v, 300watts current.

This could be used for home appliances [6]. The above mentioned circuit is described in the below figure 4.

**Fig. 4** Circuit diagram for Inverter

**Circuit Description**

- C1, C2-68 - uf, 25V Tantalum capacitor
- R1, R2 - 10 Ohm, 5 Watt resistor
- R3, R4 - 180 Ohm, 1 Watt resistor
- D1, D2 - HEP 154 Silicon Diode
- Q1, Q2 - 2N3055 NPN transistor
- T1 24V - Center Tapped Transformer

**Management of energy by using PLC Controller with workshop**

By using PLC CD-24VDC CROUZET PLC we can control both analog and discrete signal. The merit of using PLC- controller could correlate the minimum voltage and maximum voltage. The minimum voltage could be sent to minimum voltage equipment and high voltage could be sent to heavy voltage equipment .The D.C supply obtained from the solar panel would be sent directly for D.C provision. Hence by using this supply we could operate the D.C Fan & F.M Radio. The program of the controller is done by using Functional Block Diagram (FBD). The Controller is programmed so that the voltage of 200 to 220v could be used for high voltage applications and 90 to 120v could be used for low voltage applications. The output generated from the solar panel is a DC supply .This DC supply is sent to the controller to operate the DC equipment that could hold maximum of 24V.

**Result**

**Total Power Generated**

<table>
<thead>
<tr>
<th>Time</th>
<th>Fan (v)</th>
<th>Inverter (v)</th>
<th>DCVolt</th>
<th>ACVolt</th>
<th>Amps</th>
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<td>4.08</td>
<td>3.62</td>
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<tr>
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Table 2. Power dropped from inverter circuit on 20/11/2013

<table>
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<th>Time</th>
<th>Fan (v)</th>
<th>Inverter (v)</th>
<th>DCVolt</th>
<th>ACVolt</th>
<th>mps</th>
</tr>
</thead>
<tbody>
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<td></td>
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Fig. 5. Power dropped from inverter circuit on 20/11/2013

Fig. 6. Power dropped from inverter circuit on 21/11/2013

Fig. 7 (a) overview of project work
The output obtained from the inverter circuit is about 120V max and from solar panel is about 21V max. A Data log is taken for the output generated under variable period of time. The values are plotted and explained in the above graph & table. Overview of project is done and shown in figure 7 a, b and 8. Finally, through this output 6 watts CFL bulb, emergency light and 12 volt DC fan were operated.

**Conclusion**

In this work, an ON-GRID solar power generation system is designed. The output value is successfully generated and it is used for home appliances. This proposed system ensures that it could be operated as user friendly and facilitates low cost and low maintenance.

**References**

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