LOW TENSION ON-GRID SOLAR WITH BACKUP UPS

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Abstract: This paper describes the improvement in On-Grid solar power system that can be done in order to increase the efficiency of the system. In grid-connected solar PV systems the solar energy produced by the solar panels is synchronized and fed to the grid. But whenever the shutdown or fuse of call occurs, this solar power cannot be synchronized and hence it becomes unused. So the theme of the project is to effectively use the solar energy even on Shutdown period, maintenance time & fuse of call. This is done by sensing the line power in the grid and tracking out solar power from the boost converter and feeding it to the battery. Simultaneously battery discharges power to the domestic load. More than domestic, the industrial organizations can be much benefited of this designing. Application of this design leads to the greater reliability and energy conservation in the solar system.

***IndexTerms* - Grid,Battery.**

I. INTRODUCTION

The On-Grid solar power injection is one of the reliable way to minimize the electricity bill and to go green in the energy generation and consumption. In the grid-connected solar PV systems the solar energy produced by the solar panels is synchronised and fed to the grid. But whenever the shutdown or fuse of call occurs ,this solar power cannot be synchronised and hence it becomes unused. So the theme of the project is to effectively use the solar energy even on Shutdown period, maintenance time & fuse of call. This is done by sensing the line power in the grid and tracking out solar power from the boost converter and feeding it to the battery. Simultaneously battery discharges power to the domestic load. More than domestic, the industrial organisations can be much benefited of this designing. Application of this design leads to the greater reliablility and energy conservation in the solar system.

II. EXISTING SYSTEM

The power generated by the PV panel installed is fed to the grid. The synchronising unit synchronises the parameters (i.e frequency,voltage and phase) and the power is injected to the grid. In other way the system will either be used as a standalone according to the customer utility preferences..These both are beneficial in existence. But when the absence of line power from the grid. The synchronising unit cannot take a reference parameters from the grid. And during these period of time the generating power is not consumed effectively.

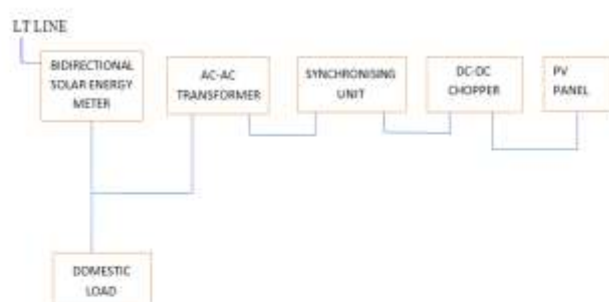

Fig. 1. Block Diagram of Existing System

III. PROPOSED SYSTEM

This system is more reliable when compared to the existing system. The controller senses the line power and drives the relay connected in the On Grid line and also the meter to domestic load line. So whenever the grid line failure occurs the solar power generation is stored in the battery and simultaneous discharges to the load. The advanced intelligence algorithm for maximum power point tracking increases the efficiency of effective solar power consumption.

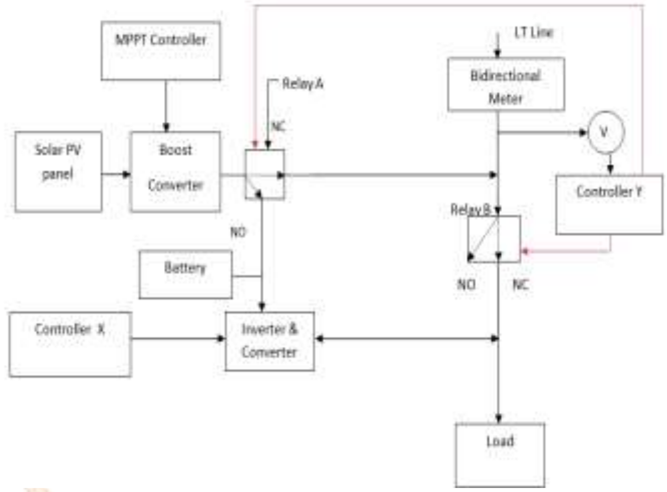

Fig. 2. Block Diagram of Proposed System

A. BASIC BLOCK OF BOOST CONVERTER

The basic configuration of a boost converter where the switch is integrated in the used IC. Often lower power converters have the diode replaced by a second switch integrated into the converter. If this is the case, all equations in this document apply besides the power dissipation equation of the diode.

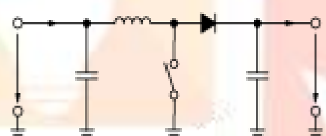

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Fig. 3. Basic Block of Boost Converter

B. INDUCTOR SELECTION

Often data sheets give a range of recommended inductor values. If this is the case, it is recommended to choose an inductor from this range. The higher the inductor value, the higher is the maximum output current because of the reduced ripple current.

The lower the inductor value, the smaller is the solution size. Note that the inductor must always have a higher current rating than the maximum current given in because the current increases with decreasing inductance.

$$L=(V_{in} \cdot (V_{out} - V_{in})) / (I_l \cdot f_s \cdot V_{out})$$

V_{in} = typical input voltage
V_{out} = desired output voltage
f_s = minimum switching frequency of the converter
I_l = estimated inductor ripple current, see below

The inductor ripple current cannot be calculated because the inductor is not known. A good estimation for the inductor ripple current is 20% to 40% of the output current.

$$I_l \text{ or } I_{out(max)} = (0.2 \text{ to } 0.4)\, V_{out}/V_{in}$$

I_l = estimated inductor ripple current
$I_{out(max)}$ = maximum output current necessary in the application.

C. RECTIFIER DIODE SELECTION

To reduce losses, Schottky diodes should be used. The forward current rating needed is equal to the maximum output current:
$I_f = I_{out\ (max)}$
I_f = average forward current of the rectifier diode

$I_{out}(max)$ = maximum output current necessary in the application

Schottky diodes have a much higher peak current rating than average rating. Therefore the higher peak current in the system is not a problem.

The other parameter that has to be checked is the power dissipation of the diode. It has to handle:

$$PD = If.Vf$$

If = average forward current of the rectifier diode.
Vf = forward voltage of the rectifier diode.

D. RELAY DRIVER

A relay is an electro-magnetic switch which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220V mains supply.Relay Driver is shown in the figure 3.4.

The diagram below shows a typical relay (with "normally-open" contacts). The current needed to operate the relay coil is more than can be supplied by most chips (op. amps etc.), so a transistor is usually needed.

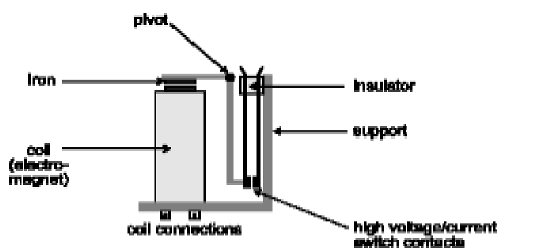

Fig. 4. Relay Driver

E. BATTERY MANAGEMENT SYSTEM

A lead-acid battery is an electrical storage device that uses a reversible chemical reaction to store energy. It uses a combination of lead plates or grids and an electrolyte consisting of a diluted sulphuric acid to convert electrical energy into potential chemical energy and back again. The electrolyte of lead-acid batteries is hazardous to your health and may produce burns and other permanent damage if you come into contact with it.

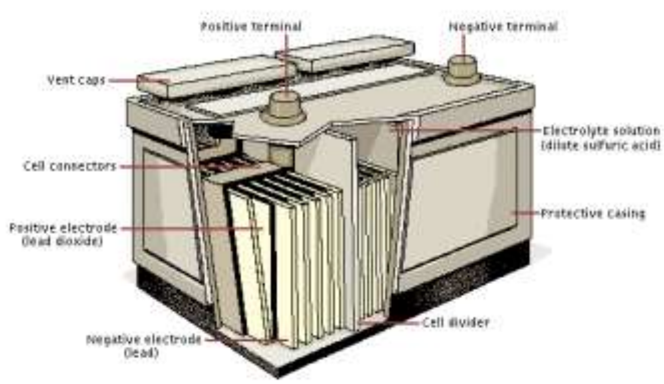

Fig. 5. Lead Acid Battery

F. RECTIFIER

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC.

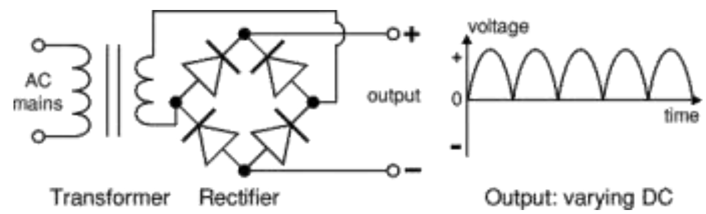

Fig. 6. Rectifier Circuit

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages). Please see the Diodes page for more details, including pictures of ridge rectifier

Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC.

G. DC SMOOTHING

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

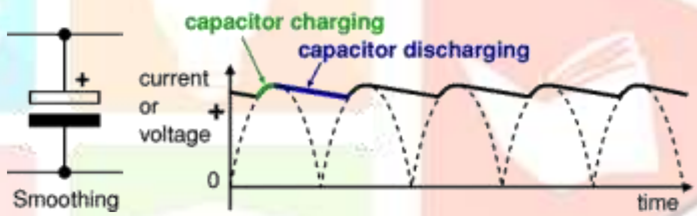

Fig. 7. DC Smoothing using Capacitor

For many circuits a ripple which is 10% of the supply voltage is satisfactory and the equation below gives the required value for the smoothing capacitor.

A larger capacitor will give fewer ripples. The capacitor value must be doubled when smoothing half-wave DC.

Smoothing Capacitor for 10% ripple,

C=5*10/vs.*f

C = smoothing capacitance in farads (F)

Io = output current from the supply in amps (A)

Vs = supply voltage in volts (V), peak value of the unsmoothed DC

f = frequency of the AC supply in hertz (Hz), 50Hz.

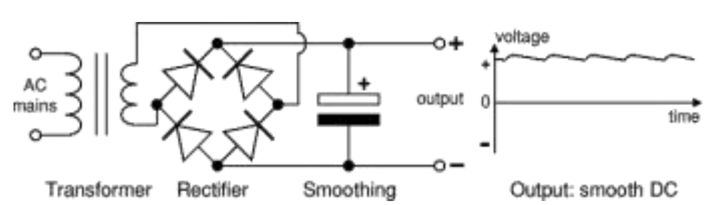

Fig. 8. Smoothing Circuit

H. REGULATOR

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and current.

Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heat sink if necessary.

1. Positive regulator
    1. input pin
    2. ground pin
    3. output pin

It regulates the positive voltage

2. Negative regulator
    1. ground pin
    2. input pin
    3. output pin
    4. It regulate the negative voltage

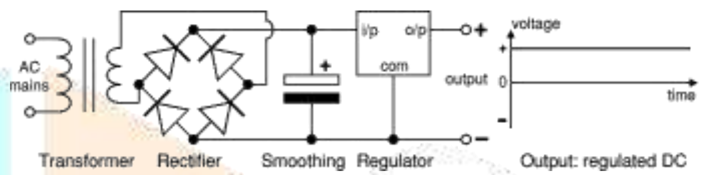

Fig. 9. Regulator

The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

I. PIC CONTROLLER

PIC 16F877A is one of the most advanced microcontroller from Microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability. It is ideal for applications such as machine control applications, measurement devices, study purpose, and so on.

Fig. 10. PIC Top View

PIC16F877A has 5 basic input/output ports. They are usually denoted by PORT A (R A), PORT B (RB), PORT C (RC), PORT D (RD), and PORT E (RE). These ports are used for input/ output interfacing. In this controller, “PORT A” is only 6 bits wide (RA-0 to RA-7), ”PORT B” , “PORT C”,”PORT D” are only 8 bits wide (RB-0 to RB-7,RC-0 to RC-7,RD-0 to RD-7), ”PORT E” has only 3 bit wide (RE-0 to RE-7).

All these ports are bi-directional. The direction of the port is controlled by using TRIS(X) registers (TRIS A used to set the direction of PORT-A, TRIS B used to set the direction for PORT-B, etc.). Setting a TRIS(X) bit ‘1’ will set the corresponding PORT(X) bit as input. Clearing a TRIS(X) bit ‘0’ will set the corresponding PORT(X) bit as output.

(If we want to set PORT A as an input, just set TRIS(A) bit to logical ‘1’ and want to set PORT B as an output, just set the PORT B bits to logical ‘0’.)

1. Analog input port (AN0 TO AN7): these ports are used for interfacing analog inputs.
2. TX and RX: These are the USART transmission and reception ports.
3. SCK: these pins are used for giving synchronous serial clock input.
4. SCL: these pins act as an output for both SPI and I2C modes.
5. DT: these are synchronous data terminals.
6. CK: synchronous clock input.

7. SD0: SPI data output (SPI Mode).
8. SD1: SPI Data input (SPI Mode).
9. SDA: data input/output in I2C Mode.
10. CCP1 and CCP2: these are capture/compare/PWM modules.
11. OSC1: oscillator input/external clock.
12. OSC2: oscillator output/clock out.
13. MCLR: master clear pin (Active low reset).
14. Vpp: programming voltage input.
15. THV: High voltage test mode controlling.
16. Vref (+/-): reference voltage.
17. SS: Slave select for the synchronous serial port.
18. T0CK1: clock input to TIMER 0.
19. T1OSO: Timer 1 oscillator output.
20. T1OS1: Timer 1 oscillator input.
21. T1CK1: clock input to Timer 1.
22. PGD: Serial programming data.
23. PGC: serial programming clock.
24. PGM: Low Voltage Programming input.
25. INT: external interrupt.
26. RD: Read control for parallel slave port.
27. CS: Select control for parallel slave.
28. PSP0 to PSP7: Parallel slave port.29 VDD: positive supply for logic and input pins.
29. VSS: Ground reference for logic and input/output pins.

IV. METHODOLOGY

The shutdown or power failure is identifed by the controller.After sensing the power from the grid, the relay is driven from NO to NC.The solar power generated is fed to the boost converter circuit.This converter circuit gives an stable 12V output voltage from which the battery is charged.When During shutdown the battery discharges its energy to the load.

Also simultaneously battery gets charged through converter circuit whose input is the power that is generated from the PV panel.

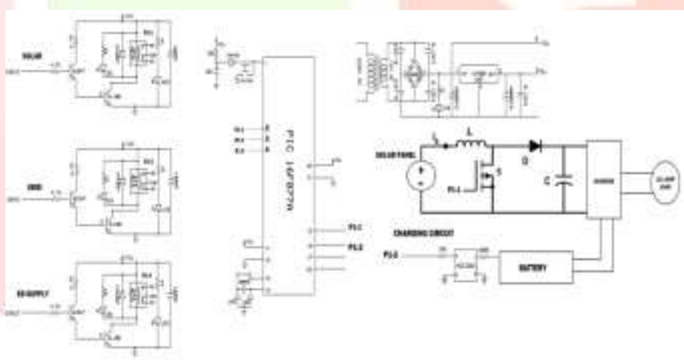

Fig. 11. Circuit Diagram of Proposed System

V. HARDWARE RESULT

The Hardware Kid Comprises of PV panel of 15W,boost converter circuit with constant 12V output,battery capacity of 7.5Ah,PIC controller 16F877A, LM7805 and LM7812 IC regulators,relays,MOC3021 switching device, SL100, BC547 Transistors.The power failure is sensed by the PIC controller, now the relay is operated to make battery charging from the boost converter with constant 12V and gets discharged to the load.

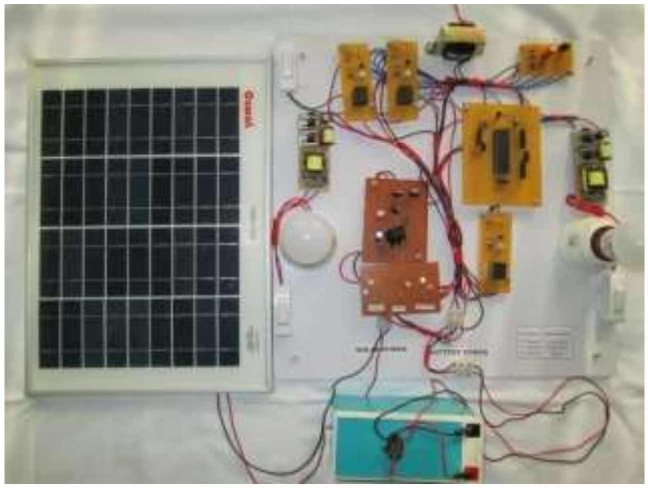

Fig. 12. Hardware Snapshot of Proposed System

VI . CONCLUSION

A new concept for an On-Grid solar system has been proposed. Testing was proposed by a prototype designed for 15. A remarkable feature of this system is that energy is conserved and reliability is increased.

Therefore even during shutdown or power failure in grid ,the system gets operated with the solar power generation.

According to test results ,1KV panel generates 5 to 6 units in a day and during fuse of call, shutdowning period this energy is not properly utilized. Hence on implementing this system design will increase the performance of functioning in the On-Grid solar power system.

VII . FUTURE SCOPE

Though this project treats only a small scale (LT consumers) system, this designing would be applicable to a larger scale system (HT consumers) with some minor changes in materials and design.

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