English
Research Express@NCKU Volume 20 Issue 5 - November 4, 2011
[http://research.ncku.edu.tw/re/articles/e/20111104/1.html]

Novel maximum-power-point-tracking controller for photovoltaic energy conversion system

Yeong-Chau Kuo, Tsorng-Juu Liang*, and Jiann-Fuh Chen

*Professor of Department of Electrical Engineering, College of Electrical Engineering and Computer Science, National Cheng Kung University

tjliang@mail.ncku.edu.tw

IEEE Transactions on Industrial Electronics, Vol. 48, No. 3, pp. 594-601, JUN 2001
Citations : 216

Abstract-- As opposed to conventional two-stage designs, a single stage photovoltaic (PV) energy conversion system is implemented, resulting in size and weight reduction and increased efficiency. In contrast with our previous voltage controlled design, a single stage current mode controller is presented. The nonlinear output power relation of $\frac{dP}{dV}$ versus V and the near linear relation of $\frac{dP}{dV}$ versus I are discussed. Using $\frac{dP}{dV}$ as an index for current control is easier than for voltage control, allowing a simpler design. An equivalent model of the proposed system is derived to analyze the characteristics of the system and to design the controller. Owing to the linear relation of the PV array parameters versus insolation, the model is easy to analyze. The proposed current controller allows a PV energy conversion system to track the maximum power point very rapidly and smoothly. In addition, single current loop controller simplifies the conventional double loop design. The proposed controller performs maximum power point tracking (MPPT) and provides power to utilities with a unity power factor that is shown in Fig. 1.

Further, the proposed controller architecture is employed to the single-phase three-wire photovoltaic energy conversion system. The proposed system employs a three-leg inverter to control the MPPT process, the line current and neutral line current. A neutral line mode controller maintains a utility neutral line current of zero. A line mode controller controls the line current so as to provide power to the utility with a unity power factor. The proposed system acts as a solar generator on sunny days and functions as an active power filter on rainy days. The system architecture and output waveform are shown in Fig. 2.

The voltage and current hybrid PWM inverters using fuzzy variable structure control technique is proposed for parallel operation. The voltage-controlled PWM inverter (VCPI) unit is developed to provide a specific sinusoidal output voltage and the current-controlled PWM inverter (CCPI) units are employed to track the distributive current. Each of the VCPI and CCPI units can be operated independently. By using the fuzzy variable structure control scheme, the parallel inverters can provide excellent performance without phase-lock-loop (PLL) circuit for synchronization. The proposed scheme can result in fast dynamic response and robustness to parameter variations. Finally, computer simulations and experimental results demonstrate the superior performance of the proposed technique that is shown in Fig. 3.

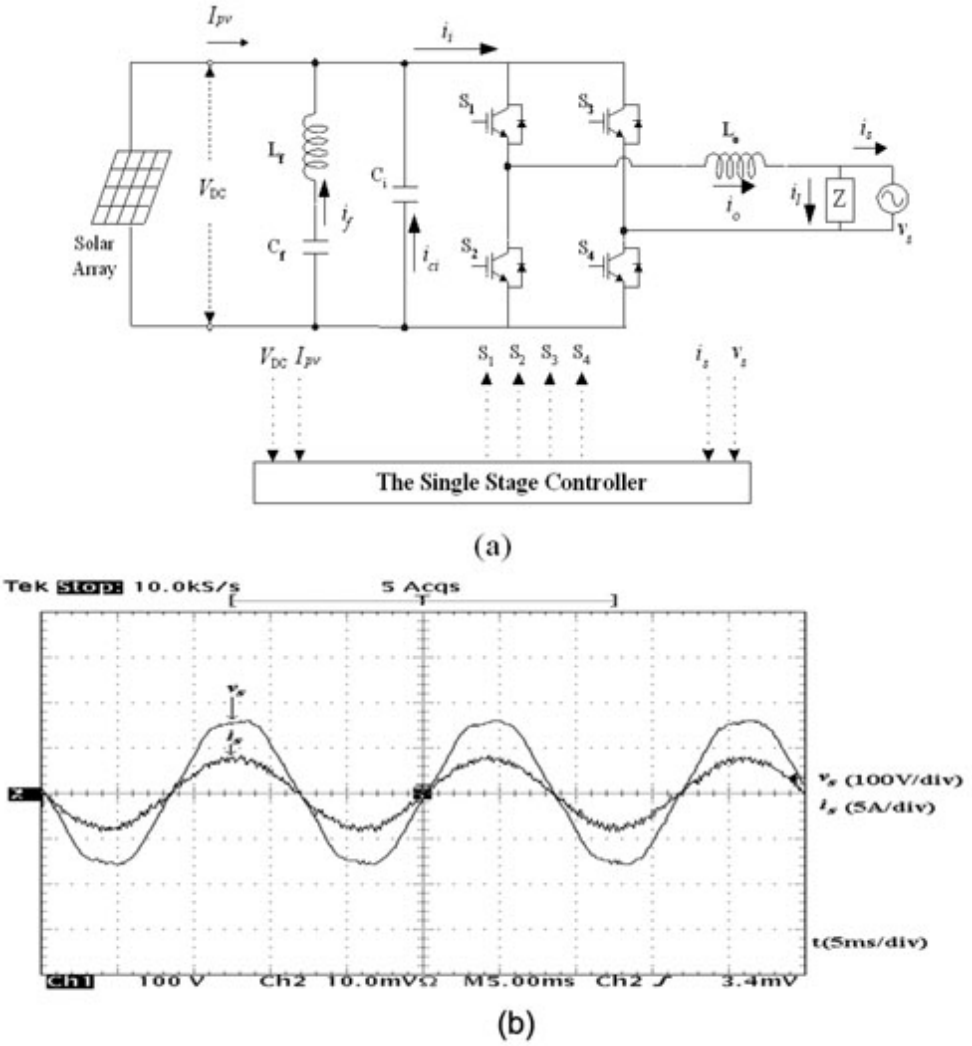
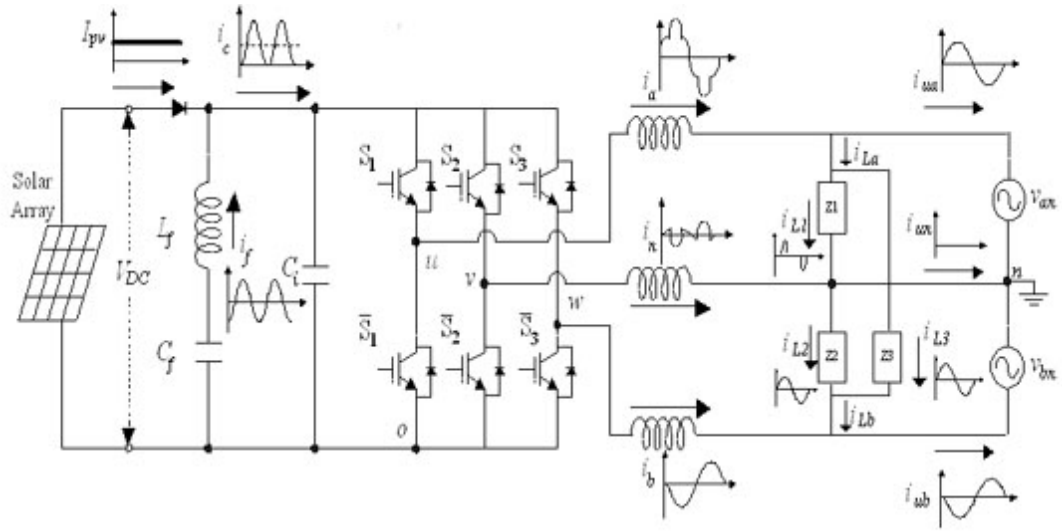
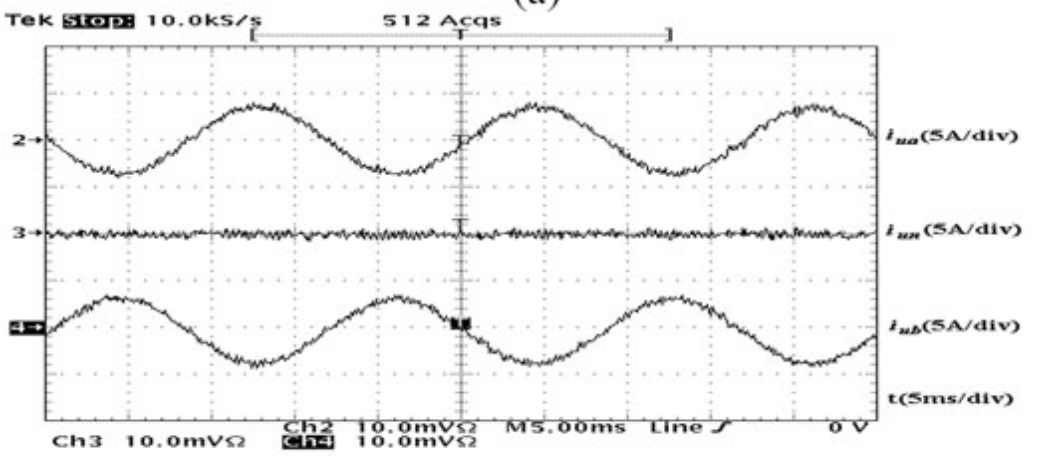


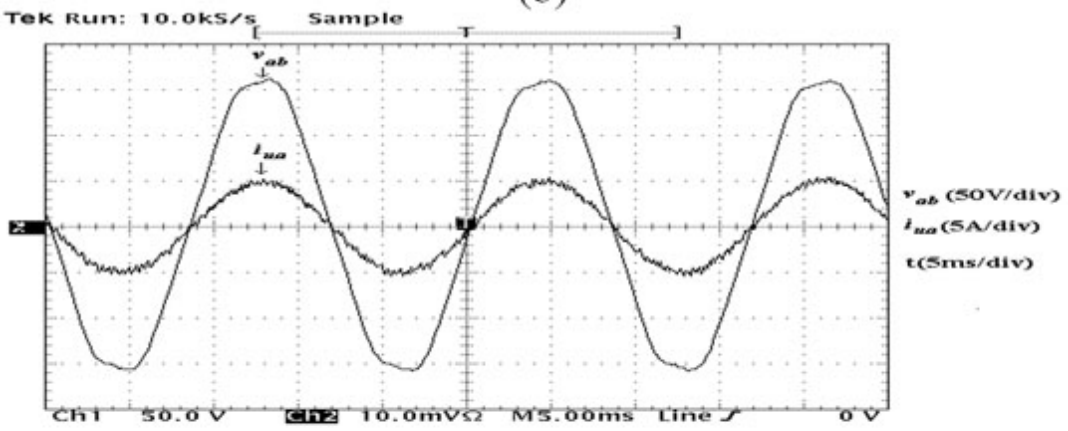
Fig. 1. Single-stage two-wire photovoltaic energy conversion system (a) Architecture, (b) *Vs*, *Is*.



(a)



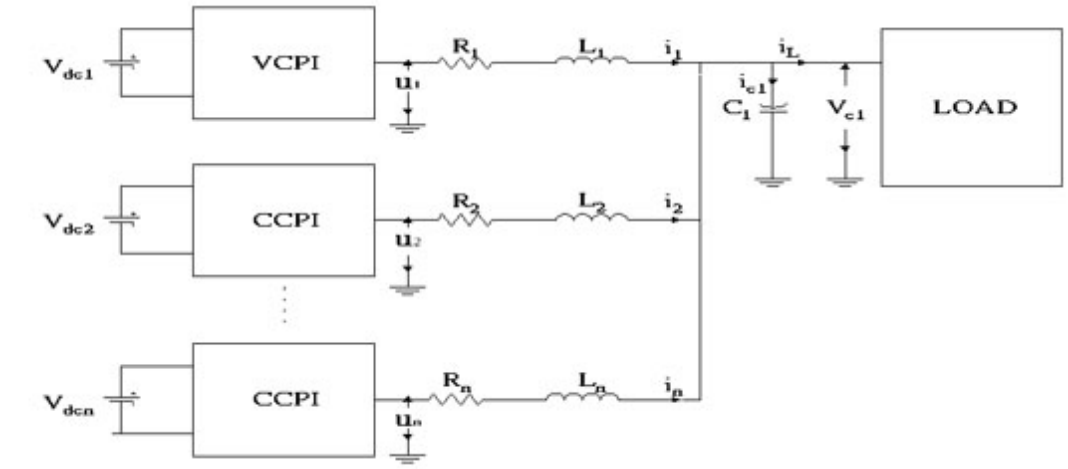
(b)



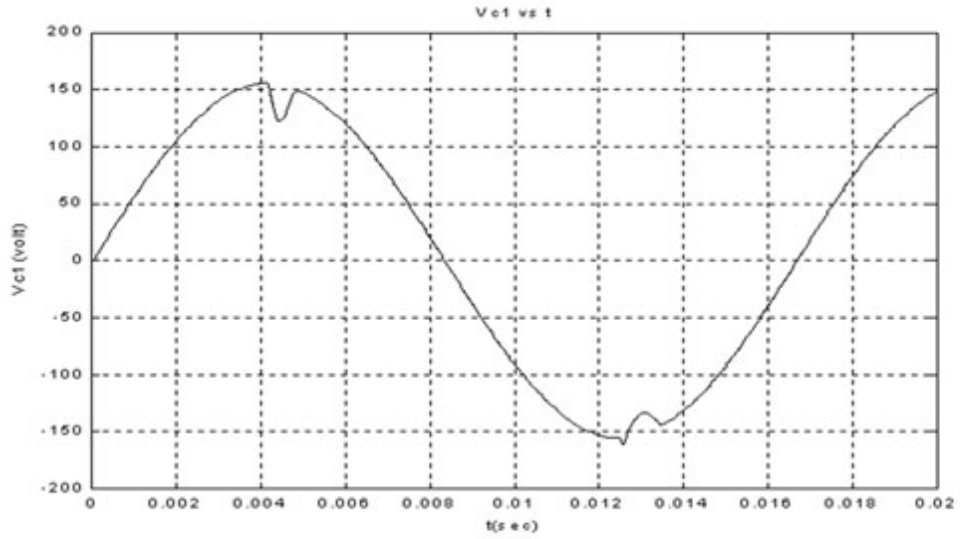
(c)

Fig. 2. Single-stage two-wire photovoltaic energy conversion system (a) Architecture, (b) i_{ua}, i_{un}, i_{ub}, (c) v_{ab}, i_{ua}.

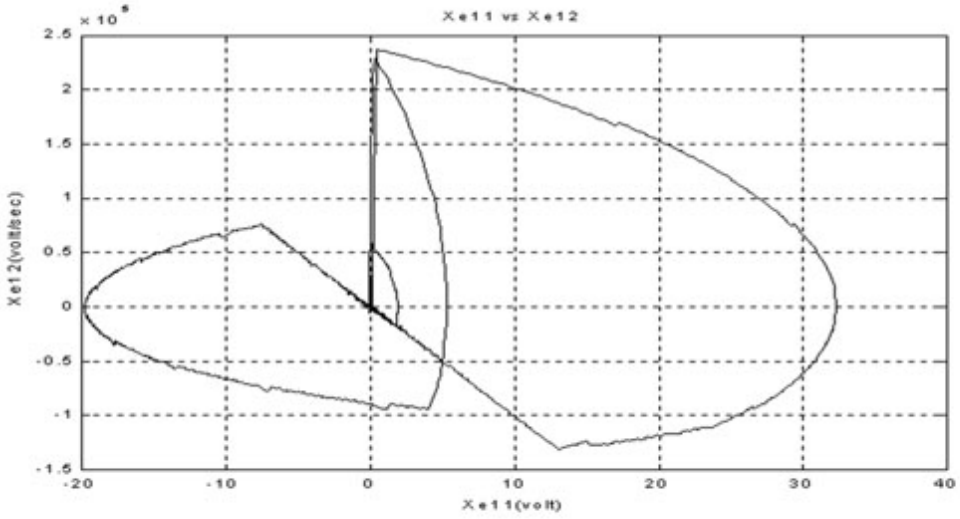
.



(a)



(b)



(c)

Fig. 3. Paralleled operation of VCPI and CCPI (a) Architecture, (b)output voltage, (c)phase plane.