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Hardware Implementation of Grey Wolf based Optimization Framework to Reduce Power Loss inForward Converter Transformer

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Abstract : Power converters are required to connect local renewable energy sources to electrical loads and storage elements and connect several microgrids or nanogrids to the main power grid. These converters have asignificant impact on the overall system's efficiency, reliability, cost, and dynamic performance. As a result, improving reliability and optimizing losses in the converter are desirable. Hence, in this proposed work, a novel Grey Wolf-based Boosting Intelligent Framework (GWbBIF) control algorithm is used to improve power system reliability through the incorporation of a forward converter at the system level. The planned work has been carried out with the help of the MATLAB/Simulink program. The simulation results will be confirmed throughhardware implementation, and then compared to traditional methods to determine the significance of the proposed method. Over conventional methods, the projected method achieved lower THD, reduced powerloss, and reduced error percentage. As a result of the overall performance analysis, the proposed GWbBIF method is more appropriate for the forward convertor coordination system.

Keywords— Forward Converter, Grey Wolf-based BoostingIntelligent Framework (GWbBIF), MATLAB

I. INTRODUCTION

Recently, there has been a surge in interest in modernizing electrical energy generation systems to provide a sustainable energy supply while reducing greenhouse gas emissions and alleviating concerns about global warming. The need for environmentally friendly power generation systems has resulted in new and emerging concepts in electrical power generation, transmission, distribution, storage, and consumption. This new paradigm is altering how the electrical grid is envisioned. Power grid modernization includes increasing the penetration of both centralized and distributed renewable energy sources, incorporating grid energy storage, and allowing electric vehicles to plug in and out of the grid. Increased integration of renewable energy into the utility grid, as well as the use of battery energy storage systems and microgrids or nanogrids, is critical in meeting the new challenges. Power converters are required to connect local renewable energy sources to electrical loads and storage elements and connect several microgrids or nanogrids to the main power grid. These converters have a significant impact on the overall system's efficiency, reliability, cost, and dynamic performance.

The growing popularity of renewable energy sources (RESs) such as uninterruptible power supplies (UPSs), wind turbines, and photovoltaics has increased the demand for DC-DC power converters. Furthermore, the smart design of the power system frame incorporates solar photovoltaic renewable energy sources. The primary reason for developing a reliability estimation framework in power electronics applications is to improve system- level performance. The forward converter is a more efficient paradigm in power systems thanother conventional converters. These converters consist of high- speed switching devices that are primarily used in transformer applications. In such kind of isolated topologies there arise the problem of transformer core saturation. This problem is tackled either by oversizing the transformer or applying the maximum duty cycle at minimum input voltage which reduces the converter efficiency. Hence, in this proposed work, a novel Grey Wolf-based Boosting Intelligent Framework (GWbBIF) control algorithm is used to improve power system reliability through the incorporation of a forwarding converter at the system level. The planned work has been carried out with the help of the MATLAB/Simulink program. The simulation results will be confirmed through hardware implementation, and then compared to traditional methods to determine the significance of the proposed method.

II. NECESSITY

It is essential to study the power converters' behavior in detail aiming to design the best hardware and software solution able to improve their performance and efficiency. The efficiency evaluation of a power electronic converter, even if it is fundamental for designing better hardware and software (controller) solutions, is always a very expensive activity (both in terms of time and resources) to conduct. In this context, power electronics converter losses evaluation studies are becoming always more and more important to reduce power electronics converters losses, zero voltage and zero current switching topologies have been developed.

Conduction losses on power electronics switching devices happen because, during the conductionperiod, switching devices do not behave as an idealswitch (zero on-state resistance and zero voltage drops). Indeed, they have on-state resistance and an amount off or ward voltage drop on the device, most of the power is in the MOSFET gate driver. Gate drive losses are frequency-dependent and are also a function of the gate capacitance of the MOSFETs. When turning the MOSFET on and off, the higher the switching frequency, the higher the gate-drive losses. This is another reason why efficiency goes down as the switching frequency goes up. PWM, switching at fixed cycles even during a light load, can be low inefficiency. Switching losses can be reduced byeither soft switching techniques or by modifying modulation technique employing space vector-based PWM techniques or sinusoidal PWM-based techniques. To avoid excessive temperature rise heat sinking in the inner layers is often more effective than heat dissipation in the component layers. Connecting thermal via to copper that is connected to the device power or return pins will achieve heat sinking. These via will then connect to copper planes underneath the IC, increasing the effective copper area for heatsinking.

The proposed work is to overcome the design problems in conventional methods whichcause these above losses. Reduction of these losses will increase reliability and stability of converter. And use of GWbBIF algorithm will give more enhanced output.

III. OBJECTIVE

1. To use a novel GWbBIF method in MATLABFrame.
2. To practically implement the forward converter.
3. To verify the proposed outcomes by comparingit with practical results.

IV. SCOPE

The usage of conventional power converters in transformers often causes power faults, so that system can shutdown at any time. Also, the fault in converters needs more power to execute the transformer function. Thus, the computational cost and loss of power is maximized this leads to poor transformer performance.

The scope of this project is to minimize the transformer power loss and to improve the stability range of forward converter. To estimate the system reliability and transformer power loss optimization using a novel GWbBIF frame work.

V. Hardware Implementation

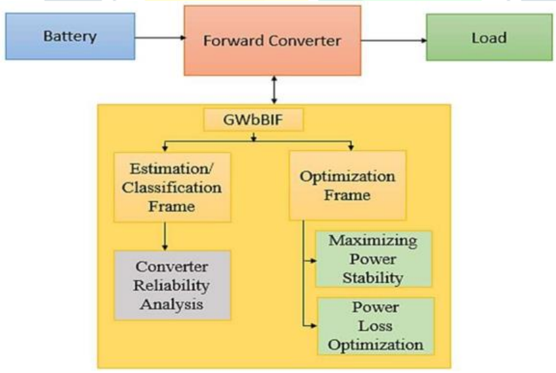

Fig.1.Block Diagram

DESCRIPTION :

The proposed system's block diagram is shown above. Using a battery source DC voltage is supplied tothe forward converter. The novel Grey Wolf based Intelligent Framework is implemented into forward converter. The GWbBIF algorithm had two frameworks, one for estimation and the other for optimization. Theestimation framework is used for converter reliability analysis, whereas the optimization framework is used for converter power loss optimization. A load is connected to the converter's output end.

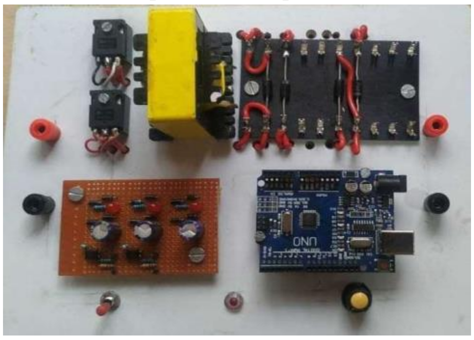

Fig.2.Hardware Kit

VI. FLOW OF HARDWARE MODEL(WORKING) :

Forward converters are essentially buck converters with isolation provided by a forward- mode transformer. to achieve the required output voltage, the forward-mode controller opens andcloses the switch with the appropriate duty cycle. The switch (SW) is typically a MOSFET, but it can also be a bipolar transistor or GaN or SiC. According to this equation, various combinations of turns ratios and duty cycles can be used to achieve the required output voltage:

$$V_{out} = V_{in} \times N_{sec} / N_{pri} \times D$$

Where,

Vout = output voltageVin = input voltage
Nsec / Npri = N2 / N1 = transformer secondary toprimary turns ratio

D = duty cycle = ton / (ton + toff)

The lower rms secondary current in the forward- mode design compared to a similar flyback design can result in lower secondary winding losses, evenif the flyback design has more turns. Because ofthe lower secondary loss, forward-modes are typically more efficient than comparable flyback designs. Another reason is that the flyback output capacitor must carry more current than the forward-mode design, which introduces capacitor losses into the equation.

A two-switch forward-mode converter (also known as an asymmetrical half-bridge forward converter) is made up of two FET switches that are sometimes combined into a single controller IC. A two-switch forward converter has the advantage of clamping the voltage across the switches to the input voltage, allowing for a wider input voltage range. A two-switch forward converter's maximum operating voltage approaches the FET voltage rating, whereas a single switch forward converter's maximum operating voltage is only halfof the FET voltage rating.Another advantage of the two-switch topology is that it does not require an auxiliary reset winding, allowing for asimpler (and less expensive) forward-mode transformer design.

VII. SIMULATION MODEL

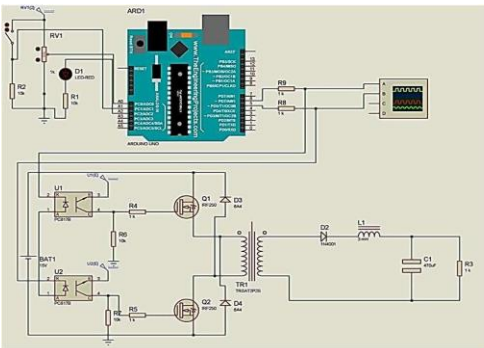

Fig.3. Simulation Circuit

VIII. Hardware Results

Parameter	Values	Values
Input voltage	12V	12V
Output voltage	40V	38V
Switching frequency	20kHz	20kHz
Outmost output power	500W	500W
Transformer turn ratio	1:2	1:2
Duty cycle	0.3	0.5

Table No.1 Hardware Result

IX. Conclusion

In this project a novel GWbBIF method has been implemented in forward convertor. The simulation results of proposed method were compared with hardware results; to determine the significance of the proposed method and it was found that the projected method achieved reduced power loss, and reduced error percentage. As a result of the overall performance analysis, the proposed GWbBIF method is more appropriate in the forward convertor coordination system.

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