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IntegratedDC-AC Inverter for Hybrid Power System

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Abstract. A 300 W/ 50 Hz single-phase sine wave with a 555 timer IC controller was designed, simulated, implemented and tested to investigate output AC power quality. An input 12 VDC power supply, which simulates PV-Wind power source, was connected to the inverter circuit and charge-discharge energy storage was also studied. Results of simulation show that as well as the experiment result is obtained.This paper is present the advantage ofhybrid system wind &solar together in power supply system from the integration between time andlocation. It showsthe evolution of wind-solar in single-phase sine wave power inverter and provides the structure of information and communications technology and equipment.Some main techniques such as the circuit topology and operation modes of the key link, algorithm of the intelligent control charging and discharging and so on.

Introduction

The Wind-solar power supply system is renewable energy supply which makes good use of wind and solar energy [1]. This system can not only provide of low cost, integration and high reliability for some systems where power transmission is not appropriate such as UAVsystem recharging itself, relay stations of communication, traffic light, workstation of reconnaissance and survey, a farming and so on, but also inaugurate a new area which resolve the problem of energy sources and environment pollution [1]

It is difficult to benefit from solar and wind energy all-weather just through solar system or wind system individually, for the limited of time and region. So it is the consummate matching of solar and wind when consider the complementary of time and region. Daytime is good sunlight and wind energy in not variable, and when loss sunlight at nighttime, the wind energy boost up for the because of the difference in temperature over the earth's surface. In the same way, backland is with more lighting while little monsoon, inshore is quite the contrary.

Wind-solar complementary power inverter consists of photoelectric system, wind power system, inverter system, controller, discharger, storage battery, load, etc, as shown in Fig.1. Among them, the inverter system is the key one. Its design involves the selection and optimization of main circuit topology, calculation and selection of main switching elements, parameters consideration of transformer and filters, waveform generator, switching power supply, protection circuits for system, etc. transform the power to the storage battery when the generated energy is larger than the power consumption, in order to protect storage battery and inverter, the charger circuit connects with the discharger to dissipate extra energy. In the system, there are two dischargers with different power levels which can be suitable for practical situations. The switching of charging and discharging is controlled by control circuit. The power inverter employs dual energy storage system to improve the reliability in the system. [2]As shown in figure (1).

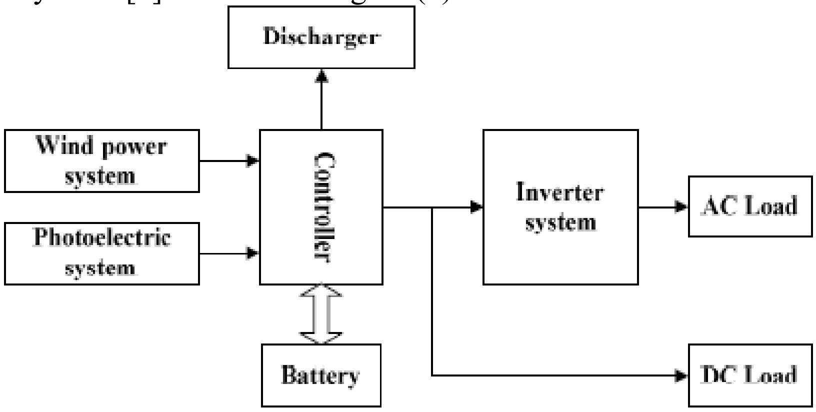


Figure1: Diagram of wind-solar complementary power supply system

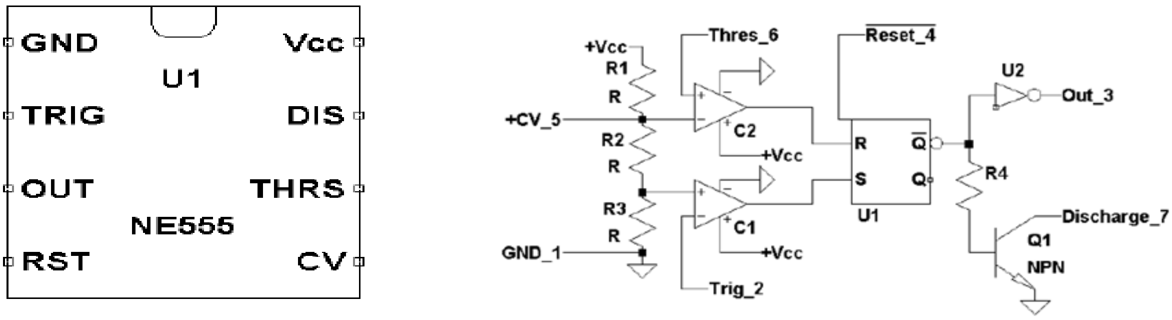
We must know the energy production by wind turbines depends on the wind velocity acting on the turbine. In addition, we cannot convert all the wind energy into electric power; we can only convert 59%, from wind power. When using an optimized system, the power available is
$P = (1/2).p\ .A\ .\ v3$ (in Watt)
Where, A is the area perpendicular to the direction of flow, meter.
p, density of air,is approximately 1.2 kg/m^3
V, wind velocity, meters per second
And the power in solar power station depends on the ratio of radiation and temperature. [3-4]

Related Work

The power electronic circuits in wind and photovoltaic power systems basically perform the following functions:
• Convert DC Into AC.
• Control Voltage.
• Control Frequency.
At the utility interface, the power flow direction and magnitude depend on the voltage magnitude and the phase relation of the site voltage with respect to the grid voltage [5]. The grid voltage being fixed, the site voltage must be controlled both in magnitude and in phase in order to feed power to the grid when available and to draw from the grid when needed. If the inverter is already included in the system for frequency conversion, the magnitude and phase control of the site voltage is done with the same inverter with no additional hardware cost [6].
Sabin (1999) and co-workers have summarized the various standards and benchmarks used in large-scale power quality, and Koval (1999) and co-workers have presented similar finding for rural (small-scale) power quality problems [7]. Many articles have appeared on the impact of new electronics technologies on power quality management, for example Poisson (1999) and co-workers have described the impact of DSP chips on the problem. Barbosa (1998) and co-workers' have described the use of PWM (pulse width- modulation) control schemes to power quality control [8]. Numerous studies have appeared describing the impact of power quality problems caused by PV systems from early work by McNeil (1983) and co-worker's in to more recent work by Oliva (1988) and co-worker's and most recently by Chowdhury (1999)[9]. Kariniotakis and Stavrakakis (1995) have written extensively on simulation problems in wind generator and power grid interactions [8].

Methodology
In this paper has been usedthe versatile (555) timer as a mono stablepulsegenerator, an astable oscillator and as a pulse width modulator and by Using the Multisim package to make simulation for the circuit andthe mathematical model is: [9 -10]

The LM555 / NE555 timer is a versatile integrated circuit that can be configured as an oscillator, a pulse width modulator and a single, variable width, pulse generator known as an astable oscillator or one shot. More data give many other applications of this device. Figure 2a is the pin-out for the LM555 timer and Figure 2b gives the internal block diagram. The LM555 have two voltage comparators, one set-reset (RS, also SR) flip-flop, one inverter and one open collector NPN transistor.



a- The pin-out for the LM555 timer IC b- Functional block diagram for the LM555 Timer
Figure2: Block Diagram for LM555

in a hold condition maintaining Q = 1. The capacitor C starts to charge toward +Vcc through Ra and Rb. proved laboratory experiment the Equation (1) gives the voltage across the capacitor as shown in eq. (1):

$$V_{pin\_2}(t) = V_f + (V_i - V_f)e^{-t/RC} \quad (1)$$

Where:
Vf is the final voltage and **Vi** is the initial voltage across the capacitor.
Substituting Ra + Rb for R, Vi = 1/3 +Vcc, and Vf = +Vcc gives as shown in eq. (2):

$$V_{pin\_2}(t) = +V_{cc} + (-2/3 +V_{cc})e^{-t/(R_a+R_b)C} \quad (2)$$

Figure (3) shows the voltage across the capacitor C and Vout as a function on time.
The capacitor initially has a voltage 1/3 +Vcc and starts charging toward +Vcc.

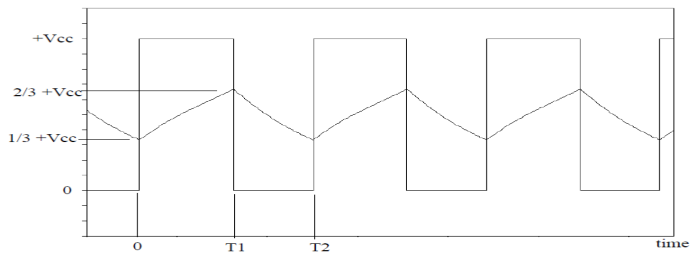


Figure 3: V_{out} and the voltage across the capacitor C as a function of time.

The time T1 it takes to charge to 2/3 +Vcc is found by substituting +2/3 +Vcc forVpin_2 (t) into Equation (2) and solving for (t) as shown in eq. (3):

$$T_1 = \ln(2) \cdot (R_a + R_b) \cdot C \quad (3)$$

During the charge cycle the capacitor C discharges through Rb and the transistorQ1. The voltage across the capacitor candefineas shown in eq. (4):

$$V_{pin\_2}(t) = (2/3 +V_{cc})\, e^{-(t - T_1)/R_b C} \quad (4)$$

The capacitor C will continue to discharge until it reaches a voltage of 1/3 +Vcc. At this point, V+ < V- of C2 and V+ > V- of C1, the output C2 = 0 and the output of C1 = 1. This puts the output of the RS-FF to the condition Q =1. The transistor Q1 turns off and Vout goes to 1 starting a new cycle of oscillation. The time it takes T2 - T1 to discharge the capacitor to 1/3 +Vcc is found by substituting this value into Equation (4) for Vpin_2 (t) and solving for t -T1,
with (t) as shown in eq. (5):

$$T2 / T2 - T1 = \ln (2) . (Rb) . C \tag{5}$$

The total time period of oscillation T2 is found by adding Equations (3) and (5)togetheras shown in eq. (6):

$$T2 = \ln(2) . (Ra + 2 . Rb) . C \tag{6}$$

The frequency of oscillation which is given by 1 / T2 as shown in eq. (7):

$$f = 1 / \ln (2). (Ra + 2. Rb). C = 1.44 / (Ra + 2 . Rb). C \tag{7}$$

The duty cycle which is defined as the time the output is low to the total timeperiod as shown in eq. (8):

$$D\% = T2 - T1 / T2 =Rb / Ra + 2. Rb.100\% \tag{8}$$

The best achievement of Equation (8) to give that for a 50% duty cycle, Ra would have to be zero which is not possible for astable oscillator circuit configuration of Figures 2 (a) and (b). To build an astable oscillator with a 50% duty cycle requires the addition of a diode, as shown in Figure (5) during charging of capacitor C, the diode is on. Principally Rb is in parallel with the on-state (forward-biased) resistance of the diode, which is typically much smaller than the resistance Rb. For the big part, this parallel combination can be considered as zero ohms. Since the parallel combination of Rb and the forward-biased diode (on) resistance are approximately zero ohms, the capacitor only charges through resistor Ra to do charge time for T1 as shown in eq. (9):

$$T1 = \ln(2) . Ra . C \tag{9}$$

When the capacitor is discharging, the diode is on and the capacitor discharges through Rb as described by equation (4) yielding a discharge time as shown in eq. (10):

$$T2 - T1 = \ln(2) . Rb . C \tag{10}$$

The total period of oscillation is then given by adding Equations (9) and (10) together as shown in eq. (11):

$$T2 - T1 = \ln(2) . (Ra + Rb) . C \tag{11}$$

And the frequency of oscillation as shown in eq. (12):

$$f = 1/ \ln (2) . (Ra + Rb) . C =1.44(Ra + Rb) . C \tag{12}$$

The duty cycle is then given by equation (13) as shown

$$D\% =T2 - T1/ T2 =Rb / Ra + Rb.100\% \tag{13}$$

If Ra = Rb, then the duty cycle reduces to 50%

Starting with Equation (1) with Vf = +Vcc and the initial voltage across the capacitor C, Vi = 0 gives as shown in eq. (14):

$$Vpin\_2 (t) = +Vcc (1 -e-t/RaC) \tag{14}$$

The total time Tp it takes the capacitor to reach 2/3 +Vcc is found by substituting this value into Equation (14) and solving for (t) as shown in eq. (15):

$$Tp = \ln(3) . Ra . C \tag{15}$$

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Conclusion

By comparison experimental results, wind -solar power supply system has small total harmonic distortion (THD), best steady state and dynamic response characteristics was obtained. The designed circuit was a heavy duty and reliable. Wind-solar sine inverter power supply not only gives better solution to the problems, such as low efficiency, high THD, charging and discharging, but also provides a reference for much further research on high-power wind - solar complementary sine wave power inverter with inductive or capacitive load. It is applicable and useable for all the ground systems.

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