Power Electronics Based Energy Management System with Storage

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Abstract

This project demonstrates the implementation of an EMS. EMS includes batteries and inSI (VSI) which can be controlled as a current source or power source depending on AC grid status and user preferences. EMS ensures that critical loads are enabled when the AC grid fails; where VSI is controlled as a source of electrical energy. It also achieves maximum control by charging the battery to local loads while powering the AC grid when loads become larger. The cost of saving energy with high shaving is estimated. The effectiveness of EMS is demonstrated by testing standards in laboratory type. The structure of control and concept embedded in EMS is discussed in detail. In today's world power system it is very important. The electronic power management system used here EMS includes batteries and a single-phase digital-controlled inverter (VSI), which can be controlled as a current source or gas power source depending on the grid ac and your preferred user. EMS ensures that critical loads are enabled when the ac grid fails; in which case, VSI is controlled as a source of electrical energy. It also achieves high power control by providing battery power to local loads while powered by an ac grid when loads become larger. The cost of saving energy with high shaving is estimated.

Keywords: Energy Management System, Voltage source inverter, Current source, voltage source, AC grid etc

Introduction

Energy efficiency and energy efficiency have become a global priority, promoted by Kyoto law and other pressure requirements to reduce waste consumption. In addition, energy security is a requirement for many installations such as military bases and health care facilities where energy consumption reduction must be achieved while maintaining critical electricity loads provided at all times. In this project an electronic power management system (EMS) was introduced to achieve maximum power control in a single phase power system while ensuring continuous supply of critical loads simultaneously. High power control, also known as high shaving, is a method used to reduce the cost of electricity for users who have

time to use (TOU) contracts with those who pay for demand.

The electricity system does not need to be a microgrid, which means that the distributed generation (DG) does not need to be part of the energy system. However, if DG units, such as photovoltaic panels or diesel generators, which are part of the EMS installation can manage these resources.

The proposed EMS for this project includes battery storage in the form of batteries to achieve three main objectives:

a) to make electricity available to critical loads at all times with or without a large grid utility.

b) reduce energy consumption to reduce electricity costs.

c) save energy generated by DG units or at a time when electricity from the grid is more expensive.

Energy efficiency and energy efficiency have become a global priority, promoted by Kyoto law and other pressure requirements to reduce waste consumption. In addition, energy security is a requirement for many installations such as military bases and health care facilities where energy consumption reduction must be achieved while maintaining critical electricity loads provided at all times. In this project, a Power-electronics-based energy management system (EMS) was introduced to achieve maximum power control in a single-phase power system while ensuring the continuation of critical loads simultaneously. High power control, also known as high shaving, is a method used to reduce the cost of electricity for users who have time to use (TOU) contracts with those who pay for demand. The power system does not need to be a micro-grid, which means that the distributed generation (DG) does not need to be part of the power system.

Objective

The primary objectives of this study can be summarized as follows:

1) To study the Energy Management System.
2) To understand the power electronics and its energy distribution.
3) To study simulation validations of the proposed EMS systems in power electronics.

Literature Review

1) Power Electronics Based Energy Management System with Storage , Giovanna Oriti, Senior Member, IEEE, Alexander L. Julian, Member, IEEE, Nathan J. Peck Electrical and Computer Engineering Department, Naval Postgraduate School 833 Dyer Road, Spanagel 437, Monterey, CA, 93943 – USA.

In this paper the performance of electronic- based EMS is illustrated with a lab prototype. The control system designed to perform the implementation of standard case tests is given in detail. The test data is shown to show how EMS supports critical loads when the AC grid is not available and how the AC grid connection is restored by EMS when the AC grid is recovered. Additionally, EMS can perform other useful functions such as high shaving. Experimental measurements with direct and non-linear loads show how EMS, controlled by the current mode, provides more power to load to achieve high shaving, thereby reducing electricity costs. A simple economic analysis is provided to support this statement.

2) *ENERGY MANAGEMENT SYSTEM BASED ON POWER ELECTRONICS, 1Shivkumar Sapare, M.Tech Student, Dept Of ECE, Khurana Sawant Institute Of Engineering And Technology, Balsond, Hingoli Dist., India.*

In this paper the performance of electronic- based EMS is illustrated with a lab prototype. The control system designed to perform the implementation of standard case tests is given in detail. The test data is shown to show how EMS supports critical loads when the AC grid is not available and how the AC grid connection is restored by EMS when the AC grid is recovered. Additionally, EMS can perform other useful functions such as high shaving. Direct and non-linear test scales show how EMS, currently controlled by the current mode, provides additional power to the load to achieve high shaving, thereby reducing electricity costs. A simple economic analysis is provided to support this statement.

Problem Identification

- **Existing System**

The increasing size of power systems and the increasing difficulty in operation have brought the challenge of finding and reducing rare events. Cascading detection and mitigation is an application that tries to detect events that fall early and prevent them from growing into a major shutdown. In the meantime, new additions to the grid are happening. The dispersed generation creates a blurring of divisions between generation, transmission and distribution. Intelligent loads have provided an opportunity to smooth the burden by participating in Demand Side Management (DSM); other loads such as an electric car can also serve as a source of support for part of the grid where the power supply is interrupted by faults. Permanent renewal such as a wind generator has brought difficulties in operation and control as well as clean energy requirements. The high penetration and integration of renewable resources reveals

differences and uncertainties in energy security and operational challenges. How EMS evolves under new developments in power grid expansion remains an important requirement for construction.

- **Proposed System**

The new EMS design should be driven by data needs for a variety of applications. It should consider existing infrastructure, as well as the cost and time of re-spraying and deploying new infrastructure. We assume that the future EMS design approach changes in three phases.

The purpose of the first phase is to improve existing systems by providing new information. Currently the design of EMS software remains the same while data from non-traditional sources is integrated with SCADA data to provide improved performance for existing EMS services. In the second phase new applications are made. EMS measurement infrastructure has also been redesigned with adequate data transfer and operational capabilities. Also, the means of communication between applications and sites of communication with "external" functions are made as necessary to achieve that. The third phase is working on designing the future EMS without any hindrance from the current situation, which means building new next-generation EMS infrastructure.

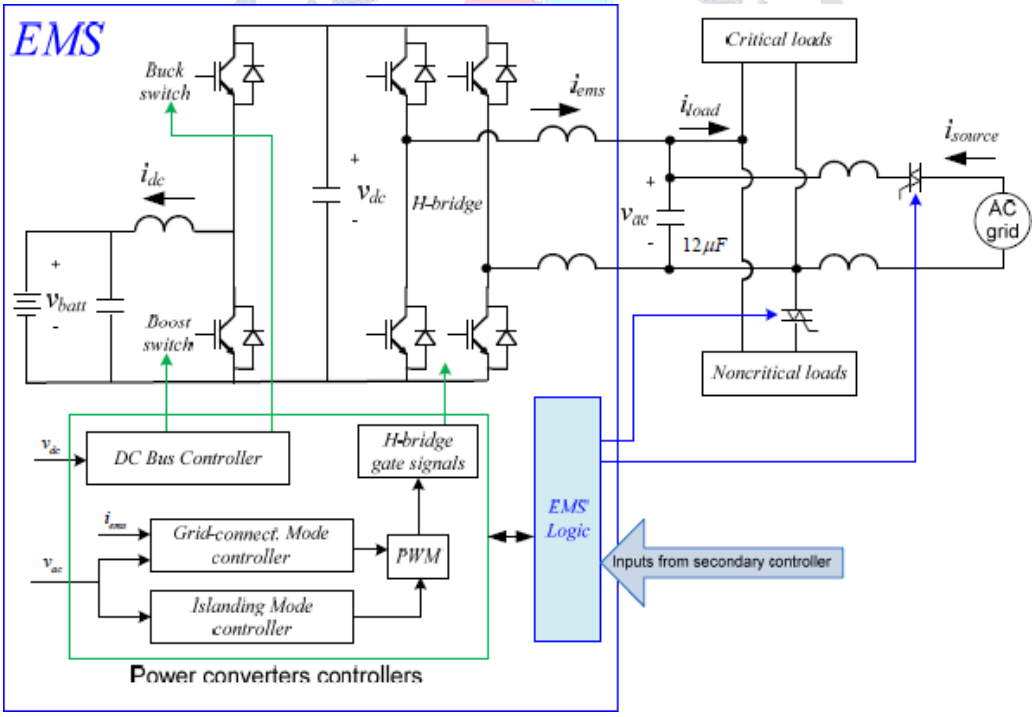

Figure 1. EMS architecture.

Critical responsibilities are those burdens that must always be empowered because they are important to the work. Unwritten loads connected in the same way as the Vac, however, can be disposed of where necessary using the thyristor button. This increases the control of power that can be directed to critical loads if necessary. The ac grid can also be disconnected where needed to activate EMS operation. Normal island mode occurs when the ac grid fails. In this operating system, the power of critical loads is guaranteed by drawing power from the battery pack.

Conclusion

In this project a management plan designed to implement the standard case assessment implementation is presented in detail. The test data is shown to show how EMS supports critical loads when the AC grid is not available and how the AC grid connection is restored by EMS when the AC grid is recovered. Additionally, EMS can perform other useful functions such as high shaving. Experimental measurements with direct and non-linear loads show how EMS, controlled by the current mode, provides more power to load to achieve high shaving, thereby reducing electricity costs. A simple economic analysis is provided to support this statement.

References

[1] G. M. Masters, *Renewable and Efficient Electric Power Systems*, J. Wiley and Sons, Inc. 2004.

[2] *IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems*, IEEE Std. 1547, 2003.

[3] J. Rocabert, A. Luna, F. Blaabjerg, P. Rodriguez, "Control of power converters in AC microgrids", *IEEE Trans. on Power Electronics*, vol. 27, No.11, Nov 2012.

[4] S. B. Kjaer, J.K. Pedersen, F. Blaabjerg, "A review of single-phase gridconnected inverters for photovoltaic modules", *IEEE Trans. on Ind. Applic*., vol. 41, no.5, Sep/Oct 2005.

[5] M. Yilmaz and P.T. Krein, "Review of battery charger topologies, charging power levels, and infrastructure for plug-in electric and hybrid vehicles", *IEEE Trans. Power Electron.*, Vol. 28, no.5, May 2013.

[6] S. Vazquez, S. M. Lukic, E. Galvan, L. G. Franquelo, J. M. Carrasco, "Energy Storage Systems for Transportand Grid Applications", *IEEE Trans. Ind. Electron.*, vol. 57, no.12, Dec 2010.

[7] F. Wang, J. L. Duarte, M.A.M. Hendrix, "Grid-Interfacing converter systems with enhanced voltage quality for microgrid application—Concept and Implementation",

IEEE Trans. Power Electron., vol. 26, no. 12, pp. 3501-3513, Dec. 2011

[8] E. Barklund, N. Pogaku, M. Prodanovic, C. Hernandez-Aramburo, T. C. Green, "Energy Management in Autonomous Microgrid Using Stability- Constrained Droop Control of Inverters", *IEEE Trans. Power Electron.*, vol. 23, no. 5, Sep 2008.

[9] S. Chakraborty, M. D. Weiss, M. G. Simões, "Distributed Intelligent Energy Management System for a Single-Phase High-Frequency AC Microgrid", *IEEE Trans. Ind. Electronics*, vol. 54, no.1, Feb 2007.

[10] Y. Chen, Y. Wu, C. Song, Y. Chen, "Design and Implementation of Energy Management System With Fuzzy Control for DC Microgrid Systems", *IEEE Trans. Power Electron.*, Vol. 28, No.4, April 2013.