

Smart Grid Control System using Solar Panel

Harish Chandra Mohanta, Rupanita Das



Abstract: As the technology grows very fast, we need more and more power so one of the ultimate choices is renewable energy. Solar energy is the best one among all types of renewable energy. This paper presents a smart grid control system using solar energy. Here, the smart grid control system consists of source board, control board, Arduino board and load board. The solar panel is the source which provides input energy to the control system. The control board composed of relay, operational amplifier (OPAMP) and the bipolar junction transistor (BJT). An interface with Arduino board is done to take inputs and give controlled output, further; we can use battery for storing our solar power and can be reusable by the load which will again enhance our solar power usability. Sunlight based solar panel gives cost investment funds by not paying for power, particularly for power costs keep on rising where the expense of sun oriented keeps on falling. Cost reserve funds likewise can be determined by wiping out the need to channel in framework control, upsetting encompassing scenes and hardscapes, fixing zones, and so on.

Keywords: Solar energy, operational amplifier (OPAMP), relay, bipolar junction transistor (BJT), Arduino.

I. INTRODUCTION

Because of the change in climate and vitality need, sustainable power source generation i.e. renewable energy has experienced a great significant growth. Progressively high penetration level of photovoltaic (PV) generation emerges in smart grid control system [1]. Solar power is irregular and variable, as the sun-oriented source at the ground level is exceptionally subject to overcast spread fluctuation, air airborne levels, and other climate parameters. The innate inconstancy of enormous scale sun-based age acquaints huge difficulties with brilliant lattice vitality the board. Exact determining of sun powered power/irradiance is basic to verify monetary activity of the smart grid system. For monitoring, controlling, and analysis in automation fields, smart grid control system is used. It is an independent power arrange framework. So as to give financially effective and top-notch smart grid is associated with generators [4-5]. Smart grid control system is described by the following characteristics [7]: –

1. User friendly
2. It contradicted to the physical and digital assaults – Optimizes resource use
3. Environment friendly
4. The utilization of extreme two-way correspondences, improved/high sensors and disseminated figuring innovation.
5. Improve the effectiveness, dependability and security of intensity conveyance and use.

The Smart Grid not just includes establishment of much new, shrewd gear at all basic age, yet additionally in transmission, dissemination, and utilization focuses. So as to get a functioning piece of the activities of a coordinated Smart Grid, essential control advancements for correspondences, information the executives, analytic examination, and work the board are additionally required [6]. Solar based energy is the difference in essentialness from light into control, either direct using photovoltaic (PV), in an indirect way using concentrated daylight-based power, or a blend. Photovoltaic cells convert light into an electric stream using the photovoltaic effect. It is used as a wellspring of intensity for little and medium-sized region. In reference to the natural issue sustainable power source assets give off an impression of being the one of the most proficient and viable arrangements [3]. Arduino is an open-source hardware and programming association, which is plans and delivers single-board microcontrollers and microcontroller units for building propelled devices. Arduino board is an open source stage which is utilized to perform input and yield tasks like to control an engine, read from the sensor and in little calculations. These sheets are exceptionally simple to begin and furthermore programming, equipment and IDE are open source. Different types of Arduino board and its details are listed in table 1.

Table 1: Different Arduino boards comparisons

Arduino Board Name	Processor	Memory	Digital I/O	Analogue I/O
Arduino Uno	16 MHz ATmega328	2KB SRAM, 32KB flash	14	6 i/ps, 0 o/p
Arduino Due	84MHz AT91SAM3X8E	96KB SRAM, 512KB flash	54	12 i/ps, 2 o/ps
Arduino Mega	16MHz ATmega2560	8B SRAM, 256KB flash	54	16 i/ps, 0 o/p

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* Correspondence Author

Harish Chandra Mohanta, Electronics and Communication Engineering Department, Centurion University of Technology and Management, Bhubaneswar, India.

Rupanita Das, Electronics and Communication Engineering Department, Centurion University of Technology and Management, Bhubaneswar, India.

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Arduino Leonardo	16MHz ATmega32u4	2.5KB SRAM, 32KB flash	20	12 i/ps, 0 o/p
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In this paper we are using Arduino board that is used to take inputs and give controlled output, further we can use battery for storing our solar power and can be reusable by the load which will again enhances our solar power usability.

This paper provides a comprehensive implementation of smart grid control system solar panel and PV power. Applications of solar panel in energy management of smart grid are also implemented in section II.

I. DESIGN AND IMPLEMENTATION

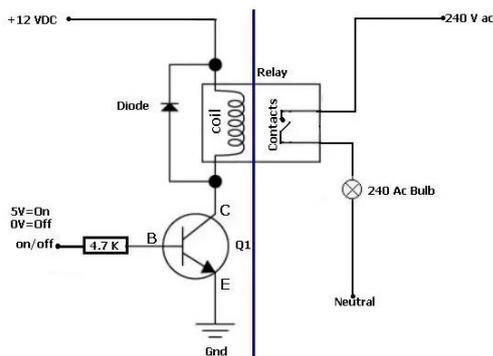


Figure 1. Circuit diagram

In this design, we designed the source board using solar panel then we designed the control board using relay, opamp and bjt then we have to interface with Arduino and finally we designed our load board. Figure 1 shows the circuit diagram of smart grid control system.

Solar Panel

Solar panel converts sun light to DC electricity. voltage is used to control the smart grid system.



Figure 2. Solar Panel

The source board consists of a solar panel as shown in figure 2.

Rectifier Circuit

For rectification purpose, we used diode in the circuit as shown in figure 1. Diode allow flow of current in one direction. The rectifier circuit changes over the AC sign to DC signal. Here the rectifier circuit goes about as a half wave rectifier circuit.

Bipolar Junction Transistor (BJT) and OPAMP

BJTs are used for the amplification of input signal. Using BJTs, we can design an operational amplifier (OPAMP). An Ideal operational amplifier (OPAMP) have infinite gain and bandwidth when utilized in the open-loop mode with ordinary

DC increases of well more than 100,000 or 100dB. The basic operation amp is of a 3-terminal device, with 2-wellsprings of information and 1-yield, (barring power associations). An operational amplifier works from either a double positive (+V) and a relating negative (- V) supply, or they can work from a solitary DC supply voltage.

UA74C1

It is General Purpose Single Opamp. It is DIP 8(Plastic package). It has large input range, no latch-up, high gain. It is used here for amplification purpose.

RELAY CIRCUIT

It is a relay circuit (JQC3FC)

It deals with the guideline of an electromagnetic attraction. At the point when the circuit detects the current, it energies the electromagnetic field which delivers the transitory electric field. The current flows through the coil deliver the magnetic field around it. Its features are super miniature, high power, low coil power consumption, suitable for house hold appliance, automation system, and electronics equipment and remote-control facilities.

Interface with Arduino

An interface with Arduino board to take inputs and give controlled output, further we can use battery for storing our solar power and can be reusable by the load which will again enhances our solar power usability.

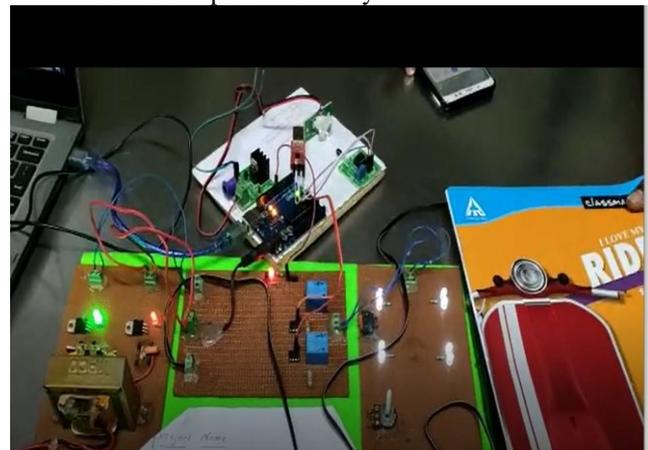


Figure 3. Implementation of smart grid control system using solar panel

II. ALGORITHM

The program follows the following steps during its implementation;

```

Here we declare the pins with variable name and data type
intsolrawsen = A0;
intgrdrawsen = A1;
constint rly =8;
longsolens = 0;
longgrdsens = 0;
floatsolvlt = 0;
floatsolamp = 0;
floatsolwat = 0;
floatgrdvlt = 0;
floatgrdamp = 0;
floatgrdwat = 0;
    
```

here we declare the pins as input or output

```
void setup() {
  Serial.begin(9600);
  pinMode(rly, OUTPUT);
}
```

Then here we define a function that will read the analog input from control board and store it in an another variable and it will multiply and stored to a different variable

```
void loop() {
  solsens = analogRead(solrawsen);
  solvlt = solsens*0.0085;
  solamp = solvlt;
  solwat = solvlt*solamp;
  grdsens = analogRead(grdrawsen);
  grdvlt = grdsens*0.0085;
  grdamp = grdvlt;
  grdwat = grdvlt*grdamp;
}
```

We have stored the power in respectively variable. Here, we will apply a decision loop that will take decision for which source will be connected whether it will be grid or it will be solar, it totally depends on the power level.

```
if(solwat<=20.25)
{
  digitalWrite(rly,HIGH);
  Serial.println("\t Solar Power is Lesser than 50%
  Connected to Grid ");
  delay (2000);
}
else if (solwat<= grdwat)
{
  digitalWrite(rly,HIGH);
  Serial.println("\t Solar Power is LOW than grdpwr
  Connected to Grid ");
  delay (2000);
}
Else
{
  digitalWrite(rly,LOW);
  Serial.println("\t Solar Power is More than 50%
  Consuming Solar ENERGY");
  delay (2000);
}
```

III. RESULTS AND ANALYSIS

The following were the results that were observed when the application was run;

```
smart_grid

int solrawsen = A0;
int grdrawsen = A1;
const int rly =8;
long solsens = 0;
long grdsens = 0;
float solvlt = 0;
float solamp = 0;
float solwat = 0;
float grdvlt = 0;
float grdamp = 0;
float grdwat = 0;

void setup() {
  Serial.begin(9600);
  pinMode (rly, OUTPUT);
}

void loop() {
  solsens = analogRead(solrawsen);
  solvlt = solsens*0.0085;
  solamp = solvlt;
  solwat = solvlt*solamp;
```

IV. CONCLUSION

To enhance renewable energy applications like solar power usability and also keeping in mind about the continuous flow of power given highest priority, solar panel was used. Here, we interfaced Arduino board to take input from our hardware circuit and give the controlled output back to our circuit. Solar panel forecasting provides energy management of smart grid control system.

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AUTHORS PROFILE



Harish Chandra Mohanta, received the M.Tech degree in Electronics and Communication Engineering from IIT Kharagpur in 2015. He is currently working as an assistant professor with the School of Engineering and Technology, Bhubaneswar Campus, Centurion University, Odisha. His current research interests include embedded system design, image processing, antenna design and development of electronic devices.



Rupanita Das received M.Tech degree in Electronics and Communication Engineering from Biju Patnaik University of Technology, Rourkela, Odisha in 2011. She is working as an assistant professor in ECE department of Centurion University of Technology and Management, Bhubaneswar, Odisha, India. Her current research interests include communication system design, embedded system design, microwave filter design and antennas design.