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Study the solution to improve the efficiency of overall Solar PV system with Designing of AC Solar panel

[1]Gunjan V. Kurwale, [2]Reema R. Nanwate, [3]Priti L. Durge, [4]Devesh U. Sarkar

[1,2,3]UG Students, [4]Assistant Professor
Electrical Engineering Department,
G. H. Raisoni Institute of Engineering & Technology,
Nagpur Maharashtra, India.

***Abstract*— An intermittent nature of Solar power generation get affects the efficiency of overall micro- grid system, the many reasons behind of that such as load, weather, the angle of the relative to the panel and the temperature of panel etc. So these problems prevent by using some new advantageous technology like FACTs devices and by designing newly type of solar micro-inverter which is nothing but the AC Solar panel. Solar micro-inverter is a device used in Solar panel in which photovoltaic's plates that convert DC generated by the solar module into AC. The Solar PV has variable DC converted into pure DC by using boost converter and DC voltage converted into AC using 3-phase 2 level inverter. The MPPT is designed and is applied to boost converter which increases the Solar PVs efficiency. Lastly all the devices are simulated and synchronized together and stimulated appropriate output is shown in this paper.**

***IndexTerms*— Micro-grid system, Solar PV system, Boost converter, MPPT technique, 3 phase 2 level inverter.**

I. INTRODUCTION -

Due to increasing environmental affairs and energy crises demand early from few decades , the demand for solar energy is increased. Solar energy is one of the most promising renewable energy source that because of their ease of installation, less maintainance ,increase efficiency of Solar cell and economics of scale and energy policy. Power from the SPV system is directly feeding into electric grid. Output power from the Solar varies with weather conditions and irradiation levels. So power electronic converters are needed to be incorporated in SPV system which gives a pure DC. A power electronic converter which converts DC power from the Solar PV cell into AC by using boost converter. MPPT technique and 3-phase 2 level inverter.

Boost converter is a (step up converter) DC to DC power converter that steps up voltage (while stepping down curruent.) from its input (supply) to its output (load). We used here inductor, diode and high frequency switch for boost converter. The BC having duty ratio is greater than 1 then only it is boost.

Now it is necessary to increase the efficiency of Solar cell for this purpose, the MPPT technique is used to increase the efficiency method are to be undertaken to match the source and load properly i.e. to increase the system performance. In this paper Solar panel output is the boost input , now the output of BC is pure which is converted into AC by using 3-phase 2 level inverter and getting sinusoidal AC voltage.

II. BLOCK DIAGRAM-

The block diagram involves solar PV having variable DC voltage, this solar PV output fed to boost converter as BC input which is to be boosted by boost converter i.e., step up chopper and then after it is to be converted into AC by using 3 phase two level inverter and getting sinusoidal AC voltage. For removing the harmonics it is necessary to connect a filter to a 3 phase inverter. Due to this the variable AC which is coming from the output of inverter is getting pure. Generally, we use low pass filter for removing the unwanted harmonic by connecting the filter to inverter. After getting the AC sinusoidal waveform we transform that power by connecting transformer and feeding to 3 phase load.

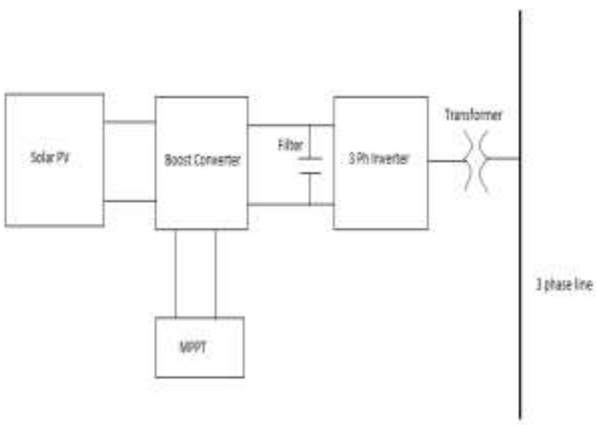
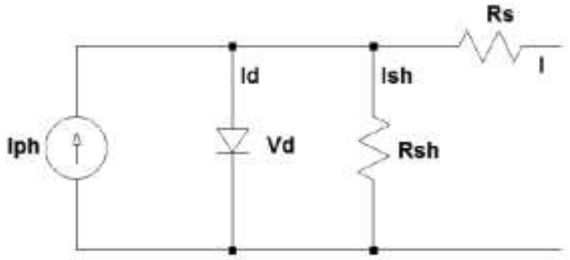


Fig. 1 Block diagram of a Proposed Model

III. GRID CONNECTED SOLAR PHOTOVOLTAIC-

Fig.2 shows that the light energy which is coming from sun is incident to solar PV cell and creates charge carriers after that PN junction collect that charge carriers and separates them. Due to this in external circuit produces a current. By the effect of photovoltaic, forward bias voltage is being produced in it.



The Equation of Current,

$$I = Iph - Ir \times e^{\left\{\frac{q \times (V + I \times Rs)}{A \times K \times T}\right\}} \qquad (1)$$

We know that,

$$Iph = [Isc + Ki \times (T - 298)] \times \frac{G}{1000} \qquad (2)$$

Where,
Iph- PV current;
q- Electron Charge;
k- Boltzmann constant;
A-Ideality factor;
Ki- Short circuit Coefficient;
Isc- Short circuit current;
G- Irradiation;
T- Temperature;
Rs- Series resistance;
Rsh- parallel resistance.

A. Designing & Simulation of Solar Photovoltaic(SPV)

For the simulation we are using constant current source for the purpose of solar PV cell and having resistance and capacitance which is connected in between the positive and negative terminal of constant current source. Also voltage measurement is connected to measure the correct output. In this paper the Solar PV DC voltage is nearly about 60 volt which is constant DC voltage taken from Solar PV cell.
Analysis: Take 25◦C as Constant Temperature, Irradiation
Is 1000w/m2, Constant Current Source is applied, Resistance & Capacitance are 1 ohm & 2mF respectively, By applying Voltage Measurement block we get a output Voltage from Solar PV cell is 60.46V. & r = Voc

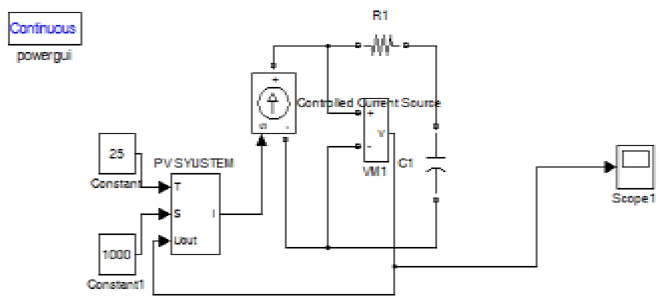


Fig. 3(a) Simulation & Designing of SPV system

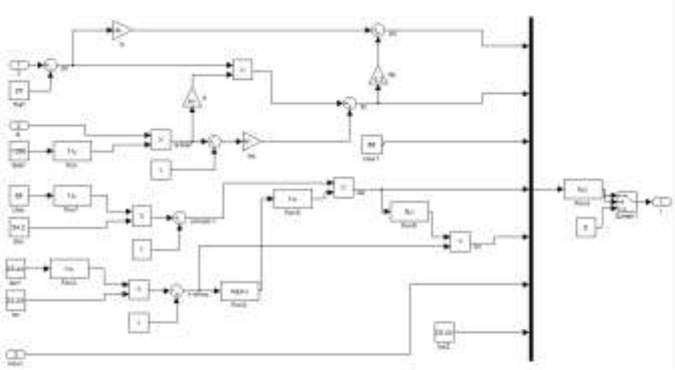


Fig. 3(b) Simulation & Designing of SPV Subsystem

The Equation of Current of Single Solar PV Cell is,

$$I = w \times \{1 - t\left[e^{\left(\frac{u-p}{s\times r}\right)} - 1\right]\} + q \qquad (3)$$

Where,

$$q = \left[\frac{(T - Tref\,)\times S}{Sref}\right] + [\frac{S}{Sref} - 1] \qquad (4)$$

Since,

$$Isc = [\frac{S}{Sref} - 1] \qquad (5)$$

From Equation (3),

Where,

$$p = (T - Tref) + q \qquad (6)$$

$$s = \left(\frac{Vm}{Voc} - 1\right) \times (\frac{1}{\log\left(1-\frac{Im}{Isc}\right)}) \qquad (7)$$

$$t = \left(1 - \frac{Im}{Isc}\right) \times [(\frac{Vm}{Voc} - 1)(\frac{1}{\log\,(1-\frac{Im}{Isc})})] \qquad (8)$$

$$u = Vout \qquad (9)$$

$$w = Isc \qquad (10)$$

& r = Voc (11)

& $r = Voc$ (11)

B. Parameters of SPV

PARAMETERS	*RATINGS*
Maximum power point current	*23.25A*
Maximum power point voltage	*54.2V*
Parallel Resistance	*415.405 ohm*
Series Resistance	*0.221 ohm*
Ideality Factor	*1.3*
Short circuit current	*25.44A*
open circuit Voltage	*66V*
Irradiation	*1000w/m2 at 25 degree Celsius*
Boltzmann constant	*1.38*10^-23*
Electron charge	*1.6*10^-19 C*

IV. BOOST CONVERTER

Boost converters a DC-DC converter that steps up voltage. It is a Step up converter. For the designing of BC diode, Inductor, high frequency switch are the main components of BC require. IGBT require for triggering of thyristors. Adjusting the chopper makes it as boost converter and takes the DC voltage from SPV and make it boosted output which is a pure DC output voltage.

A.Designing & Simulation of Boost Converter(BC)

The BC get boosted by applying the duty ratio as greater than 0.5. When it is separately Simulink the BC taking the assuming input voltage as 280V DC and get it to boost up to 1000V DC. The IGBT is used in a Boost converter. Diode, inductor, resistor, are necessary to connect to form a Chopper. After regulate or adjusting the duty ratio we make it as Boost converter. The RMS value is also being calculated, scope are giving wherever necessary to observing the appropriate output of the step up chopper.

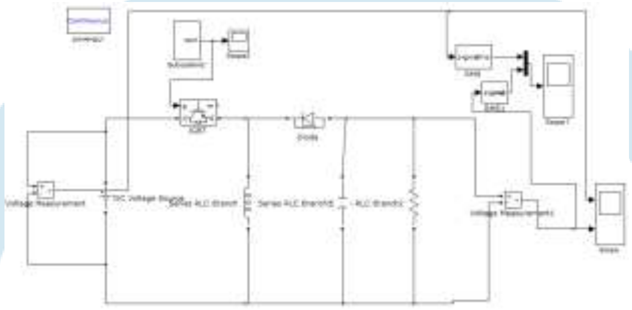


Fig. 4 Simulation & Designing of Boost Converter

V. MAXIMUM POWER POINT TRACKING

MPPT is a technique which is used to increase the efficiency of system, which is applying on a boost converter. Here we use perturb and observer method (P&O method)for simulation purpose. In this method less amount of sensor may be used.

A.Designing & Simulation of Maximum power point Tracking(MPPT)

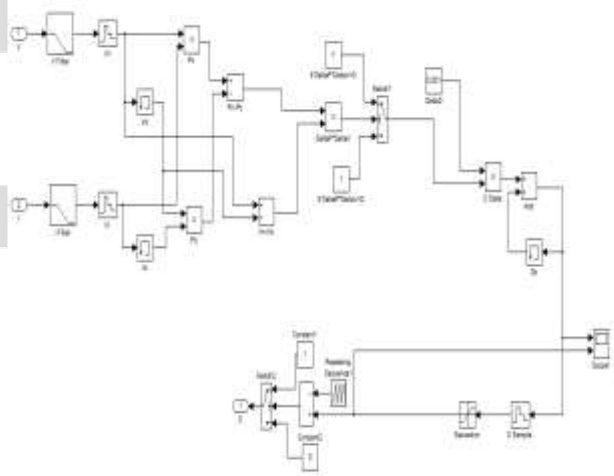


Fig. 5 Simulation of MPPT (Perturb & Observer method)

VI. 3 PHASE INVERTER

The inverters are used to converts dc power into ac power at desired output voltage and frequency. It is a static power electronic ckt. Which converts DC to variable AC. i.e., Variation in magnitude of voltage, frequency and no. of phases. This is a 120 degree phase shift, conduction of each SCR’s is 120 degree. The phase angle between two sequential thyristors either from top group or from bottom group is 120 degree. At any time one of the phases is neither connected to positive plate that particular phase voltage in that interval is uncertain if the load is unbalanced. The waveform of the output voltage depends on the switching states of the switches. The PWM inverters are used in this simulation in this method, a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components. Here we used SPWM technique used to generate balanced 3-phase AC voltage.

Assumptions: Take a DC Voltage Source is 500V, Integrated Gate Bipolar Transistor(IGBT) is applied & take Internal resistance is 1mΩ, Snubber Resistance is 0.1MΩ, Snubber Capacitance is Infinity, Gate Pulses is gives to all IGBT, Voltage Measurement blocks is used to measure the Voltage of Phases.

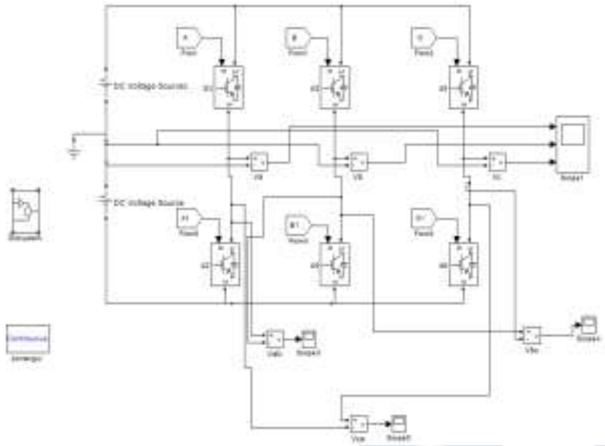


Fig. 6 Simulation of 3 Phase Inverter

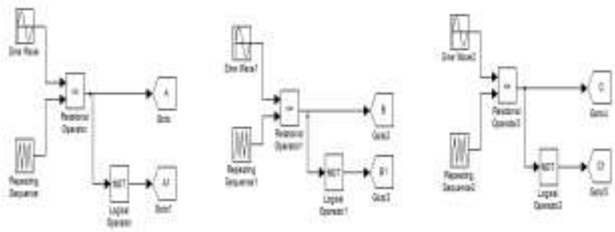
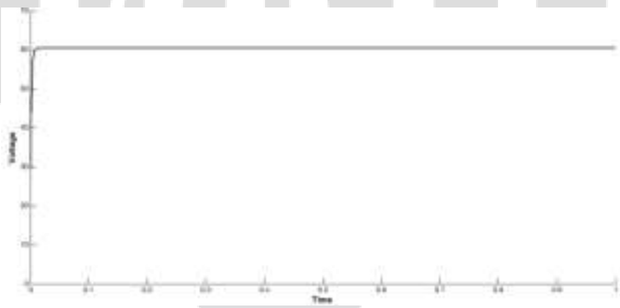


Fig. 7 Gate pulses of 3 Phase Inverter

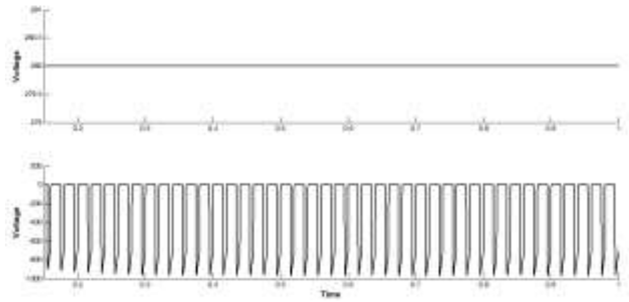
VII. SIMULATION RESULTS

A. *Simulation result of Solar PV (SPV)*



Solar PV output DC voltage is 60V

B. Simulation result of Boost Converter

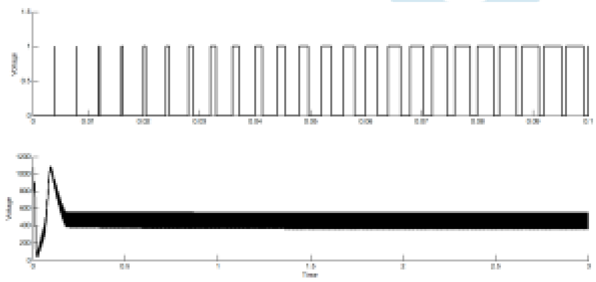


The DC input Voltage is 280V and the RMS Voltage is getting.

PARAMETERS

System Voltage	280 V
Duty Ratio	70%

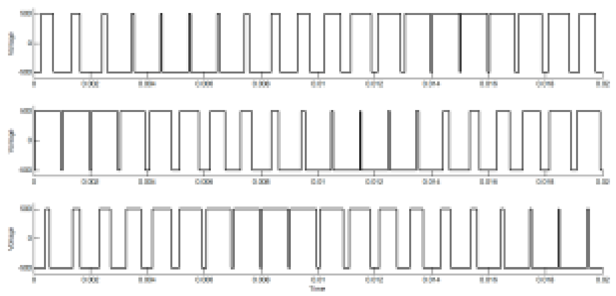
C. Simulation result of MPPT (P&O method)



Duty ratio is varying and adjusted as per the requirement of system as well as the power is getting constant 500W.

Assumptions: Feeding input Voltage & Current from Solar PV, take First-Order Voltage & Current Filter's time Constant is 1ms, Zero-Order hold Voltage(Vn) & Current(In) sample time is 0.1ms, take the Repeating Sequence time Values are [0 4ms 4ms], then Multiply delta P & delta V where delta P having (Pn-Pb) & delta V having (Vn-Vb), Applying two Switches in MPPT, For making D state take Delta D as constant value as 0.001, taking Saturation Value is 0.8 as Upper limit & 0 as lower limit.

D. Simulation result of 3 Phase Inverter

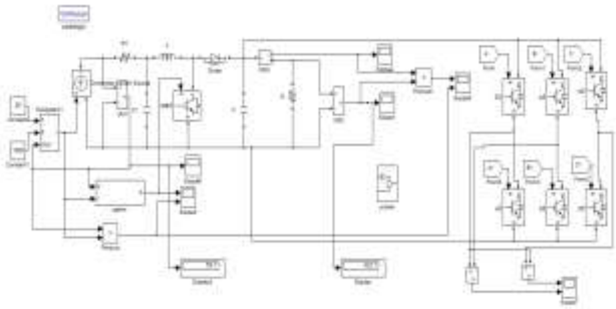


Output Voltage in the range of +500V to -500V

VIII. OVERALL SYNCHRONISED SYSTEM'S SIMULATION

After the total simulation of all parameters and designing the necessary devices for the conversion of DC to AC. After making all designing and simulation work the main task is to synchronize all the component and devices together by combining. Solar PV to boost converter to form boosted output and giving to the input of the 3 phase Inverter.

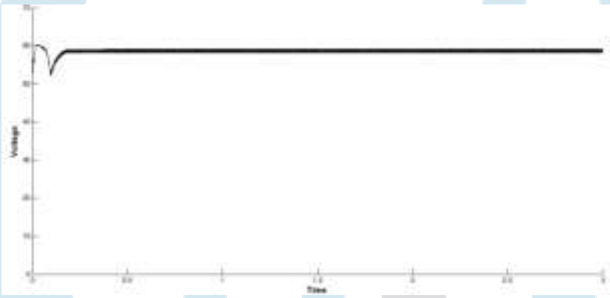
A. Designing and simulation of Synchronised system.



Solar PV 60V DC is converted to AC in the range of -400 to +400.

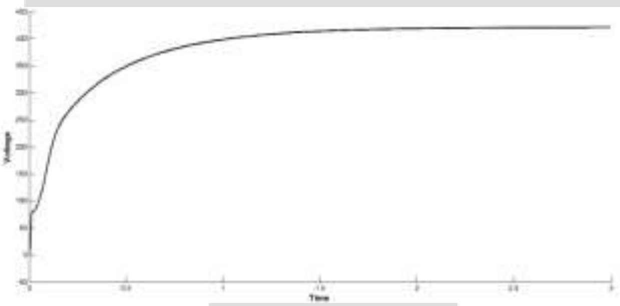
IX. RESULTS OF OVERALL SYNCHRONISED SYSTEM

A.Simulation result of Solar PV(SPV) of overall synchronized system



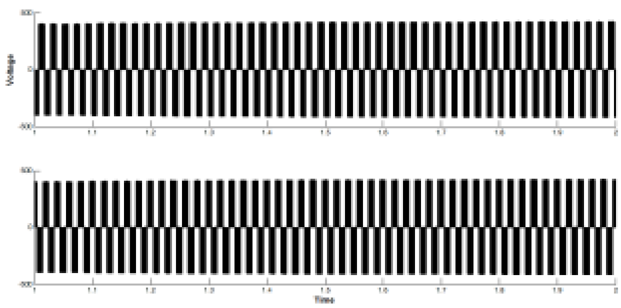
Solar PV having the same approximate 60V DC output

B.Simulation result of Boost Converter of overall synchronized system



Solar PV having the Boosted output approximate at 422V DC.

C.Simulation result of 3 Phase Inverter of overall synchronized system



AC output voltage of 3 phase inverter in between -400v to +400V.

X. CONCLUSION

Before Synchronized

The solar PV output voltage is constant 60V DC then by designing a Boost converter, Boost converter itself the Boosted output is 1000V when it having the input voltage is 280V DC. By the consideration of Solar PV to boost converter, design a 3 phase inverter.

B. After Synchronized

The output of Solar PV voltage is 60V DC and when synchronized with boost converter it get boosted up to 422V DC at that duration the MPPT having the output power is approximately 500W then the boosted output of solar PV is giving to the input of 3 phase inverter and it get conversion to AC up to -400 to +400V AC.

XI. ADDENDUM

In Synchronized System,
Solar PV: Constant Temperature is 25◦C, Irradiation is 1000 w/m2, Open Circuit Voltage (Voc) is 66V, Maximum Voltage is 54.2V, Short Circuit Current is 25.44A, and Maximum Current is 23.25A. Boost Converter: Resistance is 1Ω, Inductance is 0.01H, Capacitance is 2Mf, IGBT for Boost Converter & 3 phase Inverter having Resistance is 0.001Ω, Inductance is 0H, Forward Voltage is 1V, Current 10% fall time is 1µs & tail time is 2µs, Snubber Resistance is 0.1MΩ, Snubber Capacitance is Infinity.

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