DESIGN AND DEVELOPMENT OF POWER INVERTER USING COMBINATIONAL SWITCHES FOR IMPROVEMENT OF EFFICIENCY AT LIGHT LOADS

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ABSTRACT

For standalone residential power system Inverters are designed using peak load capacity keeping in mind. The efficiency of such inverter on light load is low. The efficiency of inverter can be improved in light load condition using switch combination in inverter. A comparative analysis of using different individual switching and combination devices will be carried out for specific load. A hardware realization of inverter for a specific capacity using most efficient switch combination will be done.

Keyword:- *Microcontroller, Inverter, high efficiency*

1. INTRODUCTION

Power available from renewable energy sources such as solar panels and fuel cells is DC and needs to be transformed to conditioned AC for residential use. A power conditioning system (PCS) is employed for this transformation. The PCS is generally composed of a front-end DC-DC converter and a power inverter. DC-DC converters provide a constant high voltage DC link for the inverter input. Typically inverters are designed for peak power requirements and optimized for a certain operating point. However, in a stand-alone residential house electrical demand is highly dynamic and stays at low power levels (below 500W) about 20 hours in a day Thus, residential electrical demand characteristics must be taken into account in the inverter design and control stages in stand-alone applications.

In this study, the use of a parallel switch combination, referred as hybrid switch, is analyzed for efficiency improvement at light load conditions. A half-bridge inverter with hybrid switch is experimentally evaluated in terms of efficiency. Since the power inverter will operate at light loads most of its operation life in the stand alone residential applications, improved light load efficiency will result in more efficient use of limited sources and considerable energy savings. For example, this will mean hydrogen savings for fuel cell powered residential systems and less solar panel area for solar powered residential systems.

2. LITERATURE SURVEY

The literature survey carried out related to the study of improving efficiency of inverter **K. Hoffmann [1]** This paper provides simulation and measurement demonstrate that the conducting power losses of power converters can be minimized by the parallel connection of corresponding IGBTs and MOSFETs. For this, four different IGBT-types were analysed together with a super junction MOSFET. Concerning the cost of materials the amount of total

silicon was not increased compared to the parallel operation of two MOSFETs. It has been found out that the current sharing between unipolar and bipolar semiconductor strongly depends on several parameters. The chosen MOSFET and IGBT types and their conducting characteristics are very important.

J. Karst [2] In this paper provides the hybrid combination of MOSFET and IGBT connected in parallel has been revisited in case of hard switching. Due to improvements in semiconductor performance concerning both IGBTs and MOSFETs a switching frequency region has been identified in which the usage of the proposed hybrid switch can be advantageous at no extra cost.

M. Soja [3] This paper provides the appropriate design procedures and methods and usage of modern powerful switches in the power and digital components in control part, it is possible to improve the efficiency of power electronics converters. The complete analysis of converter losses allows to understand of their origin and points on possible direction of improving efficiency.

3. METHODS FOR EFFICIENCY IMPROVING

1. Optimal topology selection
2. Design optimization
3. Efficiency optimization by digital control
4. Parallel connection of converters with the proper turn ON/OFF strategy

1. Optimal topology selection

Choosing the right topology requires detailed knowledge of all the available choice. There are many well known circuits that fit certain applications well, but to find the best solution for given application is needed to understand how to choice of topology may affect the key parameters, cost, overall size, EMC performance and efficiency. Each topology have to be evaluated in two stage: firstly for most important and then for less important characteristics.

2. Design optimization

Converter design optimization is reduced to defining the objective function (efficiency, price and etc or a combination of them) and finding its max/min. Defining the objective function means finding a mathematical dependency (efficiency) of all relevant variables in the system. The converter efficiency decisively influence the switching frequency and characteristics of semiconductor switches.

3. Efficiency optimization by digital control

The application of digital control brought new opportunities for improving power converters efficiency. Particularly interesting for the application of digital system is multiphase control which is now widely applied to power supply converter for microprocessors.

4. Improving efficiency by parallel connected converter

Power converter efficiency improving bring concept based on the parallel connection of multiple converter with the appropriate turn ON/OFF strategy.

4. SYSTEM DESCRIPTION

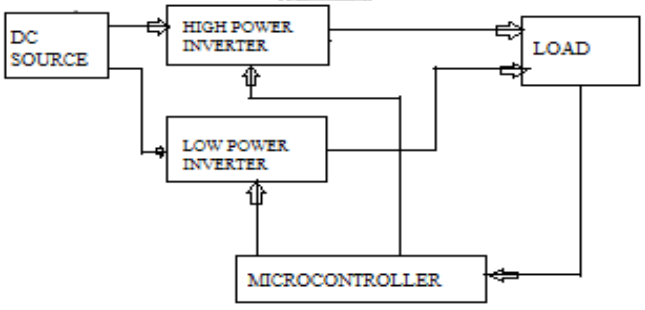

Figure 1 System Block Diagram

DC input source is connected to the both inverter which are connected in parallel. One of these low power inverter (< 100W) and another is high power inverter (< 500 W). The load is directly connected to the inverter output. Microcontroller is the heart of the control system. According the load demand controller decide which inverter comes in operation. It is helpful for increasing the efficiency of inverter. Controller sense the output power and give command to the inverter to operate. When the requirement of output is low then the controller gives signal to low power inverter and if output is increased then controller switch the inverter from low power to high power inverter. The switching of inverter is done by the controller and because this the efficiency of the inverter is increases.

5. RESIDENTIAL ELECTRICAL DEMAND

A residential system for a 2 BHK apartment is considered for the study. The details of the loads included are shown below in table 1.

Table 1 Load calculation for a Residential System

Sr. No.	Specification	Quantity	Wattage	Total
1	Fluorescent lights	6	30	180
2	Fan	5	50	250
3	Refrigerator	1	500	500
4	Computers	1	375	375
5	Iron	1	1000	1000
6	Microwave Oven	1	800	800
7	Blender	1	300	300
8	Washing Machine	1	500	500
9	CD Player	1	30	30
Total Peak Demand = 5 KW				

The measurements give us clear picture of residential electrical demand characteristics. The histogram of residential electrical demand over a day is shown in Figure 2. As seen, while the maximum demand is around 5 kW, power demands between 0-500 W constitutes about 85% of the daily demand, which corresponds to about 20 hours in day.

Considering the demand characteristics, a power inverter designed and optimized for operating at a certain power level will not be a good choice for renewable energy supplied stand-alone residential house. A typical efficiency curve of an inverter is shown in Figure 3. As seen, the inverter efficiency is low at light load condition and if the light load efficiency can be improved, more efficient use of renewable energy sources could be achieved.

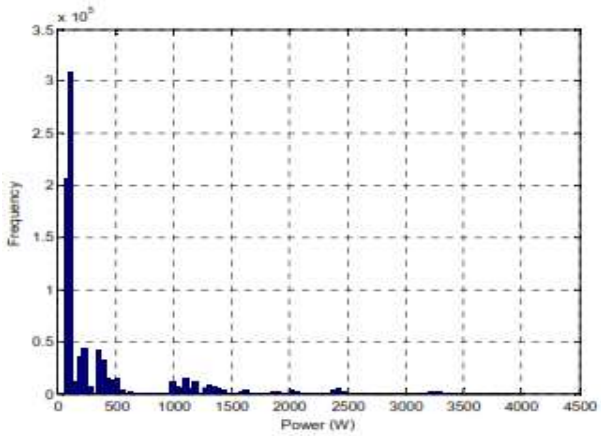

Figure 2 Histogram of the daily residential electrical power demand

A parallel switch combination is proposed to improve light load efficiency of the inverter in a stand-alone renewable energy supplied residential power system. Only one of switches will be active based on instantaneous load current feedback in the proposed hybrid switch.

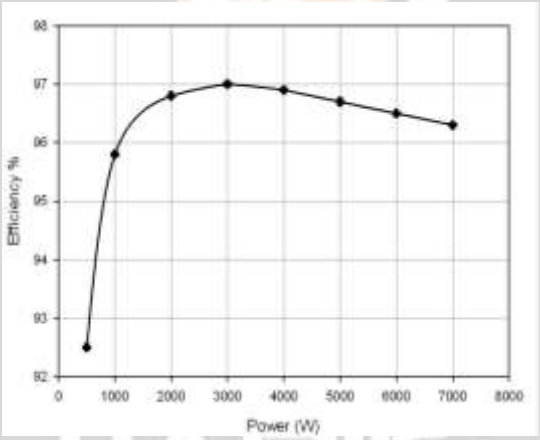

Figure 3 Typical efficiency curve of an inverter

6. CONCLUSION

In this paper method of efficiency improvement is clearly define. According to residential demand parallel switch inverter is better to use for the light load to improve the efficiency.

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8. REFERENCE

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