A Novel Rectifier for Hybrid Wind and Solar System

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Abstract – *Environmentally friendly solutions are becoming more prominent than ever as a result of concern regarding the state of our deteriorating planet. This paper presents a new system configuration of the front-end rectifier stage for a hybrid wind/photovoltaic energy system. This configuration allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources. The inherent nature of this Cuk-SEPIC fused converter, additional input filters are not necessary to filter out high frequency harmonics. Harmonic content is detrimental for the generator lifespan, heating issues, and efficiency. The fused multi- input rectifier stage also allows Maximum Power Point Tracking (MPPT) to be used to extract maximum power from the wind and sun when it is available. An adaptive MPPT algorithm will be used for the wind system and a standard perturb and observe method will be used for the PV system. Operational analysis of the proposed system will be discussed in this paper. Simulation results are given to highlight the merits of the proposed circuit.*

Keywords*: MPPT- Maximum Power Point Tracking*

I. Introduction

The increase in renewable energy systems with various sources becomes greater than before. There is an enormous need for integrated power converters that are capable of interfacing and controlling several power terminals with low cost and compact structure. Renewable energy sources such as wind, solar, fuel cells hold more potential to meet our energy demand. A large proportion of the world's population lives in remote rural areas that are geographically isolated and sparsely populated. The main advantage of renewable energy over fossil fuels and nuclear power is the absence of harmful emissions, including carbon, sulphur, nitrogen oxides and radioactive products. In this way renewable energy sources do not have the high external cost and social issues of the alternates. Moreover supply and consumption of energy based on conventional fossil fuel is considered as a significant factor of global warming and environmental deterioration. The utilization of natural energy is recognized as a new energy source which will eventually replace conventional energy sources. The concept of hybridizing renewable energy sources is that the base load is to be covered by largest and firmly available renewable sources and other intermittent sources should augment the base load to cover the peak load of an isolated mini electric grid system.

II. HYBRID ENERGY

Hybrid energy system is a photovoltaic array coupled with a wind turbine. This would create more output from the wind turbine during the winter whereas during the summer the solar panels would produce their peak output. In recent years, there has been an increase in the use of renewable energy due to the growing concern over the pollution caused by fossil fuel based energy. Renewable energy sources such as photovoltaic (PV) and wind energy can be used to enhance the safety, reliability and sustainability and transmission efficiency of a power system. Renewable energy resources will be an increasingly important part of power generation in the new millennium. This proposal focuses on control of two major renewable energy sources: Solar and wind energy. Maximum power point tracking (MPPT) algorithm is used for tracking maximum power from solar energy and wind energy.

II.1. Wind Energy

Wind energy is the fastest-growing renewable source of clean energy. It has shown its great potential for combating climatic change, ensuring clean and efficient energy. It can make major contribution towards satisfying the global need for clean and RES. For modeling the energy produced by wind power all components in the system is also to be modeled. First the wind turbine has to be modeled, including the mechanical drive train such as shafts, gearboxes and bearings. Second the electrical machine, permanent magnet synchronous machine is used and connected to a
model of the power electronic devices such as controlled rectifiers or back to back converters (with variable frequency.

II.2. Solar Energy

Photovoltaic (PV) offers an environmentally friendly source of electricity. Worldwide, photovoltaic account for 500 MW of power generation with an annual growth rate greater than 20%. In the near future photovoltaic power is expected to become more cost effective and will be almost price competitive with traditional sources of energy with development and breakthrough in new cell materials and power electronics technologies solar power can prove to be an efficient, environmental friendly and safe means of power. In this module the solar cells is a fundamental power conversion unit of a photovoltaic system.

The maximum power point tracking (MPPT) of the PV output for all sunshine conditions, therefore, becomes a key control in the device operation for successful PV applications. The MPPT control is a challenging control method because the sunshine condition that determines the amount of sun energy into the PV array may change all the time and the current voltage characteristic of PV array is highly nonlinear. Due to the fact that solar and wind energy source is intermittent and quite variable, longitude, latitude, weather and limited daytime should be considered in acquiring electrical energy from PV system and wind turbine system and also it is possible that power fluctuations can be observed since photovoltaic and wind power source is highly dependent on the weather conditions. The main disadvantage of wind turbines is that naturally variable wind speed causes voltage and power fluctuation problems at the load side. The problems in generation of energy can be solved by using appropriate power converters and control strategies.. In the near future using hybrid systems for electricity generation may have more profitable in parallel with the technological advances. Photovoltaic and wind systems are the source of energy in standalone systems. Efficient use of energy is very important, since there is no utility line a battery set becomes essential because energy power is provided in an irregular way from the renewable source leaving aside this issue a power conversion stage is required in order to make sure a good output power quality.

II.3. Block Diagram

The proposed model consists of integrated converter, inverter, and load. The MPPT method is applicable for both wind and solar inputs. Wind and Solar PV sources are modeled separately.

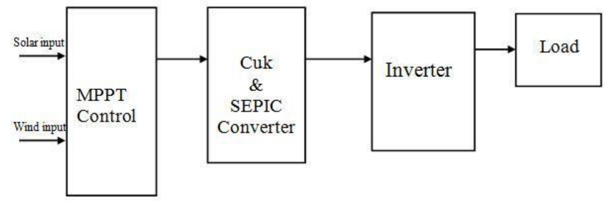

Fig 2.1 Block diagram of the proposed model

When the input from wind is high then the integrated converter acts as Cuk converter. When the input from solar is high then the integrated converter acts as SEPIC converter. The converted voltage is again inverted for applying to the load. The inverter converts dc output to required ac output voltage. The ac output voltage could be fixed at a fixed or variable frequency.

II.4.Over all Circuit Diagram

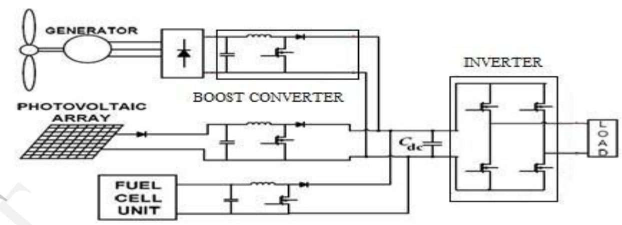

Fig 2.2 Hybrid System with Multi connected boost converter

II 4.1 Integrated Converters

Multi port converters a promising concept for hybrid power sources have attracted increasing research interest recently. Economic aspects of the technologies are sufficiently promising to include them in developing power generation capacity for developing countries. The dc-dc converter inputs an unregulated dc voltage input and outputs a constant or regulated voltage. Dc-dc power converters are employed in a variety of applications including power supplies for personal computers; office equipment spacecraft power systems, laptop computers and telecommunications equipment as well as dc motor drives. The input to a dc-dc converter is an unregulated dc voltage (Vg). The converter produces a regulated output voltage V, having a magnitude (polarity) that differs from Vg. High efficiency is invariably required since cooling of inefficient power converters is difficult and expensive. The ideal dc-dc converter exhibits 100% efficiency in practice efficiencies of 70% to 95% is typically obtained. This is achieved using switched-mode or chopper circuits whose elements dissipate negligible power. Pulse-width modulation (PWM) allows control and regulation of the total output voltage. This approach is also employed in applications involving alternating current including high-efficiency dc-ac power converters (inverters and power amplifiers), ac-ac power converters and some ac-dc power converters (low-harmonic rectifiers). In switching regulator circuits, semiconductor switches control the dynamic transfer of power from input to output with very short transition times. Because of this switching action there is ripple added to output voltage. The output requirement is a dc voltage with a minimum superimposition of ac ripple.

Pulse width modulation (PWM) is the most widely used method for controlling the output voltage. It maintains a constant switching frequency and varies the duty cycle. Duty cycle is defined as the ratio of switch on time to reciprocal of the switching frequency (fsw). Since the switching frequency is fixed, this modulation scheme has a relatively narrow noise spectrum allowing a simple low pass filter to sharply reduce peak-to-peak ripple at output voltage. This requirement is achieved by arranging an inductor and capacitor in the converter in such a manner as to form a low pass filter network. This requires the frequency of low pass filter to be much less than switching frequency (fsw). The Converter is the combination of Cuk and SEPIC converters, the input from the source can be either buck or boosted or stabilized at the particular value and the inductor in circuit further provides the function of filter by reducing harmonics. The cuk and SEPIC converters are used in the proposed model.

II 4.2 Cuk Converters

The Cuk converter is a type of DC-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. The Cuk converter contains inductors in series with the converter input and output ports. The switch network alternately connects a capacitor to the input and output inductors. The conversion ratio M (D) is identical to that of the buck-boost converter. Hence, this converter also inverts the voltage polarity, while either increasing or decreasing the voltage magnitude. Cuk converters are derived from the cascading of buck and boost converters. The Buck, boost and buck-boost converters all these transfer the energy between input and output using the inductor and analysis is based on voltage balance across the inductor. The Cuk converter utilizes capacitive energy transfer and analysis is based on current balance of the capacitor. The circuit diagram of Cuk Converter is shown in fig 1.3.

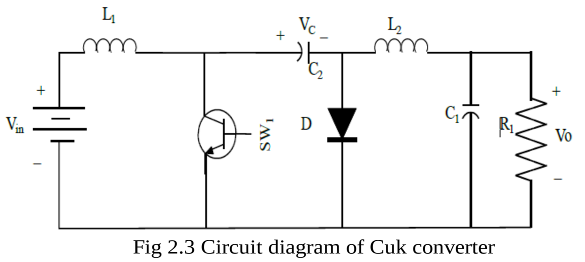

Fig 2.3 Circuit diagram of Cuk converter

A non-isolated Cuk converter comprises two inductors, two capacitors, a switch and a diode. It is an inverting converter so the output voltage is negative with respect to the input voltage. The capacitors are used to transfer energy and are connected alternately to the input and to the output of the converter via the Commutation of the transistor and the diode.

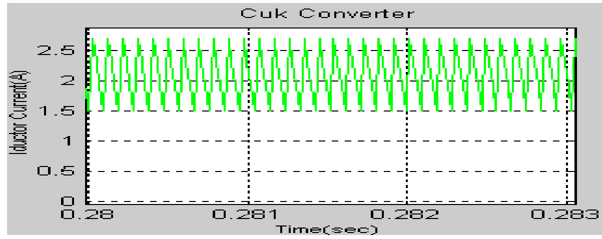

Fig 2.4 Simulation Output of Inductor current characteristics

The diagram shown in fig 3.4 indicates the Cuk converter inductor current waveform. The two inductors L1 and L2 are used to convert the input voltage source (Vi) and the output voltage source (Co) into current sources. Indeed, at a short time scale an inductor can be considered as a current source as it maintains a constant current. This conversion is necessary because if the capacitor were connected directly to the voltage source the current would be limited only by (parasitic) resistance resulting in high energy loss. Charging a capacitor with a current source (the inductor) prevents resistive current limiting and its associated energy loss. As with other converters (buck converter, boost converter, buck-boost converter) the Cuk converter can either operate in continuous or discontinuous current mode. However, these converters can also operate in discontinuous voltage mode (i.e., the voltage across the capacitor drops to zero during the commutation cycle.

II 4.3 Continuous mode

In steady state, the energy stored in the inductors has to remain the same at the beginning and at the end of a commutation cycle. The energy in an inductor is given by:

$$E=1/2LI^2 \quad (1.1)$$

This implies that the current through the inductors has to be the same at the beginning and at the end of the commutation cycle. As the evolution of the current through an inductor is related to the voltage across it.

$$V_L=L\ dI/dt \quad (1.2)$$

The average value of the inductor voltages over a commutation period have to be zero to satisfy the steady-state requirements. The capacitors C and Co are large enough for the voltage ripple across them. In the off-state, inductor L1 is connected in series with Vi and Capacitor.

Therefore

$$V_{L1} = V_i - V_{C.} \quad (1.3)$$

As the diode D is forward biased (with zero voltage drop), L2 is directly connected to the output capacitor.

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Therefore VL2 = Vo. In the on-state, inductor L1 is directly connected to the input source.
Therefore

$V_{L1} = V_i$ (1.4)

Inductor L2 is connected in series with C and the output capacitor so VL2 = Vo + VC .The converter operates in on-state from t=0 to t=DT (D is the duty cycle) and in off state from DT to T (i.e. during a period equal to (1-D) T). The average values of VL1 and VL2 are therefore

$V_{L1}=D.V_i+(1-D).(V_i-V_c)=(V_i-(1-D).V_c)$ (1.5)

$V_{L2}=D(V_0+V_C)+(1-D)-V_0=(V_0+D.V_C)$ (1.6)

As both average voltage have to be zero to satisfy the steady-state conditions the equation can be written as,

$V_c=V_0/D$ (1.7)

So the average voltage across L_1 becomes:

$V_{L1}=(V_i+(1-D).V_0/D)=0$ (1.8)

This can be written as

$V_0/V_i=D/1-D$ (1.9)

II4.4 Discontinuous mode

Much like all DC-DC converters Cuk converters rely on the ability of the inductors in the circuit to provide continuous current, in much the same way a capacitor in a rectifier filter provides continuous voltage. If this inductor is too small or below the critical inductance then the current will be discontinuous.
The minimum inductance is given by:

$L_{1min}=(1-D)^{2R}/2Df_s$ (1.10)

Single-ended primary inductor converter (SEPIC) is a type of DC-DC converter allowing the electrical potential (voltage) at its output to be greater than, less than or equal to that at its input. The output of the SEPIC is controlled by the duty cycle of the control transistor. The SEPIC converters combine the best features of the boost and fly back topologies making it especially advantageous in high applications. In addition, ripple current can be steered away from the input, dramatically reducing input noise filtering requirements.
A SEPIC is similar to a traditional buck-boost converter, but has advantages of having non-inverted output (the output voltage is of the same polarity as the input voltage) the isolation between its input and output (provided by a capacitor in series) and true shutdown mode when the switch is turned off its output drops to 0 V. SEPIC converters are useful in applications in which a battery voltage can be above and below that of the regulator's intended output. The single-ended primary inductance converter (SEPIC) can also either increase or decrease the voltage magnitude. However, it does not invert the polarity. The conversion ratio is M (D) = D/ (1 – D).

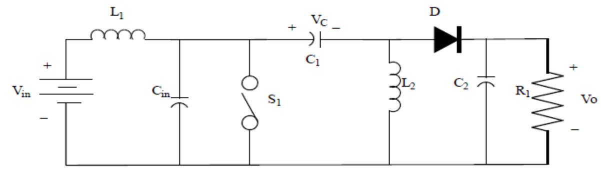

Fig 2.5 Circuit diagram of Sepic converter

The schematic diagram for a basic SEPIC converter is shown in fig 2.5. As with other switched mode power supplies (specifically DC-to-DC converters), the SEPIC exchanges energy between the capacitors and inductors in order to convert from one voltage to another. The amount of energy exchanged is controlled by switch S1, which is typically a transistor such as a MOSFET. MOSFETs offer much higher input impedance and lower voltage drop than bipolar junction transistors (BJTs) and do not require biasing resistors (as MOSFET switching is controlled by differences in voltage rather than a current, as with BJTs). It operates in both continuous and discontinuous mode.

II 4.5Integration of Cuk and Sepic Converters

Hybrid renewable energy systems (RES) are becoming popular for remote area power generation applications due to advances in renewable energy technologies and subsequent rise in prices of petroleum products. A hybrid energy system usually consists of two or more renewable energy sources used together to provide increased system efficiency as well as greater balance in energy supply.

The circuit diagram of the Cuk and Sepic converters are seen in fig 2.3 & 2.5. The integration of these circuits reduces the circuit components and thereby increases circuit efficiency. The fusion of the two converters is achieved by reconfiguring the two existing diodes from each converter and the shared utilization of the Cuk output inductor by the Sepic converter. The fig 2.5 depicts the diagram for converter integration.

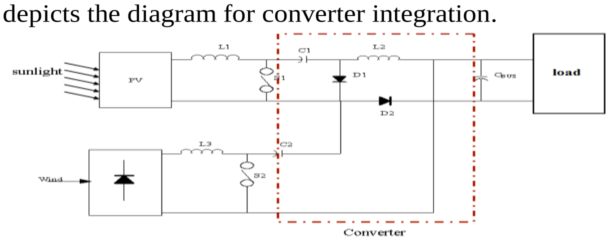

Fig 2.6 Diagram of converter integration

The capacitor CIN is required to reduce the effects of the parasitic inductance and internal resistance of the power supply.The boost/buck capabilities of the SEPIC are possible because of capacitor C_1 and inductor L_2. Inductor L_1 and switch S_1 create a standard boost converter, which generate a voltage (VS_1) that is higher than V_{IN} whose magnitude is determined by the duty cycle of the switch S_1. Since the average voltage across C_1 is V_{IN}, the output voltage (V_O) is $VS_1 - V_{IN}$. If VS_1 is less than double VIN, then the output voltage will be less than the input voltage. If VS_1 is greater than double V_{IN}, then the output voltage will be greater than the input voltage. A SEPIC is said to be in discontinuous-conduction mode (discontinuous mode) if the current through the inductor L_1 is allowed to fall to zero. The voltage drop and switching time of diode D_1 is critical to a SEPIC's reliability and efficiency. The diode's switching time needs to be extremely fast in order to not generate high voltage spikes across the inductors which could cause damage to components. The resistances in the inductors and the capacitors can also have large effects on the converter efficiency and ripple. Inductors with lower series resistance allow less energy to be dissipated as heat resulting in greater efficiency (a larger portion of the input power being transferred to the load). Capacitors with low equivalent series resistance should also be used for C_1 and C_2 to minimize ripple and prevent heat build-up, especially in C_1 where the current is changing direction frequently.

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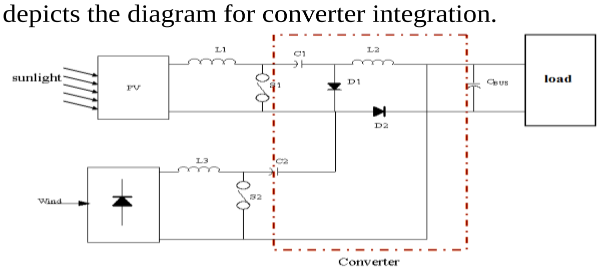


Fig 2.6 Diagram of converter integration

New multi input Cuk-SEPIC rectifier stage additional input filters are not necessary to filter out high frequency harmonics both renewable sources can be stepped up/down (supports wide ranges of PV and wind input). MPPT can be realized for each source i.e. individual and simultaneous operation is supported.

One of the inputs is connected to the output of the PV array and the other input connected to the output of a generator. The fusion of the two converters is achieved by reconfiguring the two existing diodes from each converter and the shared utilization of the Cuk output inductor by the SEPIC converter. This configuration allows each converter to operate normally, individually in the event that one source is unavailable. The diode D_1 turns off and D_2 turns on, the proposed circuit becomes a SEPIC converter. On the other hand, if only the PV source is available, then D_2 turns off and D_1 will always be on and the circuit becomes a Cuk converter. In both cases, both converters have step-up/down capability which provides more design flexibility in the system if duty ratio control is utilized to perform MPPT control. If the turn on duration of S_1 is longer than S_2 the switching sequence can be analyzed. To provide a better explanation, the inductor current waveforms of each switching state are given as follows assuming that $D_2 > D_1$.

The mathematical expression that relates the total output voltage and the two input sources are

$$V_0 V_i = D_1 - D \qquad (1.11)$$

Thus the expression for wind input is shown by replacing Vi as Vw, and for solar PV input, it is shown by replacing Vi as Vpv. Based on the maximum input from the RES the converters operate either as cuk converter or SEPIC converter.

II 4.7 *Maximum Power Point Tracking Method*

A common inherent drawback of wind and PV systems is the intermittent nature of their energy sources. Wind energy is capable of supplying large amounts of power but its presence is highly unpredictable. Solar energy is present throughout the day, but the solar irradiation levels vary due to sun intensity and unpredictable shadows cast by clouds, birds, trees, etc. These drawbacks tend to make these renewable systems inefficient. MPPT process in wind energy conversion system is based on directly adjusting the dc/dc converter duty cycle. To describe a wind turbines power characteristic, equation (2.1) describes the mechanical power that is generated by the wind

$$p = \rho A C_p \, \lambda \, \beta \, v \qquad (1.12)$$

A solar cell is comprised of a P-N junction semiconductor that produces currents via the photovoltaic effect. PV arrays are constructed by placing numerous solar cells connected in series and in parallel. A PV cell is a diode of a large-area forward bias with a photo voltage. There is a particular optimal voltage for each irradiation level that corresponds to maximum output power. Therefore by adjusting the output current (or voltage) of the PV array maximum power from the array can be drawn. The method used to extract maximum power is incremental conductance method.

II 4.8 Incremental conductance

The incremental conductance method is based on comparing the instantaneous panel conductance with the incremental panel conductance. The input impedance of the DC-DC converter is matched with optimum impedance of PV panel. The incremental conductance algorithm is based on the fact that the slope of the curve power vs voltage (current) of the PV module is zero at the MPP, positive (negative) on the left of it and negative (positive) on the right. By comparing the increment of the power vs the increment of the voltage (current) between two consecutives samples, the change in the MPP voltage can be determined. The algorithm uses the fact that the derivative of the output power P with respect to the panel voltage V is equal to zero at the maximum power point. One of the advantages of the Incremental Conductance algorithm is that it does not oscillate around the MPP. The wind power system design must optimize the annual energy capture at a given site. The only operating mode for extracting the maximum energy is to vary the turbine speed with varying wind speed such that at all times the TSR is continuously equal to that required for the maximum power coefficient *C*p

$$dP/dV = IdV/dV + VdI/dV = I + VdI/dV = 0 \qquad (1.13)$$

III. Experimental Result

The permanent magnet synchronous machine (PMSM) is primarily associated with high performance applications and is normally fed by a voltage source inverter (VSI). The machine is of the synchronous type and the rotor field is created by permanent magnets attached to the rotor. The advantage of using permanent magnets in the rotor circuit is that the design of the machine is simplified and that there are virtually no losses in the rotor circuit since the rotor is free of currents. Single-input dc–dc converter topologies that is suitable to be expanded into their multiple input converter versions.

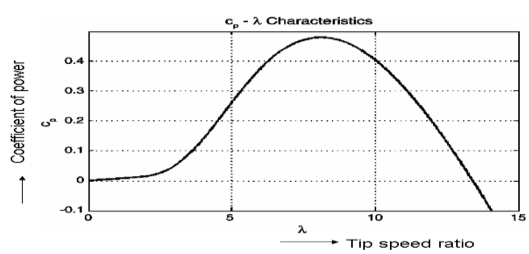


Fig 3.1 Cp Vs lambda characteristics of the wind turbine

The fig 3.1 shows the characteristics of coefficient of power Cp versus lambda value. The maximum value of CP is only 0.47, achieved at a tip speed ratio of 7 which is much less than the Betz limit

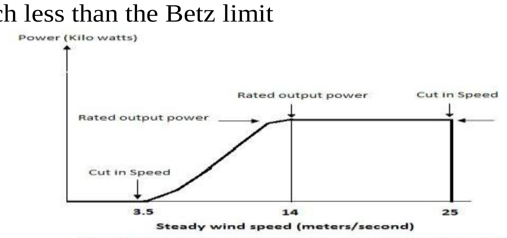


Fig 3.2 Characteristics of turbine speed versus power

The fig 3.2 shows the characteristics of turbine speed referred to generator side versus power. The value of turbine speed increases as the power value increases. The turbine speed is denoted in rpm.

III.1Simulation of Wind Model

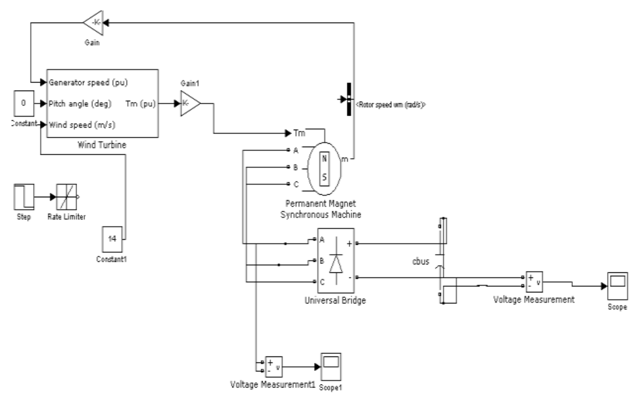


Fig 3.3 Simulation model of wind energy

Permanent Magnet synchronous Generator provides an optimal solution for variable speed wind turbines. The maximum power point for each speed value is traced using Maximum Power Point Tracking (MPPT) algorithm. The rotating speed of permanent-magnet generator should be adjusted to capture maximum wind power.

III.2 Output Voltage of Wind model

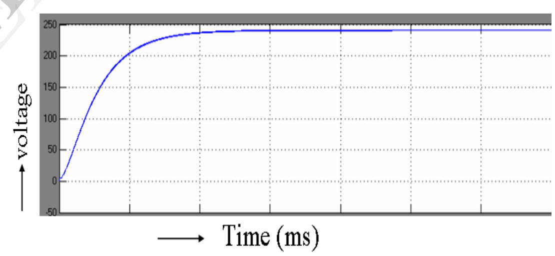


Fig 3.4 Output voltage of the wind model

The Output voltage of wind model is drawn between the Voltage (V) and the Time T(ms).

III.3. Solar Photovoltaic Module

A photovoltaic array (PVA) simulation model is developed using basic circuit equations of the photovoltaic (PV) solar cells including the effects of solar irradiation and temperature changes. The simplified equivalent photovoltaic cell is shown in Fig 3.5

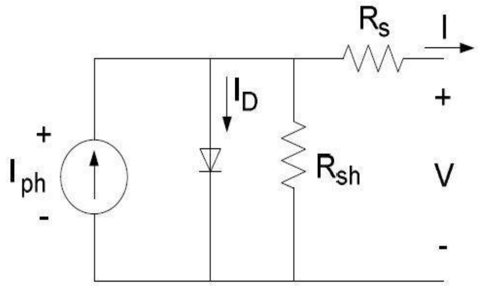


Fig 3.5 Equivalent model for photovoltaic cell

III.4.Simulation of Solar Model

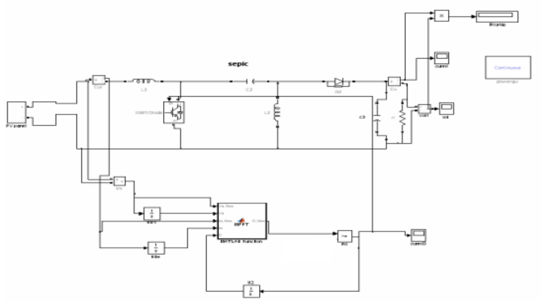


Fig 3.6 Simulation model for solar photovoltaic module

The electric power generated by a photovoltaic panel is unstable according to the irradiation level and the temperature. The amount of power generated by a PV depends on the operating voltage of the array.

III.5.Output Current of Solar Model

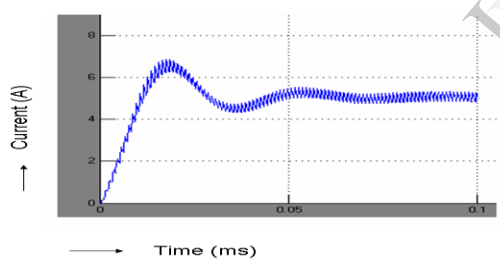


Fig 3.7 Output current for solar model

The combined model of wind and solar panel with integrated converter model is simulated using mat lab Simulink. The electrical system powered by solar arrays requires special design considerations due to varying nature of the solar power generated resulting from unpredictable and sudden changes in weather conditions which change the solar irradiation level as well as the cell operating temperature. In the present proposal, the solar (PV) power system has been proposed with simple technology which can work as a standalone device or as a primary source of hybrid power supply system.

III.5. Simulation of the hybrid wind and solar Model

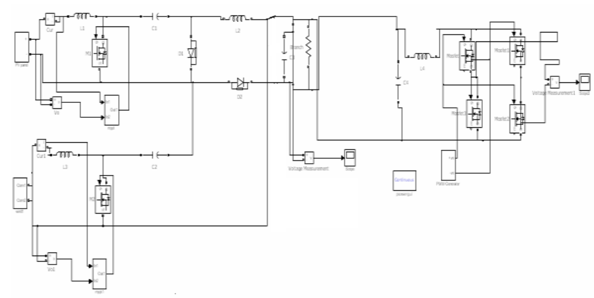


Fig 3.8 Simulation circuit of proposed model.

The output from wind and solar models are given to integrated converter. The integrated converter is a combination of Cuk and SEPIC converter .The fusion of the two converters is achieved by reconfiguring the two existing diodes from each converter and the shared utilization of the Cuk output inductor by the SEPIC converter.

III.6. Output Voltage of the Proposed Model

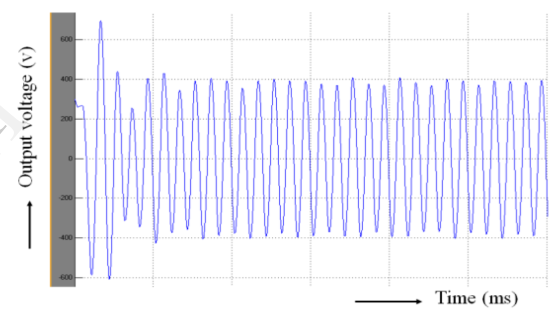


Fig 4.9 Output voltage of proposed model with filter circuit

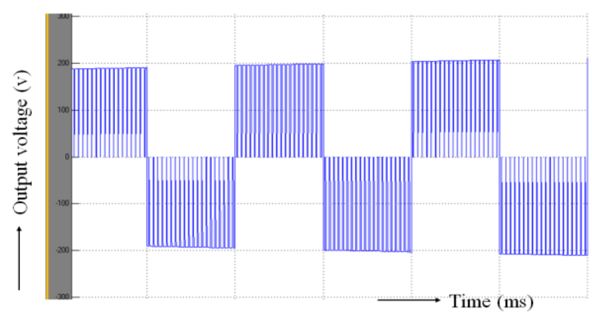


Fig 4.10 Output voltage of proposed model without filter circuit

IV. Hardware Implementation

The module of integrated converter topology consists of

- Power Supply Unit
- Cuk & SEPIC converter circuit
- Driver Circuit
- R-Load

IV.1 Hardware Block Diagram

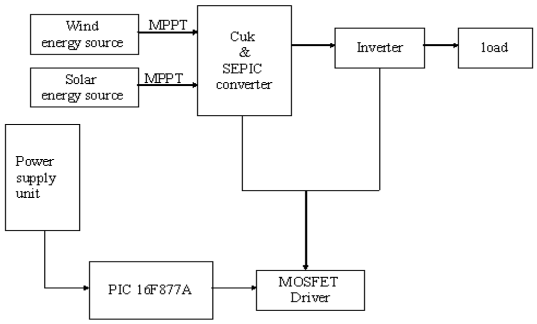


Fig 4.1 Block diagram of the hardware module

Fig 4.1 depicts the block diagram of the hardware module. The RPS is used as one of the input and transformer is used as another input to the integrated converter. MOSFET is used as a switch mainly because of its high thermal resistivity. In addition heat sink is used to reduce heat in MOSFET and regulator. MOSFET acts as a main device in power circuit. In order to control MOSFET control circuit is used. The microcontroller is used for providing controlled pulses to the power circuit. The output from control circuit is not enough to drive the MOSFET so driver circuit is used. The driver circuit acts as an amplifier. The resistive load of 1KΩ is used.

IV.1.1 Power Supply Unit

A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source. The regulating ICs are present in the power supply unit to provide constant source to power and control unit. The freewheeling diodes are present to avoid damage due to dissipation of stored energy. The capacitors are used for filtering purpose.

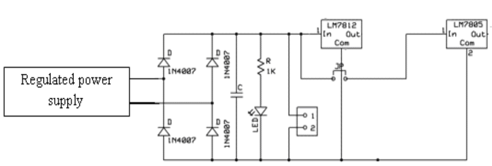


Fig 4.2 Power supply unit

IV.1.2Cuk and Sepic Converter Unit

Cuk and SEPIC converter are designed by using capacitor and inductor. For integrating the converter common capacitor bus is used. When the solar source is alone available then the converter acts as a SEPIC converter and when the wind source is alone available then the converter acts as cuk converter. When both sources are available then the maximum power is tracked by using MPPT algorithm which depends upon the duty cycle of the converters. If the power from solar is maximum then the integrated converter acts as SEPIC converter or if the power from wind is higher than the integrated converter acts as cuk converter. Finally whatever the input sources the integrated converter act based on that and produces constant boosted output.

IV.1.2 Inverter

By using inverter circuit we can convert dc power into ac power at any desired output voltage and frequency. The frequency of the ac output voltage can be fixed at any desired fixed frequency (or) variable frequency. By varying the input dc voltage and maintaining the gain of the inverter constant, the output ac voltage can be changed. In modern times for the conversion from dc-to-ac, thyristor with forced commutation or other controllable turn-on and turn-off devices like BJT, MOSFET, IGBT, MCT, GTO, etc. are used. Many industrial applications require variable voltage, variable frequency supplies.A number of dc power sources such as batteries, dc generators, and rectified power supplies are available. The inverter supplies ac power to the load and it must be capable of cyclically reverse the output voltage. If the load on the inverter circuit is resistive, the output voltage and current waveforms will be square waves.

IV.1.3 Driver Circuit

To turn a power MOSFET on, the gate terminal must be set to a voltage at least 10 volts greater than the source terminal (about 4 volts for logic level MOSFETs). This is comfortably above the Vgs (th) parameter. One feature of power MOSFETs is that they have a large stray capacitance between the gate and the other terminals, Ciss. The effect of this is that when the pulse to the gate terminal arrives, it must first charge this capacitance up before the gate voltage can reach the 10 volts required. The gate terminal then effectively does take current. Therefore the circuit that drives the gate terminal should be capable of supplying a reasonable current so the stray capacitance can be charged up as quickly as possible. The best way to do this is to use a dedicated MOSFET driver chip. There are a lot of MOSFET driver chips available from several companies. Some require the MOSFET source terminal to be grounded (for the lower 2 MOSFETs in a full bridge or just a simple switching circuit). Some can drive a MOSFET with the source at a higher voltage. These have an on-chip charge pump, which means they can generate the 22 volts required to turn the upper MOSFET in a full bridge on. The TDA340 even controls the switching sequence for you. Some can supply as much as 6 Amps current as a very short pulse to charge up the stray gate capacitance. The IR2110 is high voltage, high speed power MOSFET driver with independent high and low side referenced output channels.

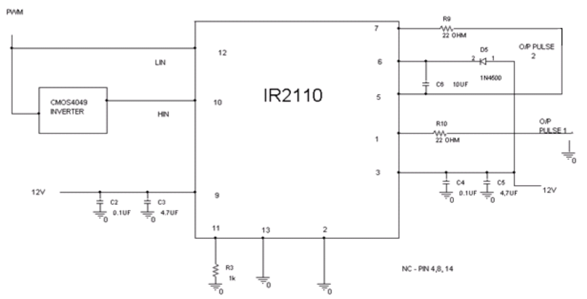


Fig 4.3 Design of driver circuit

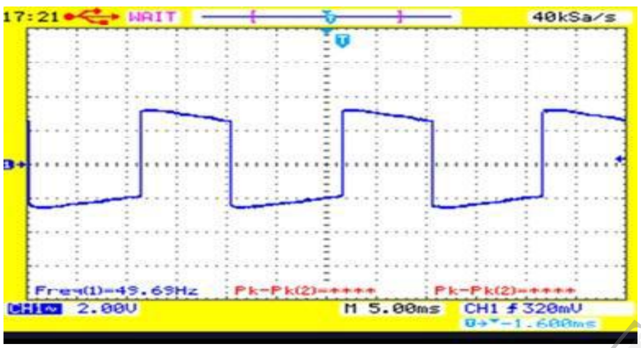


Fig4.4 Wind Output Characteristics

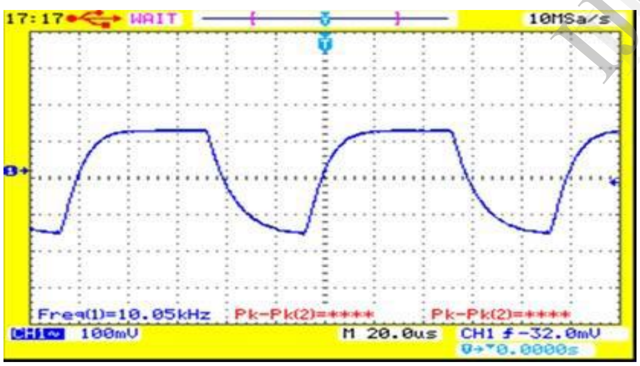
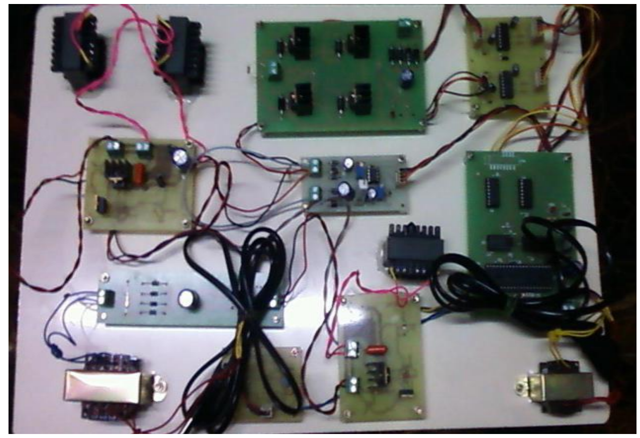


Fig.4.5Solar Output Characteristics

IV.2.Hardware Module



V. Conclusion

The separate converters are integrated in order to minimize the circuit components and to improve the circuit efficiency. The simple and most efficient integrated converter has been proposed for the hybrid RES.MPPT can be realized for each source individual and simultaneous operation is supported. Accurate models for alternate energy sources, such as wind turbine, and photovoltaic, to form a hybrid energy system and offering a low cost wind energy system using permanent magnet generator .This proposed model reduces the filtering components. The system is flexible to be quickly adapted and optimized for various applications. The advantages of MPPT algorithm are robustness and they are easy to implement when compared to the several maximum power point tracking methods available. Hybrid generation system takes a different merit that the wind-PV power naturally complements one another to certain amount, there by facilitating continuous output power for full day.

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