MICROPROCESSOR CONTROLLED DIGITAL SWITCHING TECHNIQUE

Vivek Gusain, Varsha Chauhan
Department of Information technology
Dronacharya College of Engineering, Gurgaon, India

Abstract- **A novel microprocessor-controlled electronic ballast with class-E resonant inverter is employed to link a photovoltaic (PV)-powered battery energy storage system (BESS) as a main power source with a utility ac power as a complementary source. The proposed strategy aims to control power flow either from the PV-powered BESS or from the utility ac power line to the electronic ballast. This novel design has lower loss, easier control, and higher efficiency than the traditional photovoltaic panel has. A 27W fluorescent lamp is ignited by electronic ballast with a class-E topology to validate the proposed theoretical analyses. When the electronic ballast is driven by the PV-powered BESS and the utility ac power, overall efficiency of the proposed system is 94.2% and 91.1%, respectively. Experimental results demonstrate the functionality of the overall system, indicating that it is a good solution for several hybrid source applications.**

Index Term- **Electronic ballast, Hybrid source ,Battery energy ,Storage system ,class-E resonant inverter.**

I. INTRODUCTION

Giving growing public concern over the exhaustion of fossil fuel reserves and pollution problems incurred by conventional power generation, renewable energy sources such as solar, wind, micro-hydraulic, biomass, geothermal, hydrogen, and tidal are extensively adopted in industrial, commercial and military applications [1-6]. Moreover, fluctuations and increases in oil prices have negatively impacted the world economy, particularly economies in developing countries.

Photovoltaic (PV) energy as an alternative energy source has been widely investigated as it is pollution-free, abundant and widely available. The PV energy applications can be divided into grid-connection systems and stand-alone systems. In grid-connection systems, an inverter stage plays an important role as the interface device between the PV power generation system and the utility. To connect to a utility, an inverter stage must be operated in grid-connection mode. Notably, an inverter stage can synchronize with utility ac sources.

Additionally, inverters must be operated in switching mode when connected to a grid, and the current transferred onto a grid must be regulated to follow the reference signal. At the same time, active power switches of the inverter must be driven properly to generate a series of sinusoidal pulse width modulation (SPWM) waveforms. Then, through a LC lowpass filter, this inverter can generate sinusoidal voltage along with the utility to supply power to loads [7,8]. However, such PV systems are typically idle at night or during cloudy days.

However, system components have not been used optimally. Conversely, traditional stand-alone systems have advantages of a simple system configuration and control scheme

II. OPERATING PRINCIPLE OF ELECTRONIC BALLAT WITH CLASS-E RESONANT INVERTER

Unlike traditional ballast (Fig.1), this electronic ballast, which is driven by dc voltage, does not require an inverter stage with a large and heavy transformer with a filter circuit. Figure 5 schematically shows the circuit in the proposed single-switch electronic ballast for solar energy applications.The input terminal has a choke inductor *LE*, which is generally large for the small ripple at the input dc current. The electronic ballast uses a class-E ZVS load resonant inverter to drive the fluorescent lamp. The diode *D* provides a path for the resonant current of the class-E ZVS resonant inverter. Metal–oxide–semiconductor field-effect transistors (MOSFETs) are preferred because their body diodes can be used as antiparallel diodes for operation beyond resonance. The fluorescent lamp is connected in parallel with a preheating capacitor *Cf*, which is in series with an resonant inductor *Ls* and a resonant capacitor *Cs*. The capacitor *Cf* provides a sufficiently high ignition voltage to the lamp during the initial start-up and then appropriate filament heating at a steady state. A resonant energy tanks, *Ls*, and *Cs*, which are in series with the lamp network, comprise the load resonant circuit of the class-E ZVS resonant inverter. The load resonant circuit of the class-E resonant inverter is formed by the fluorescent lamp and reactive components *Ls*, *Cs Cp*, and *Cf* In this investigation,the dc voltage *Vdc* is obtained from the BESS, which is fed by a PV array.

III. SINGLE-STAGE HIGH-POWER-FACTOR ELECTRONIC BALLAST FOR FLUORESCENT LAMPS

Conventionally, when high-frequency electronic ballasts consume ac power from a utility, a diode-bridge rectifier with a bulk electrolytic capacitor is often utilized to convert ac voltage into smoothed dc-link voltage for high-frequency electronic ballasts. Such a rectifier circuit inevitably draws an input current with narrow pulses, which is notorious for having a very poor power factor and serious harmonic distortion. The power factor (PF) is typically ≤0.6 and total harmonic distortion (THD) can exceed 100%. The widespread use of high-frequency electronic ballasts for fluorescent lamps is a significant source of

DC-link Capacitor *Cdc*	200 μ F
Inductor *Lp*	0.68mH
Inductor *LE*	6.5nF
Inductor *Ls*	1.97mH
Capacitor *CE*	9.35nF
Capacitor *Cs*	32.8nF
capacitor *Cp*	6.5nF
Capacitor *Cf*	6.5nF

Table.Circuit parameter

power pollution. However, a high power factor, including reductions in the rms line current and line current harmonic distortion, can cause a utility to increase its efficiency and reduce pollution. Therefore, high-frequency electronic ballast requires a filter circuit.

IV. EXPERIMENT RESULTS

The proposed system (Fig.3) connects two different sources and two power relays. A programmable intelligent computer (PIC) microprocessor senses and controls the operation of peripheral interface devices such as the terminal voltage of the BESS, relay operational status, pulse-width-modulated (PWM) signal generation, and duty cycle control. Furthermore, the computer microprocessor controls energy management,including battery charging/discharging. The entire control system (Fig. 3) optimizes the energy performance of the hybrid system based on system state information, the BESS and the utility ac line. If the BESS operates at an output power condition (when providing energy to the electronic ballast, the terminal voltage of the BESS gradually declines), the microprocessor system only supervises the BESS policy of the hybrid source system. Once the terminal voltage of the BESS drops to the preset value, the utility ac line source supplies power to the single-stage high-power-factor electronic ballast.

The microprocessor-controlled system controls energy management of the BESS energy system and output power of the utility ac line source system.

V. CONCLUSIONS

This work presents novel electronic ballast with a simple structure, small volume, light weight, and low energy transfer losses. The electronic ballast circuit utilizes only a single active power switch and, unlike the traditional electronic ballast driven by a PV-powered BESS, does not require any output transformer. No power loss occurs between the BESS and electronic ballast without an additional power processing stage. Moreover, since commutations in the active power switch of the resonant inverter are achieved at zero voltage, electronic ballast switching losses are very low, resulting in extremely high efficiency. Consequently, ballast efficiency can be as high as 94.21%. A prototype of the proposed ballast for a 27W fluorescent lamp was implemented. As expected, a lamp current waveform with a low crest factor is obtained. The proposed topology is a viable solution for implementing low-cost high-efficiency electronic ballasts for PV-powered BESS applications.

REFERENCES

[1] W. Wongsaichua, W. J. Lee, S. Oraintara, C. Kwan, F. Zhang,"Integrated High-Speed Intelligent Utility Tie Unit for Disbursed/Renewable Generation Facilities**,**" IEEE Transactions on Industry Applications, Vol. 41, No. 2, March/April 2005, pp. 507-513.
[2] J. M. Carrasco, L. G. Franquelo, J. T. Bialasiewicz, E. Galvan, R. C. P. Guisado, Ma. A. M. Prats,J. I. Leon, N. Moreno-Alfonso, "Power-Electronic Systems for the Grid Integration of Renewable Energy Sources: A Survey" IEEE Transactions on Industrial Electronics, Vol.
53, No. 4, June 2006, pp. 1002-1016**.**
[3] A. Canova, L. Giaccone, F. Spertino,M. Tartaglia, "Electrical Impact of Photovoltaic Plant in Distributed Network," IEEE Transactions on Industry Applications, Vol. 45, No. 1, January/February 2009, pp. 341-347**.**
[4] C. Yang,K. M. Smedley, "One-Cycle-Controlled Three-Phase Grid- Connected Inverters and Their Parallel Operation," IEEE Transactions on Industry Applications, Vol. 44, No. 2, March/April 2008, pp. 663-671.
[5] S. Alepuz, S. Busquets-Monge, J. Bordonau, J. Gago, D. Gonzalez, J. Balcells, "Interfacing Renewable Energy Sources to the Utility Grid Using a Three-Level Inverter," IEEE Transactions on Industrial Electronics, Vol. 53, No. 5, October 2006, pp. 1504-1511.
[6] J. B.Cardell, and S. R. Connors, "Wind Power in New England: Modeling and Analysis of Nondispatchable Renewable Energy Technologies," IEEE Transactions on Power Systems, Vol. 13, No. 2, pp. 710-715, May 1998
[7] S. B. Kjaer, J. K. Pedersen, F. Blaabjerg, "A Review of Single-Phase Grid-Connected Inverters for Photovoltaic Modules," IEEE Transactions on Industry Applications, Vol. 41, No. 5, September/October 2005, pp. 1292-1306.
[8] C. A. Hernandez-Aramburo, T. C. Green, N. Mugniot, "Fuelinsumption minimization of a microgrid," IEEE Transactions on Industry Applications, Vol. 41, No. 3, May/June 2005, pp. 673-681.