

Wind and Solar Hybrid Power Full-bridge Inverter Design and Control Strategy

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Abstract

This paper presents PIC16F627A-I/P microprocessor-controlled single-phase inverter topology. using PWN modified sine wave pulse driving full-bridge inverter circuit. the inverter equalize the voltage loop control to achieve low voltage DC input. standard electricity output. optimizing the inverter output performance. significantly improved the output frequency stability and the current harmonic distortion.

Keywords

Wind and Solar hybrid, Full-bridge inverter, PWM, Modified sine wave.

1. Introduction

Nature. solar and wind power are the most common. but also an inexhaustible supply of renewable energy. both in the time variation on a strong complementary distribution [1]. As the scenery alone generating poor stability. low energy density. affected by weather factors such problems. so using wind and solar power system has become a major trend. Wind and solar power system is the same time the use of solar and wind energy to supply the load. you can maximize the use of green renewable energy. Two complementary resources makes wind and solar power generation system with a good match between the distribution of resources to ensure that the output power and energy. and can greatly improve the continuity and stability of the system power supply.

2. Wind and Solar Power Generation System

2.1. System and Inverter Circuit Design

Under normal circumstances. a comprehensive collection of wind and solar power generation system modules. control modules. rectifiers . batteries and unloading etc. . solar photovoltaic systems and wind power and wind through the system using the controller translates the energy stored in batteries [2] . Battery low voltage DC output rectifier filter through the boost and get high-voltage direct current . direct current through the inverter system photovoltaic modules can be converted into a standard AC power . so the inverter system is a renewable energy and power generation is an important device . but also the key technology lies.

In this paper. the design of the main sources of wind and solar energy generation system with two inverters . solar photovoltaic array module is composed of two units from (per unit capacity of 22 V. 50 W). and the other from the wind turbine. In the study of solar radiation intensity . measured one minute voltage meter voltage data by temperature . wind . photovoltaic arrays and wind power at regular intervals. The control circuit of the conventional inverter main circuit realized with a square wave mode . the circuit is relatively simple. low cost. low efficiency. the harmonic component . high noise. This paper presents a single-phase full-bridge topology inverter via a PIC16F627A-I / P microprocessor- controlled inverter stage link using modified pulse -driven full-bridge inverter circuit . low voltage DC input. standard

electricity output . easy implementation. while the load current harmonic distortion has also been improved.

2.2. Design of the Main Circuit Topology

This design of wind and solar power generation system consists of solar photovoltaic arrays. wind turbines . wind up the controller . charger . battery . unloading . and a single-phase full-bridge inverter circuit shown in Figure 1 .

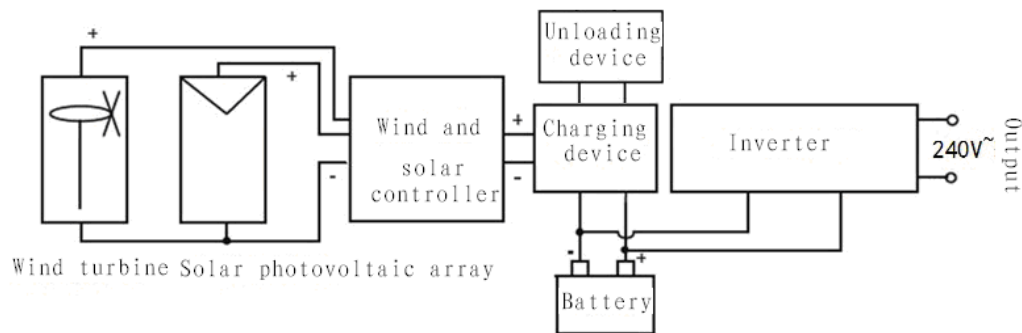


Fig 1. Wind and solar power generation system

2.3. Solar Hybrid Control System

Wind and solar power system controller is used to control the solar PV array and wind turbine charger input voltage. the circuit shown in Figure 2. Since the night does not produce a DC voltage of the PV array. and therefore a DC voltage generated depends on the day of light radiation intensity of the sun during the day. WTG whether it is day or night can produce a DC voltage whose value depends on the wind speed. Voltage deserve solar photovoltaic arrays and wind turbines to generate higher than the battery voltage. wind and solar power generation control system can control the battery charging process is controlled by PIC16F877A chip [3].

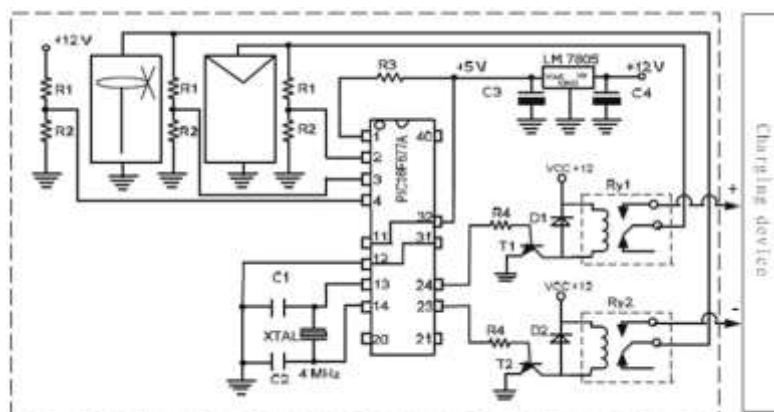


Fig 2. Wind and solar power generation system controller circuit

2.4. Charging Device

Figure 3 shows the circuit of a charging device of the system. it charges the battery. Charging circuit means input 15 V-40 V DC voltage. the diode D3 for protection of over-voltage arc. too. if the reverse power. the diode causes a short circuit. a fuse blow 4 amps. Input voltage capacitor C5 is relying on regulation. as the switching regulator to charge the capacitor. Select the green light-emitting diodes and resistors in series and 1KΩ 1KΩ indicating the charging circuit. DC pulse width variation LM2576-ADJ voltage regulator for the inductor L1 to offer. When the output pulse. the inductor stores energy; When the pulse off. the inductor releases energy to the capacitor C6. forming a current loop through the Schottky diode D4. Resistors R5 and R6

constitute trimmer potentiometer divider circuit. as LM2576-ADJ IC regulator output voltage feedback settings.

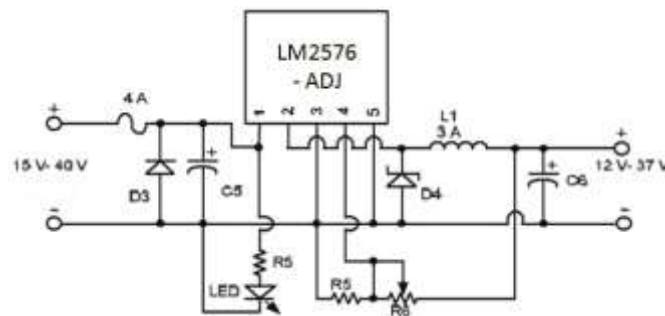


Fig 3. Charging device circuit

2.5. Full-bridge Inverter

The inverter is a DC into AC circuit structure devices [4]. is composed of four full-bridge drive tube turns working on each band sine wave. more suitable for high-power applications. Single-phase full-bridge inverter circuit by a pulse drive circuit and a full bridge circuit shown in Figure 4. The circuit is / P pin 10.11.12.17 and 18 on five pulse driven by the microprocessor PIC16F628A-I

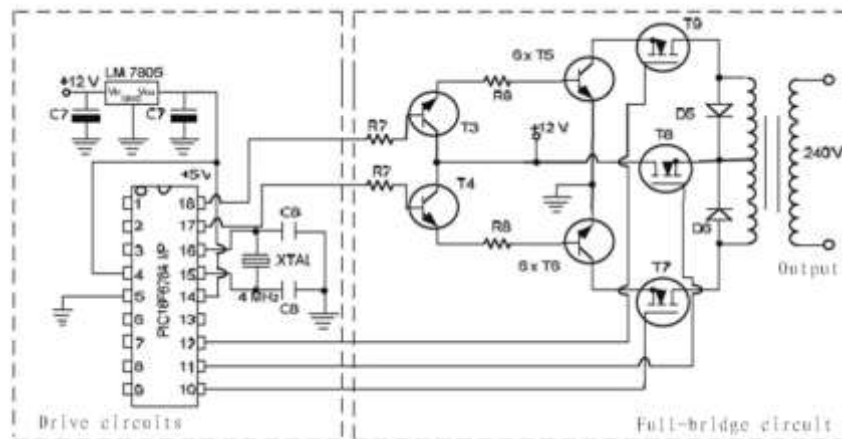


Fig 4. Single-phase full-bridge inverter circuit

The inverter circuit includes a full-bridge inverter and a filter circuit. wherein completion of full-bridge inverter converting DC to AC. Filter circuit filter to get the AC harmonic components required; controlling the inverter bridge circuit to complete the switch to achieve some control and protection functions based on sinusoidal pulse width modulation (SPWM) principle. the full-bridge input-output relations are satisfied:

$$U_i = MU_{dc} \quad (1)$$

Wherein. U_i is the inverter output voltage. M is the modulation index. U_{dc} the DC bus voltage. In the inverter circuit 50 Hz sine wave output. the open-loop transfer function model:

$$G(s) = \frac{L_R s + R}{a_0 + a_1 s + a_2 s^2 + a_3 s^3} \quad (2)$$

$$a_0 = R + 2r; \quad a_1 = L_R + 2L + 2RrC; \quad a_2 = 2rL_R C + 2RLC; \quad a_3 = 2CLL_R$$

When the closed loop control of the inverter, the DC bus voltage and load changes Udc PWM pulse width adjustment, stable AC voltage output. Except load changes, the system supplying power to the load is directly affected by the quality and reliability change Udc. Udc stability is therefore an important indicator of the quality of the power generation system of the inverter. Udc is accused of taking the amount of the mathematical model of the system can be expressed as:

$$C \frac{dU_{dc}}{dt} = I_{PV} + I_{WT} + I_{CT} + I_{CD} - I_E \quad (3)$$

IPV is the PV array output current; IWT for the wind turbine output current; ICT battery output current; ICD grid rectified output current; IE load current of the inverter required; C DC smoothing capacitor capacity. The controller detects the total current consumption of the DC bus, each assigned to a separate module for generating a current loop control unit, the master controller specifies the output current through the outer loop control and monitoring of the overall control, a stable voltage Udc, while the inverse closed loop voltage transformer equalization control, thereby optimizing the inverter output performance [5].

3. Wind Inverter Control Strategy Research and Testing

3.1. Weather Conditions and Scenery Voltage Test

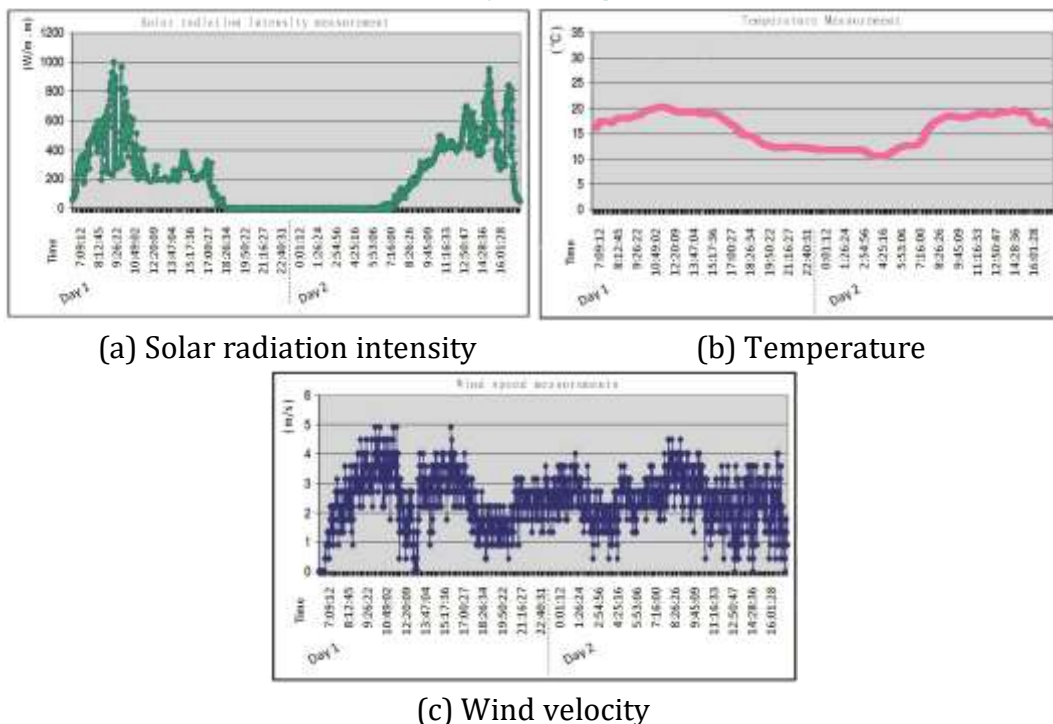


Fig 5. Weather condition measurement

To test a single-phase full-bridge power generating wind and solar power generation system performance, the input system inverter device connected to the solar photovoltaic arrays and wind turbines, the output load connected 20W, 50Hz, 220V hydraulic balance of PULSA Series 680 diaphragm metering pumps. Solar and wind power array real-time measurement of the output voltage with a voltage recorder, whose value depends on the intensity of solar radiation, wind speed and temperature. Among days during solar radiation measurement, temperature and weather conditions, wind speed measurements Fig 5 (a), (b) and (c) below. One of the

biggest. smallest. and average solar radiation intensity was 0 W/m². 1012 W/m² and 212.3 W/m²; minimum. maximum and average wind speed of 0 m / s. 4.97 m / s and 2.35 m / s; maximum. minimum and average temperature of 20.3°C. 11.2°C and 16.34°C.

The output voltage of the solar photovoltaic array solar radiation intensity and temperature. wind turbine output voltage affected by wind speed. If the solar radiation increases. and the temperature is constant. the output voltage of the PV array is increased. or if the temperature rises. the constant intensity of solar radiation will cause the output voltage of the PV array drops [6.7.8]. On the other hand. if the wind speed is below the minimum or above the maximum wind speed started working wind speed. wind turbine whose output voltage is zero. only between wind speed between the two in order to output rated voltage [9]. Solar photovoltaic arrays and wind turbine output voltage as shown in Figure 6.

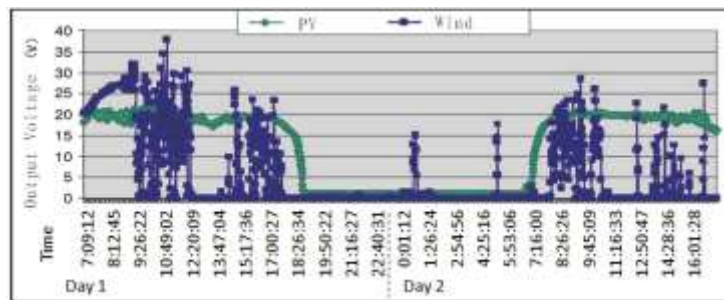
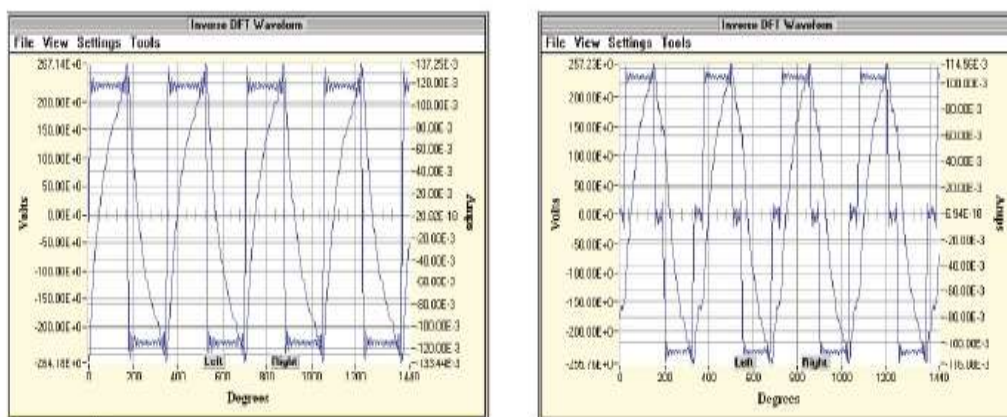


Fig 6. Measured output voltage

3.2. Inverter Control Strategy and Test

Full-bridge inverter circuit is driven by a pulse waveform of the pulse generated by the driving circuit. as a microcontroller PIC16F628A-I / P 4 as shown in the previous figure. The main circuit of the inverter power needed to achieve a pulse waveform control. where the use of two square wave and modified sine wave inverter voltage output for comparison. Traditional modified sine wave inverter is generated by each wave voltage ladder superposition. this way the presence of complex control circuits. power switches used in many superimposed lines. as well as size and weight of the inverter and other large many problems. this project uses PWM pulse width modulation generated [10]. Figure 7 (a) and (b) are two ways to control the resulting single-phase inverter solar hybrid power system AC load voltage and current waveforms. Figure China wave control ratio correction wave control AC RMS load voltage and current to be high. which means wind and solar power generation system inverter AC output pulse waveform directly affect the RMS voltage and current AC load.



(a) Square wave

(b) Modified sine wave

Fig 7. Wind and solar system inverter AC load voltage and current waveforms

3.3. Current Harmonic Distortion (CTHD) Test

The output load current harmonics generated hydraulically balanced diaphragm metering pump to the transformer's secondary side distortion. Figure 8 (a) and (b) respectively. under the current harmonic spectrum of the square wave and modified sine wave control. Seen from the figure correction wave controlled current harmonic spectrum to be significantly smaller than the square-wave control. by measuring the square wave and modified sine wave average current harmonic distortion of 39.86% and 17.29% respectively.

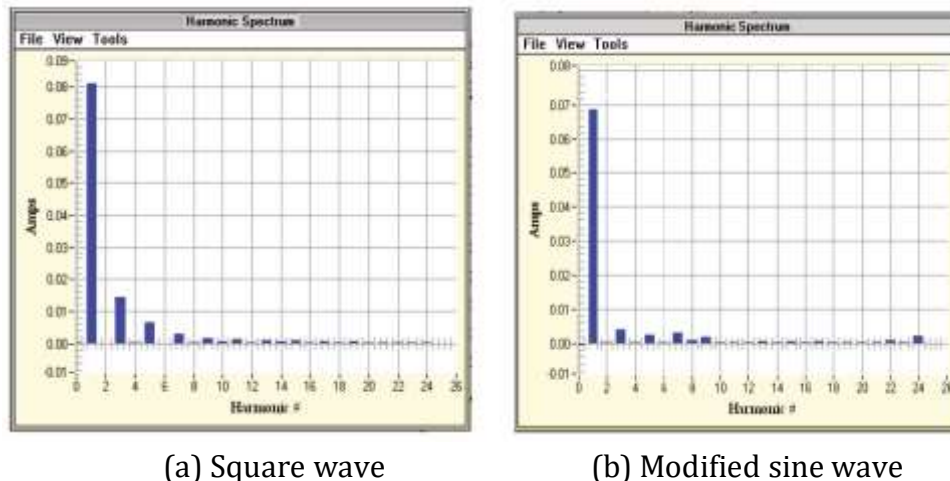


Fig 8. Wind and solar power generation system inverter current harmonic spectrum

4. Conclusion

Both wind power and solar power generation complementary combination of two new energy to achieve natural resource allocation. technical solutions integration. performance and price ratio reached a maximum utilization of new energy rationalization. Solar radiation and temperature will affect the PV array voltage. wind velocity will affect the voltage through wind and solar power controller. the output voltage is used to charge the battery. This article is designed for wind and solar power generation system using single-phase full-bridge topology inverter microcontroller control. and link using modified sine wave inverter stage pulse-driven full-bridge inverter circuit. low current harmonic spectrum. significantly improves the current harmonic distortion of the inverter output frequency is stable. has a high cost performance.

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