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Design Of Portable Stand-Alone Micro Inverter For Micro Load & Emergency Applications

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ABSTRACT - Nowadays there is no power supply to our homes for many numbers of days due to natural calamities. This requires a technology that may run the tube lights and fans, by using battery means and so there will be no darkness at any areas and anytime. Normally inverters in combination with battery are used as backup power. But these inverters are larger in size and weight. Also, the efficiency of inverters is about 60% only and with the upcoming technologies we can minimize the size, with an increase in the efficiency of the inverters greatly. Micro inverter is the key for next generation inverters. They are in the size of a person‟s palm and weighs less than 2kg. They have an efficiency of about 95% and can be used anywhere, even with the help of bike or car batteries. One micro inverter has the capacity to supply 200Watts which is enough to supply the basic equipment in our house.

Keywords: interleaved-flyback converter, micro inverter, Solar PV array.

1. INTRODUCTION

The inverters we use today have high power supply capacity but with less efficiency. These are larger in size and weight. So they cannot be carried easily. Normal inverters have a Alternate Current (AC) to Direct current (DC) converter a battery and a DC to AC inverter [1-3]. Since there are many switching devices used their efficiency is greatly reduced. Thus they have only about 60% efficiency [4]. The micro inverters which are used in solar powered grid connected system can be used as backup power for homes. In grid connected system there is interleaved transformer. But in this proposed design we have a stand-alone fly back transformer. The DC to AC converter is replaced with the fly back transformer. Thus the switching loses is neglected. The transformer steps up the voltage provided by the battery. The DC to AC converter used here is half bridge rectifier. Since there is few switches are used the efficiency is not affected much. Thus this inverter will have a efficiency of about 95%. Due to the use of fly back transformer the size of the inverter is reduced greatly [5-6]. The grid connected micro inverters are used to draw power from the Solar panels and supply it to the grid [7-9]. From each solar panels used a micro inverter is attached to it. Each micro inverter will have interleaved flyback transformer. DC power generated by solar panel is converted to AC by the micro inverter. Thus individually each and every panel generates a AC power. Since every panel are connected to the grid each micro inverter should generate same output [10]. The Fig 1. shows the micro inverter in single solar panel.

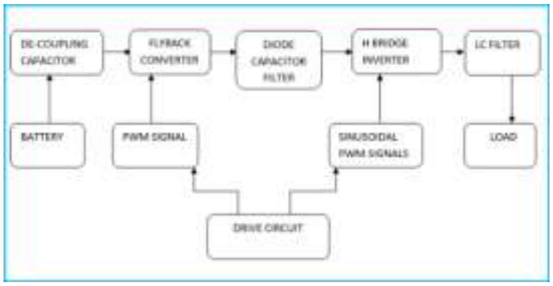


Fig 1.Block diagram of an existing flyback converter fed H-Bridge inverter

2. FLYBACK CONVERTE

Fly-back converter is the most used Switched Mode Power Supply (SMPS) circuit for low commonly output power applications where the output voltage needs to be isolated from the input main supply. The output power of fly-back type SMPS networks may vary from few watts of less than 100 watts. The entire network topology of this converter is significantly modest than other SMPS circuits. Input to this circuit is usually an free DC voltage obtained by correcting the benefit AC voltage charted by a simple capacitor filter. This network can provide unity or multiple secluded output voltages and can function over wide range of input voltage deviation. In regard of energy-efficiency, fly-back power supplies are substandard to many other SMPS network but it‟s simple circuit topology and low cost makes it unique in low output power range. The commonly used fly-back converter requires a single controllable switch like, IGBT. A two-switch topology circuit that offers improved energy efficiency and less voltage stress across the switches but it costs more and the circuit complexity is also increases slightly. It has high conversion ratio, the output power is high, it can reduce the switching loss and has high conversion efficiency. It is used for High-power applications, Alternative energy for the applications.

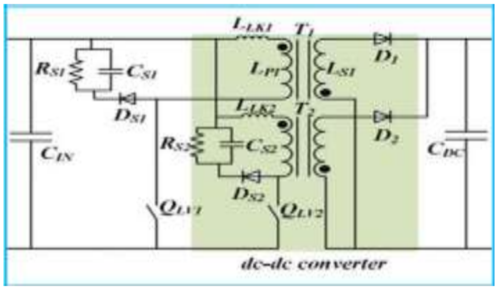


Fig 2. Interleaved fly back converter

The pulse width modulation technique is applied to control the output voltage of the inverter which is also known as variable duty cycle regulation as shown in Fig 6. Generation of the preferred output voltage is attained by relating the desired oriented waveform (modulating signal) with a higher- frequency triangular „carrier" wave as

portrayed schematically. Depending on the signal voltage , whether it is large or small ,the carrier wave form can either be positive or negative. DC bus voltage measured at the output. Note that ,over an area of one triangle wave, the average energy applied to the load is proportional to the amplitude of the signal (assumed constant) at this period. The resulting sliced square waveform comprises a duplication of the preferred waveform in the low frequency components, with the higher frequency components being at frequencies of a close to the carrier frequency. Notice that the Root Mean Square (RMS) value of the AC voltage waveform is still equal to the DC bus voltage, and hence the THD is not affected by the Pulse Width Modulation

(PWM) process. The harmonical constituents are just lifted into a higher frequency range and are repeatedly strained due to inductances in the AC system. When the modulating signal is a sinusoid of amplitude Am, and the amplitude of the triangular carrier is (Ac), the ratio (m=Am/Ac) is known as the modulation index. Note that on operating modulation index can control the amplitude of the related output voltage. PWM amplifier can

run in cool condition than the usual lined

power amplifiers, which requires considerably less heat sink mass. At around

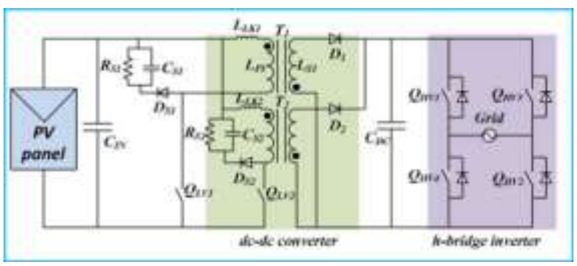
90% efficiciency, PWM makes electromagnetic wave viable at power levels where hydraulics used as the only option.

3. PROPOSED SYSTEM

The fig 2. shows working principle of grid connected micro inverter .The simple structure of the flyback topology and easy power flow control with high power quality at the grid are the key motivations for this work. The flyback converter is renowned as the lowest cost converter among the secluded topologies since it uses the least number of components. Instead of interleaved flyback transformer, in this proposed system we use stand-alone flyback transformer. Flyback transformer is used to attain the high step up voltage gain. This portable stand-alone micro inverter is designed to use for homes when there is no power supply. The source for this inverter is battery which can be from one which is in bike.

The major advantage of this type of inverter is that they are very less in weight and also in size. Since the battery used is from the bike it can charged simply by starting the bike. The inverters works until the battery is charged. This is not connected to the grid. The output power supplied by it is used for the home appliances. The maximum power a stand-alone micro inverter can give is 200W. The Fig 3. Shown here explains the circuit diagram of the model.

Fig 3.Grid connected interleaved fly back micro inverter



The battery energy is applied to the flyback converter through a decoupling capacitor. The fly back converter uses a metal–oxide–

semiconductor field-effect transistor (MOSFET) for switching at the primary side, a flyback transformer, and a diode at the secondary side. The topology also has to employ a H-bridge inverter and a low-pass filter for proper interface to the grid. When the flyback switch (S1) is turned ON, a current flow from the common point (the PV source) into the magnetizing inductance of the flyback transformer, and energy is stored in the form of magnetic field. During the on time of the switch, no current flows to the output due to the position of the secondary side diode; therefore, energy to the grid is supplied by the capacitor (Cf) and the inductor (Lf).

When the flyback switch is turned OFF, the energy stored in the magnetizing inductance is transferred into the grid in the form of current. Due to this reason the flyback inverter can acts as the voltage-controlled current sources. The Discontinuous Conduction Mode (DCM), operation of converter under open-loop control produces triangular current pulses at every switching period. If Sinusoidal Pulse Width Modulation (SPWM) method is used for control, the inverter will regulate these current pulses into a sinusoidal current in phase with the grid voltage. The H-bridge inverter is only responsible for unfolding the sinusoidally modulated dc current packs into ac at the right moment. Since the switches of the inverter are operated at the normal frequency, the switching losses are insignificant as shown in fig 4. Only conduction losses are concerned. Due to this reason, the bridge can use the thyristor or even transistor switches for less cost. However, for easy control also theavailability in the laboratory for fast prototyping, we prefer using insulated-gate bipolar transistor (IGBT) switches for this design. The low-pass filter after the IGBT inverter is responsible for supplying a current with low Total Hormonic Distortion (THD) by removing the high frequency harmonics of the pulsed current waveforms.

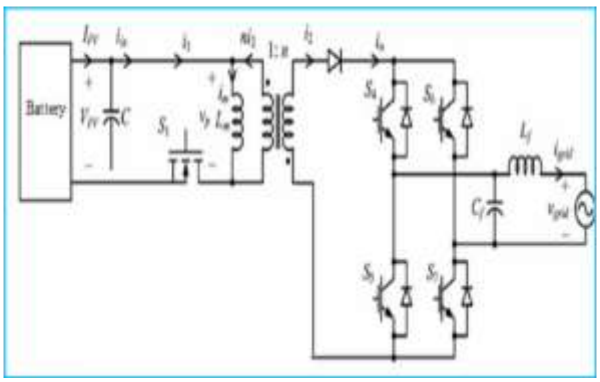
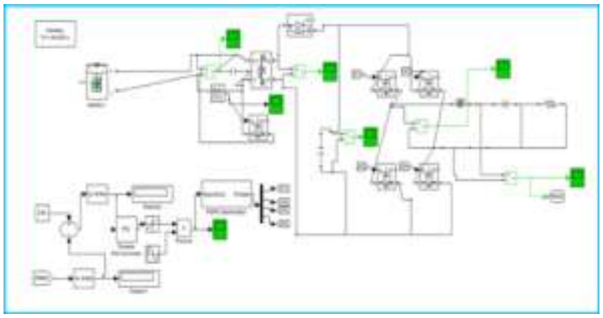


Fig 4. Circuit diagram

Fig 5. Sinusoidal DC wave form

4. SIMULATION RESULTS

The Fig 6. Shows the simulation for our proposed model. Sim Power Systems customs the Simulink circumstances, admitting us to form a model using the simple click and drag procedures. Not only can you draw the circuit topology rapidly, but your analysis of the circuit can include its interactions with mechanical, thermal, control, and other disciplines.



The fig 7 Shows the primary winding MOSFET‟S pulse and is needed for increasing the efficiency. The fig 8. Shows the power after MOSFET switching.

Fig 6**.** Simulation for proposed model

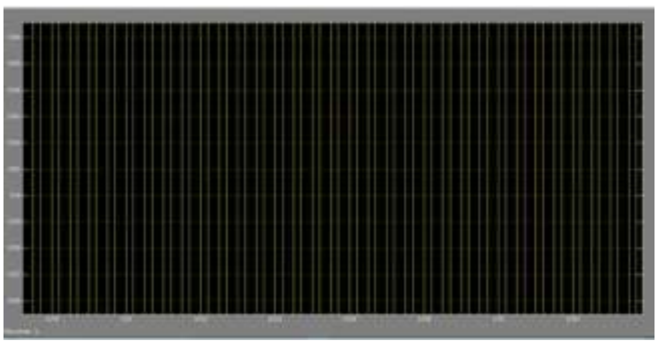


Fig 7.Pulse for primary winding MOSFET

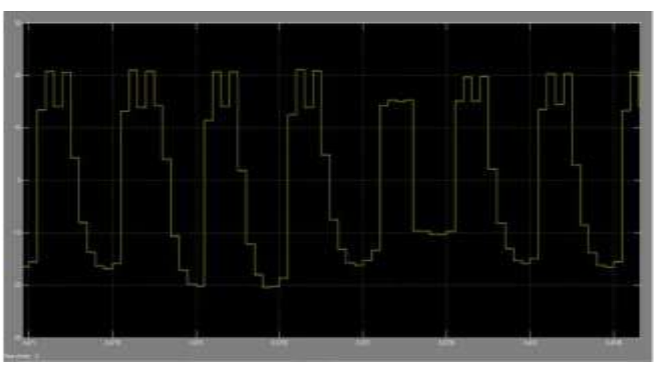


Fig 8. Power after MOSFET switching

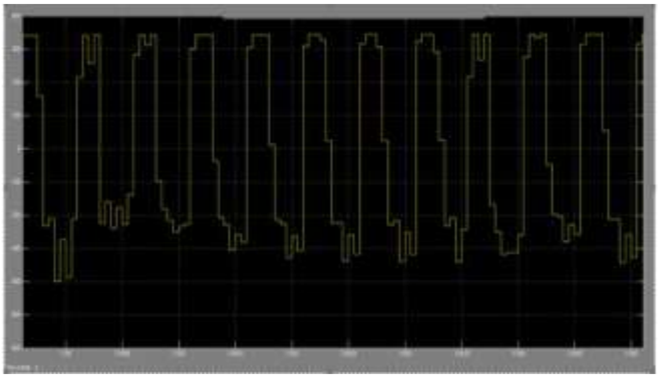


Fig 9. Transformer output without filter

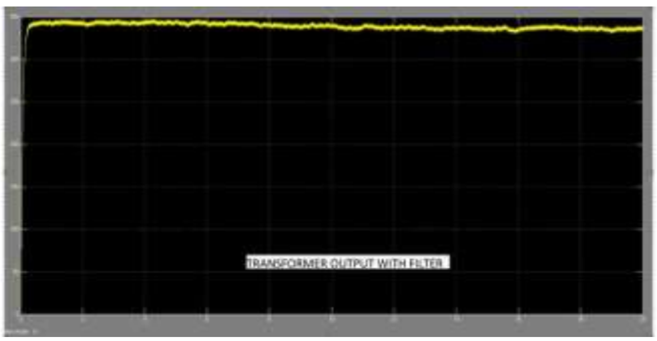


Fig 10. Transformer output with filter

The fig 9. Shows the transformer output without filter and the fig 10. Shows the

output of the transformer with filter. The sine wave pulse of transformer is showed in the Fig 11. The final output obtained by the H-bridgeInverter is clearly shown in Fig 12. The fig.13. displays the analysis of FFT.

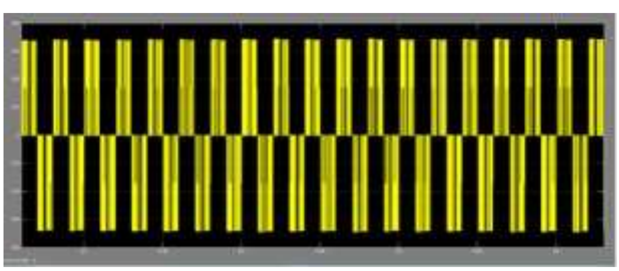


Fig11. Output of h-bridge and input to PID

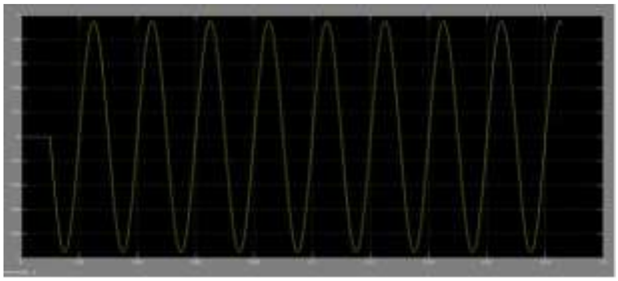


Fig12. Final output from H bridge Inverter

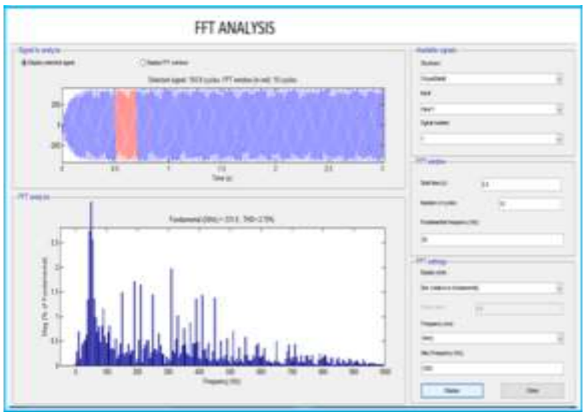


Fig 10. FFT analysis

5. CONCLUSION

A flyback converter based portable stand-alone micro inverter is designed and simulation results are verified. The flyback topology is designated for its simplicity structure and easy to control of power flow with high power quality outputs. During natural calamities this micro inverter can be used from the bike battery to supply some of our equipment in our home without AC supply to charge the battery.

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