Journal of Advances in Science and Technology
Vol. 12, Issue No. 25, (Special Issue) December-2016, ISSN 2230-9659

Renewable Energy Management using Embedded Systems

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Abstract – The project titled Solar Energy Based Dual Meter is an attempt to achieve maximum utilization of the solar energy. The basic function of the Dual Meter is to give supply when mains 230 voltage is not there. When supply is there, the Dual Meter charges the Battery to its limit using AC mains. This system stores the energy when it is available and uses it when there is no supply. That means total units consumed are almost same as Dual Meter draws more current to charge the battery. And the system wholly depends upon the Power Supply Authority for the supply. But this Solar Energy Based Dual Meter eliminates that dependency and allows the Dual Meter to charge the battery using naturally available energy, Sun.

Key words – Solar Panel, Inverter, RS 232 Trans Receiver, LED Display.

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INTRODUCTION

Since human evolution, mankind has exploited naturally available resources such as Wind, Water & Solar energy. The availability of resources restricts the use of Wind and Water energies as alternative power sources. But Sun is available since birth of solar system and will remain there as single infinite energy source.

There are some hopes that the sun will become a main source of energy in the 21st century. By then, sources of oil will be almost exhausted and will only play a minor part in the supplying of energy. The present interest in solar energy is therefore not surprising. Some work has already been done with solar cells and solar panels.

Most of the energy that we get from the greatest reservoir of energy, the Sun, remains unused. The only way to store the energy from the sun is to convert it into electrical form and then using this electrical signal to charge batteries and thus store the energy in chemical form. For this we make use of solar panels consisting of solar cells. The solar cell gives an electrical output which is proportional to the intensity of light falling over it.

The other novel feature of this project or system is to check the day-light intensity and accordingly switches the appropriate loads. This decision is done by electronics means and one or two loads are switched on, which are needed to that condition.

2. BLOCK DIAGRAM

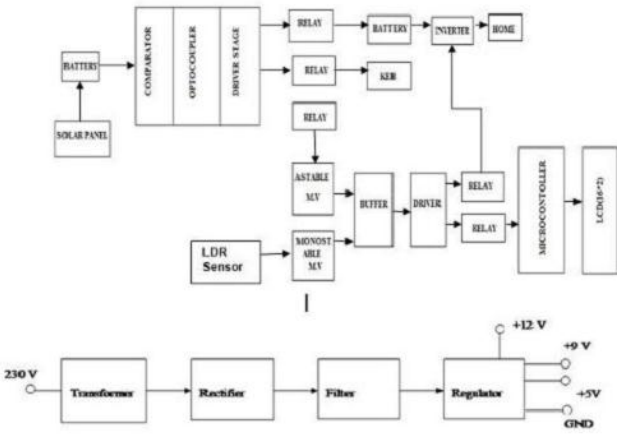

Figure 1: Block Diagram of the project

Methodology*:* The main aim of this project is effective utilization of solar energy for home and if battery gets full charged then the solar energy will be transferred to KEB. *Power supply unit:* This section needs two voltages viz., +12 V & +5 V, as working voltages. Hence specially designed power supply is constructed to get regulated power supplies.

Solar Panel: Solar panel refers either to a photovoltaic module, a solar thermal energy panel, or to a set of solar photovoltaic (PV) modules electrically connected and mounted on a supporting structure. A PV module is a packaged, connected assembly of solar cells. Solar panels can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential

applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts.

The efficiency of a module determines the area of a module given the same rated output - an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. There are a few solar panels available that are exceeding 19% efficiency. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring.

Battery: An electric battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Each cell contains a positive terminal, or cathode, and a negative terminal, or anode. Electrolytes allow ions to move between the electrodes and terminals, which allows current to flow out of the battery to perform work.

Astable Multivibrator: The astable multivibrator is another type of cross-coupled transistor switching circuit that has NO stable output states as it changes from one state to the other all the time. The Astable circuit consists of two switching transistors, a cross coupled feedback network, and two time delay capacitors which allow oscillation between the two states with no external trigger signal to produce the change in state.

Comparator: In electronics, a comparator is a device that compares two voltages or currents and outputs a digital signal indicating which is larger. It has two analog input terminals and one binary digital output.

A comparator consists of a specialized high gain differential amplifier. They are commonly used in devices that measure and digitize analog signals, such as analog-to-digital converters (ADCs), as well as relaxation oscillators.

Microcontroller: A Microcontroller (sometimes abbreviated µC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input / output peripherals. Neither program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems.

Buffers: Buffers do not affect the logical state of a digital signal (i.e. a logic 1 input results in a logic 1 output whereas logic 0 input results in a logic 0 output). Buffers are normally used to provide extra current drive at the output but can also be used to regularize the logic present at an interface.

Drivers: This section is used to drive the relay where the output is complement of input which is applied to the drive but current will be amplified.

Relays: It is an electromagnetic device which is used to drive the load connected across the relay and the o/p of relay can be connected to controller or load for further processing.

Indicator: This stage provides visual indication of which relay is actuated and deactivated, by glowing respective LED or Buzzer.

3. INTERNAL CIRCUIT FOR COMPARATOR, OPTOCOUPLER AND DRIVER MODULE

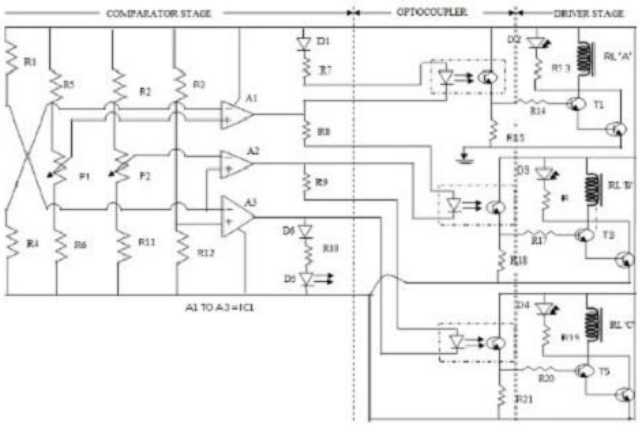

Figure 2: Internal Circuit of Comparator, Optocoupler and Driver Module

When there is a variation in the temp/illumination in the thermistor or LDR, it measures impedance of the sensor smartly and decides which gate to open. The circuit diagram shows that three operational amplifiers compare the drop across the test leads to a fixed voltage and indicate which of the two is highest by switching their output to the positive supply level or ground.

The three comparators A1, A2 & A3 are used to compare the Identity Card input and decide, whether it got Administrator Level or Manager Level or Employee Level privilege. There are two presets P1 & P2 allowing user to set the reference value. The

first preset P1 is biased with R5 & R6 and its variable end goes to Non-inverting pin of Comparator A1.

The second preset P2 is biased similarly using R2 & R11 and its variable end is connected to Inverting end of Comparator A2.This circuit accepts the Identity Card inputs across the resistors R1 & R4. Out of these two inputs one is fed to Inverting pin of comparator A1 and other input is fed to Non- Inverting pin of comparator A2 and Inverting pin of comparator A1.

The three comparator gives the Administrator, Manager, & Employee Level Indication at comparator A1, A2 & A3's output pins. These three outputs are fed to relay driver stage through Optoisolator.

4. INVERTER CIRCUIT

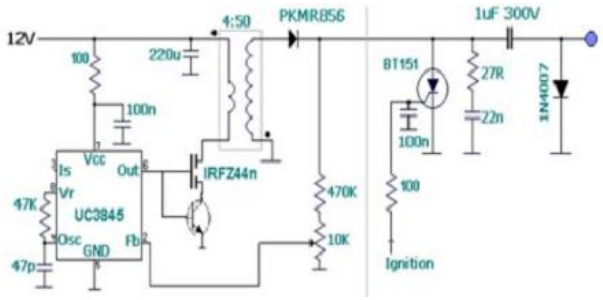

Figure 3: GSM Modem Kit

An inverter is an electronic device that can transform a direct current (DC) into alternating current (AC) at a given voltage and frequency. For example, if we have to feed a household appliance that operates in alternating current 230V (50Hz frequency) but we do not have available the alternating current network, thanks out occurs we can feed it, however, taking advantage of a direct current source, such as a 12V battery (DC) .Therefore essential to its use for supply by direct current, electrical devices that operate in alternating current**.**

The inverters are used in photovoltaic off-grid (stand-alone) for powering electric remote houses, mountain chalets, mobile homes, boats and are also used in grid-connected photovoltaic systems to enter the current produced by the plant directly into the power grid distribution.

The inverters are also used in many other applications, ranging from UPS to speed controllers for electric motors, from power supplies switching to lighting. By the term "inverter" is designed to include a group "rectifier-inverter", supplied with alternating current and used to vary the voltage and the frequency of the alternating current output as a function of the incoming (eg for the supply of particular machinery). The most common inverters used to power the AC loads are of three types: square wave inverter (suitable for resistive loads), modified sine wave inverter (suitable for resistive, capacitive, inductive loads can produce noise) and pure sine wave inverter (suitable for all types of loads because faithfully reproduce a sine wave equal to that of our domestic power supply).

5. RESULT AND DISCUSSION

Case 1: When battery is fully charge then supply is given to KEB.

Fig. 4: LCD Display for consumed unit and amount

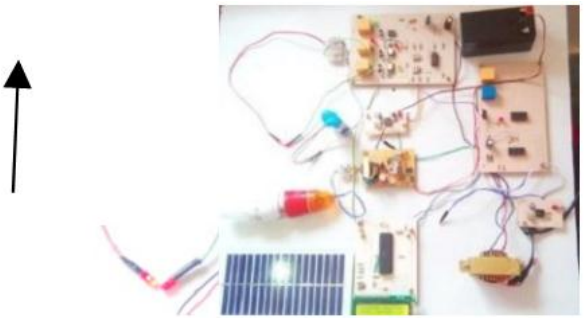

Fig. 5: KEB supply shown by glowing LED

Case 2: When battery is half charge then supply is given to Home.

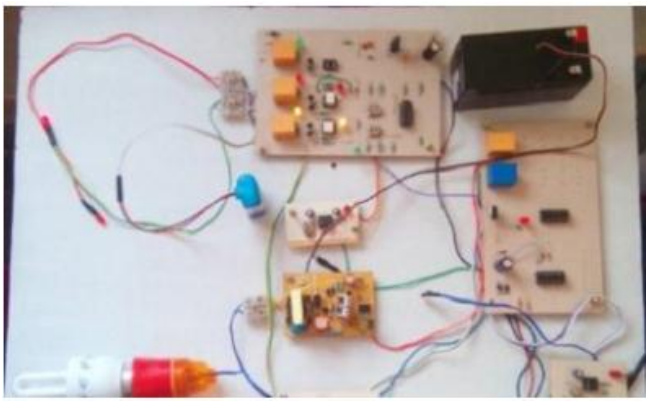

Fig. 6: Home supply is shown by glowing LED

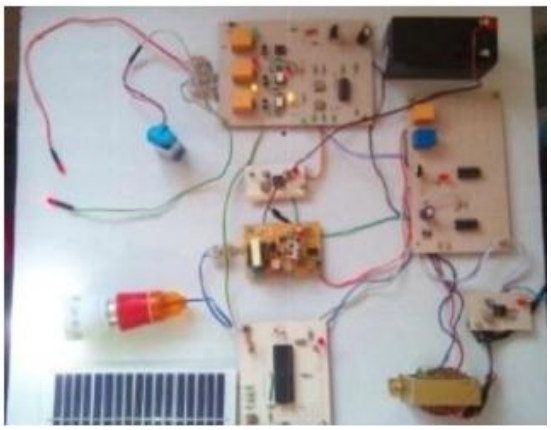

Fig 7 Automatic bulb glowing at night time

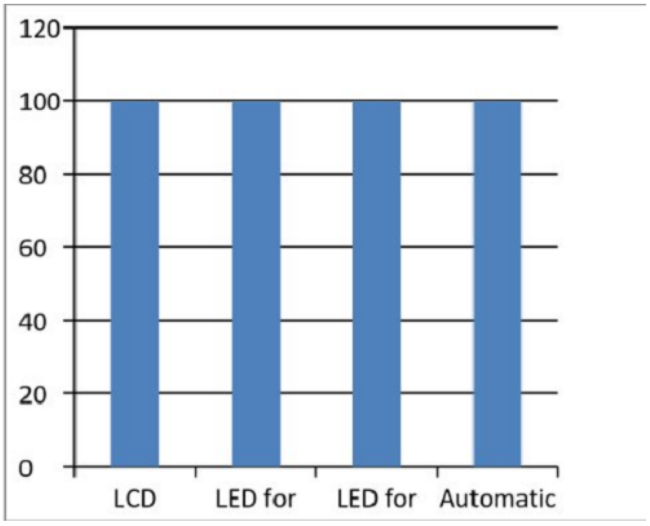

Fig. 8: Parameter v/s Efficiency

The Energy Saving Using Dual Meter is done for maximum utilisation of solar energy for Home purpose and transmitting extra energy to KEB to demonstrate we have used LCD Display, LED for home, LED for KEB and automatic bulb.

Table 1 : Result and efficiency

Sr. No.	Parameter	No. of times tested	Correct result	Efficiency
1.	LCD Display	5	5	100%
2.	LED for Home	5	5	100%
3.	LED for KEB	5	5	100%
4.	Automatic Bulb	5	5	100%

6. ADVANTAGES

- High reliability, due to the usage of power semiconductor devices.
- System monitored without any difficulty (no need of full attention).
- As this system uses both Solar Energy and Mains Supply to charge its Battery, chances of facing Blackout conditions is very less.
- No wastage of power and effective in implementation.
- System costs less with reliability and longer life.
- Lower weight because of reduction in components. And expenditure on care & maintenance of the system is negligible.
- It can be used as a decentralized energy system right at the place of use; hence there is no need of transmission line.

7. APPLICATIONS

SMART GRID: A smart grid allows for a two-way street, adding computer intelligence and communications to the electricity distribution network and much of what's connected to it, from solar panels, smart appliances, plug-in cars. It holds great promise for cleaner, more efficient power, healthier air and lower greenhouse gas emissions.

SMART HOME: Solar energy is stored in a battery and this DC power (direct current) is sent to an inverter, which converts DC power into Ac power, which runs a home without 230V supply.

A PLUG-IN ELECTRIC VEHICLE (PEV): A plug-in electric vehicle (PEV) is any motor vehicle that can be recharged from an external source of electricity, such as wall sockets, and the electricity stored in the rechargeable battery packs drives or contributes to drive the wheels.

7. CONCLUSION AND FUTURE SCOPE

This paper is based on Micro-controller (89C51). Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested.

There is always chance to improve any system as research & development is an endless process. Our system is no exception to this phenomenon. The following developments can be done in future for this project. In future we can use this project in several applications by adding additional components to it. A smart grid uses digital technology to improve the reliability, security, and efficiency of the electricity system. By adding GPS and GSM we make billing wirelessly via a message.

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