A MODIFIED SVPWM FOR PV AND WIND INTEGRATED SYSTEM

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Abstract :

Nowadays power generation by means of renewable energy resources are more common. Renewable energy resources does not cause any problem to the environment. This paper mainly focus on wind and solar energy for generation of power. Since wind and solar energy both are renewable energy resources. Power generation by means of solar and wind energy both in combined named as hybrid power generation. Wind and solar energy are unstable in nature. But wind and solar energy are the best method to provide or to satisfy the load demand. Power generation by means of combined wind and solar energy. Called hybrid system will be more usefull to supply remote communities. However these remote communities does not connected with power grid. These areas are named as off-grid or stand alone power supplies. Number of villages in this world are still excled from power these villages are energized by means of extended grid or by diesel generators. But diesel generators are uneconomical. In order to reduce the cost of generation of power to meet the load requirement focused on wind and solar energy for generating electrical energy. By using the combination of solar and wind energy resources we also reduce the usuage of fossil fuels. Generating electrical energy by means of renewable energy resources will have many advantages. It is economical, non polluting, not depletable.Generating electrical energy compraise of the following blocks. The blocks are wind energy turbine, photo voltaic observer, to save energy battery, converters, finally to three phase inverter circuit with load. This paper mainly focus on switching or triggering method of 30 inverter here we used space vector pulse width modulation technique.

Keywords : *SVPWM, Modified SVPWM, Hybrid system, Diesel generators.*

1. INTRODUCTION

In order to reduce greenhouse effect and global warming. We introduce a new method to generate electrical energy. That is hybrid system (Both wind and solar energy) method of generating power. Its very familiar nowadays, integration of wind and solar energy.[1][2] It is Economical,

Solar Energy

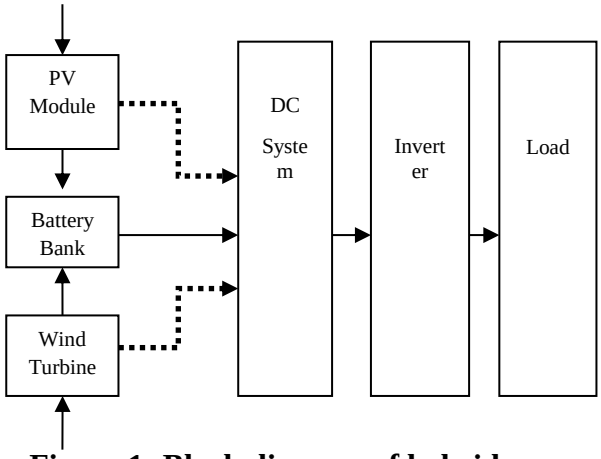


Figure 1 :Block diagram of hybrid system

Generating electrical energy by means of solar and wind energy compraise of the following blocks. P-V module designed inorder to observe the solar power, wind turbine designed to catch the entire wind energy. These two sources of energy are fed to a battery bank. Inorder to energize and battery bank. [3][4] These three input sources of energy are collected in DC System.In India the utilized voltage is alternating current source. 230V for single phase and 440v for three phase. So, should convert this DC source to utilizable AC source by means of inverter[3].

This paper mainly concentrate on switching or triggering sequence of three phase inverter circuit. Here we have chosen modified space vector pulse width modulation technique. Because of its advantage. Traditional SVPWM will have some disadvantages like unbalanced operation, complicated switching sequence. So to avoid these disadvantages we have chosen modified SVPWM technique and also this system will have reduced harmonic distortion variation of SVPWM results in quality to meet our requirements. The space vector pulse width modulation method is the best method when compared to any other method. It is suitable for variable frequency drive applications.Due to its advantages it is used worldwide. It also have good

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performance characteristics we carried out simulation.

2. DESCRIPTION OF HYBRID RENEWABLE ENERGY SCHEMES

In order to meet the load demand in off-grid areas or standalone loads hybrid systems are designed.Most accepted hybrid systems includes the combination of wind and solar energy.But wind and solar energies are not available at all time and at all periods. Below black diagram represents the format of hybrid renewable energy generation.[5][6]

PV Module is used to observe the solar radiation as much as maximum as possible. The PV module comprise of number of solar cells or photovoltaic cells. On the other hand wind energy is observed by means of wind generators. Both renewable energy resources are being saved by battery as DC source. We need AC source to drive motor so DC is converted by means of inverter circuit. Switching of inverter are the another problem. Traditional space vector pulse width modulation method are used for switching the inverter circuit. But this method have several disadvantages like unbalanced operation complication in switching. To avoid the disadvantages. This paper concentrates on space vector pulse width modulation for switching the inverter circuit. This system avoids the disadvantages of traditional method. It also have the advantages like harmonic distortion is less and also have good performance characteristics. After getting the output from inverter circuit it is fed directly to load circuit to meet the demand.[5][6] Number of villages and remote communities will get power by means of this renewable hybrid energy systems.

In this research work a novel approach for hybrid renewable energy system (By wind and solar) is proposed. Switching method for inverter is space vector pulse width modulation and it is compared with traditional space vector pulse width modulation. The below figure shows the overall methodology of hybrid system (with solar and wind) with grid connected for load.[7] traditional space vector pulse width modulation technique.

3.SOFTWARE SIMULTION – FPGA TOOL

- Sinusoidal PWM (SPWM)
- Modified space vector pulse width modulation

4. MODIFIED THREE PHASE INVERTER CONFIGURATION

The modified circuit consists of three single inverters, they are connected with modified space vector pulse width modulation technique is used for generating

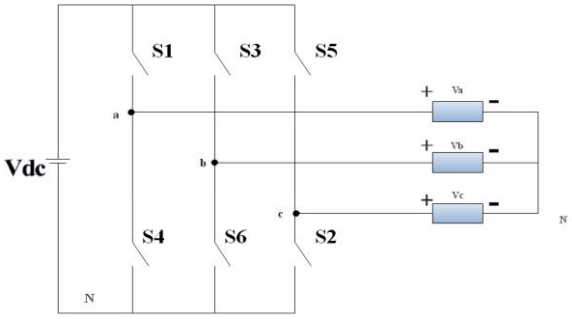


Figure 2 :Proposed 3ø Inverter configuration

5. LC FILTER CIRCUIT

In order to avoid the harmonic distortion in current, the three phase LC filter circuits are designed the obtained output sinusoidal current will have some low harmonic distortion to avoid this distortion in current LC Filter circuit is used

6. PLUSE WIDTH MODULATION TECHNIQUE

The simple block diagram showing the PWM Technique.The Block diagram consists of the following blocks namely current controller, (V_{abc}). Inverter Current (I_{abc}). Reference from instantaneous active current component. It is from DC Capacitor (ID). Reference from instantaneous reactive current component [I_q]. Instantaneous active current component [I_d] [9][10]

7. CURRENT CONTROLLER

It is used because of control of steady state error of control system and it is easy to implement.

$y(t) = K_p * e(t) + Ki \int_0^t e(t)dt$

$y(t) = V_d/V_q$

kp = proportional Gain Id

K_i – Integral Gain

Err – error signal

When does an error signal generate

The Error signal will generate only when there exists a difference instantaneous active current component and reference active current component or vice-versa.

The controller get toned when the proportional gain kp is increased to maximum. The steady state error can be eliminated by tuning ki integral gain and kp proportional gain at the same time.

8. SPACE VECTOR PWM

It is one on the advanced and powerful PWM method. It is more suitable method for variable frequency drive applications. It reduces the

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total harmonic distortion and lower order harmonics.

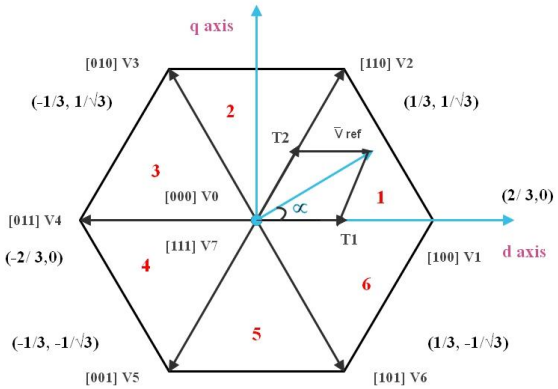


Figure 3

9. PRINCIPLE

It a, b, c →Reference frame

d-q → Stationary frame

The reference voltage is given as V_{ref}.

V_{ref} is obtained by the combination of eight switching patterns (V_0 to V_7)

The Vector is divided into six equal sectors in a plane

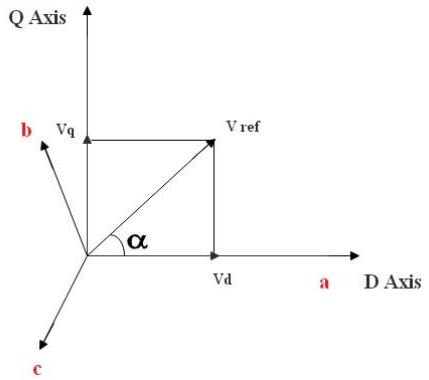
$V_a(t) = V_m \sin wt$

$V_b(t) = V_m \sin (wt - 120°)$ R

$V_c(t) = V_m \sin (wt + 120°)$

$V_d = V_{an} – ½ V_{bn} – ½ V_{cn}$ B

$V_a = √3/2\ V_{bn} – √3/2\ \ √cn$ Y



Vector diagram

10. WORKING

S_1 to S_6 are the six switches depends upon the operation of these switches output voltage is obtained.

When S_1 on S_2 off

S_3 on S_4 off

S_5 on S_6 off

V_{ref} is sampled a regular interval of Time, T

V_{ref} is Calculated by Adjacent vectors and Zero Vectors.

$T_0 = T – T_1 – T_2$

T → Sampling period

$V_1, V_2, V_3, V_4, V_5 – V_6$

Are six active vectors it takes the Hexogonal axes.

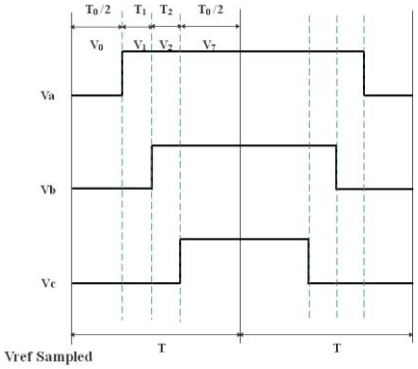


Figure 4

V_0, V_7 are two zero vectors. It lies at origin and when no voltage is applied to load. Each sector is divided 60° each.

Switching Table

Table 1 : Switching Table

a	b	c	van	vbn	vcn	vab	vbc	vca
0	0	0	0	0	0	0	0	0
1	0	0	2/3	-1/3	-1/3	1	0	-1
1	1	0	1/3	1/3	-2/3	0	1	-1
0	1	0	-1/3	2/3	-1/3	-1	1	0
0	1	1	-2/3	1/3	1/3	-1	0	1
0	0	1	-1/3	-1/3	2/3	0	-1	1
1	0	1	1/3	-2/3	1/3	1	-1	0
1	1	1	0	0	0	0	0	0

Advantages

1. Reduced switching frequency
2. Less current ripple
3. Output voltage is high
4. Improved harmonic performance

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5. This system is very simple and can be implemented directly to hardware system by means of digital signal processor (DSP)

SIMULATION OF PROPOSED MODIFIED SVPWM SCHEME FOR HYBRID SYSTEM

The simulation model is designed and implemented in Matlab/Simulink enviroment. Two cases are studied and compared with traditional SVPWM and modified SVPWM scheme. The first case is the system which operates with R load and it has parameters is shown in table 2. Table 3 compares the result of traditional SVPWM and modified SVPWM scheme.

Table 2: Parameter involved in hardware setup

S.No	Parameters	Values
1	Hybrid Dc voltage	100V
2	Switch device: IGBT resistor on	0.02Ω
3	IGBT forward voltage	2.5V
4	Diode resistor on	0.01 Ω
5	Diode forward voltage	0.8V
6	Leakage capacitor	10nF
7	Restive load	10 Ω
8	Reference output	96.8V
9	Proposed SVPWM switching frequency	10kHz
10	Dead-time interval	1 µs

The figure 5 shows the simulated result of output voltage of hybrid system from boost/buck converter where it will maintain a constant output voltage of 100V. The figure 6 shows the experimental result of output voltage waveform from the converter. The figure 7 shows the high and low side reference wave form for the modified SVPWM and has a reference voltage level of 12V. The figure 8 shows the Switching Vectors for Modified SVPWM. The figure 9 shows the Switching Pulses for Modified SVPWM and figure 10 shows the corresponding experimental output. The figure 11shows the output voltage of phase to phase voltage and 12 shows the experimental output voltage. The figure 13 shows the three phase current waveform and figure 14 shows the single phase current waveform, figure 15 shows the experiment current waveform.

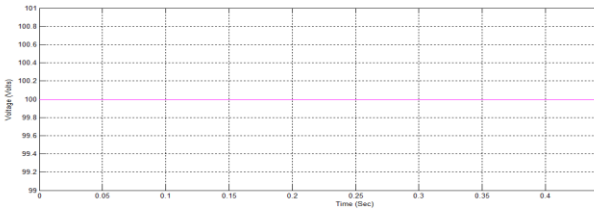


Figure 5: Simulation of Input Direct Current

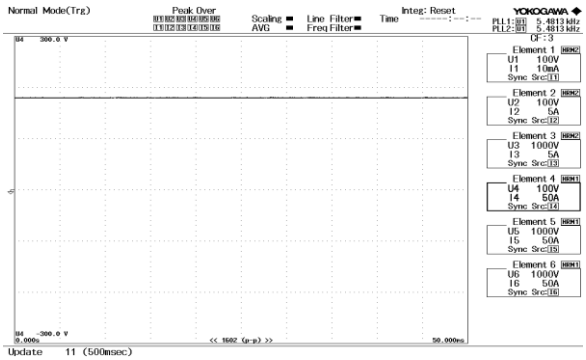


Figure 6: Input Direct Current

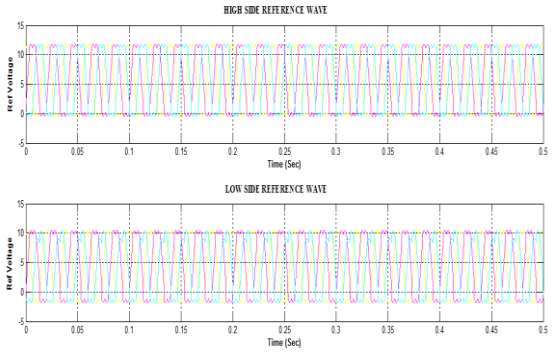


Figure 7: Reference Wave forms

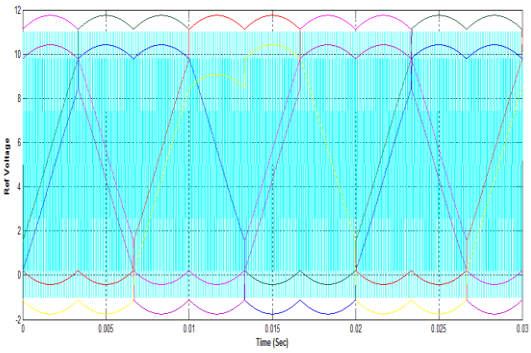


Figure 8: Time Vs Reference CE waves

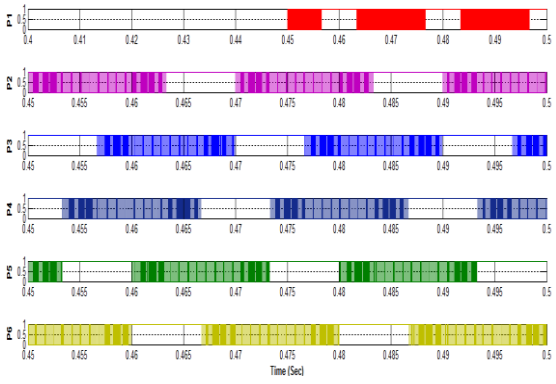


Figure 9: Triggering Pulses

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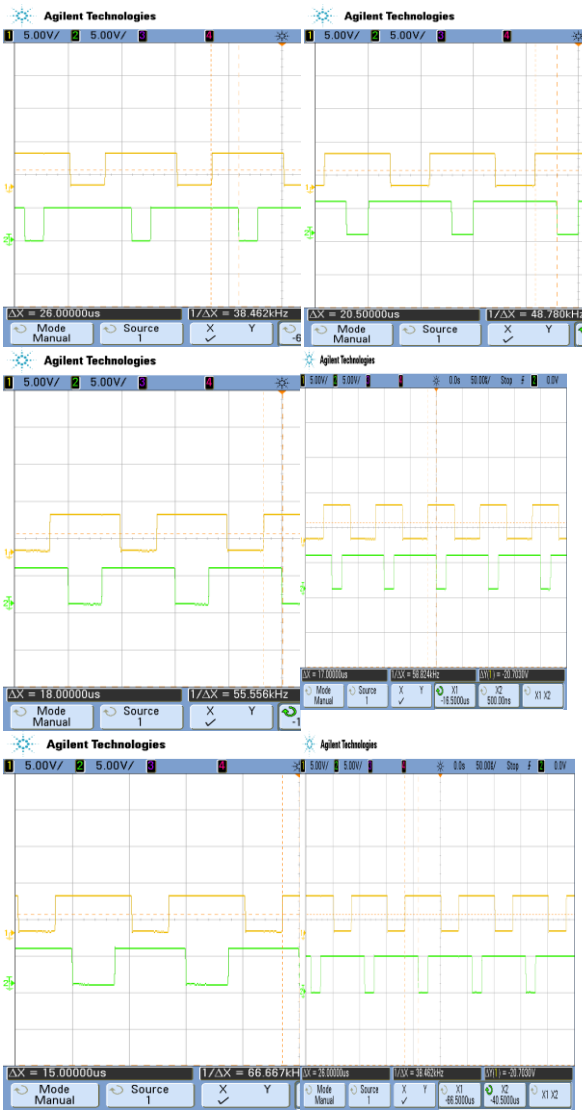


Figure 10: Triggering Pulse Wveforms

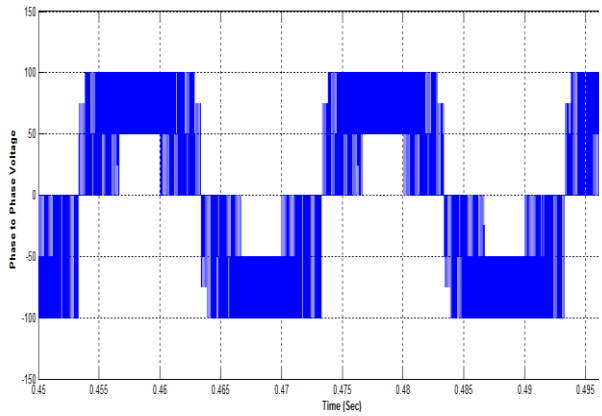


Figure 11: Output waveforms of software simulation

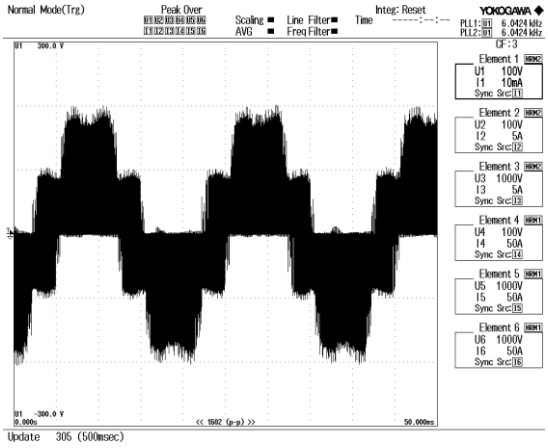


Figure 12: Phase Voltage waveforms

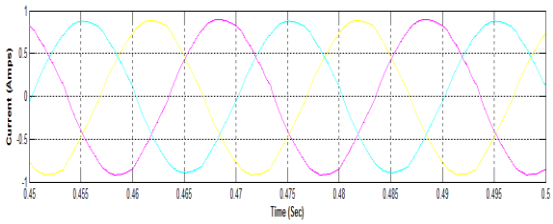


Figure 13: Current wave form

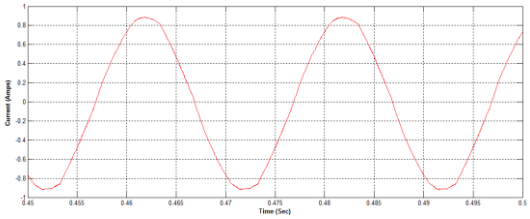


Figure 14: Single phase 230V, 50Hz AC Waveforms

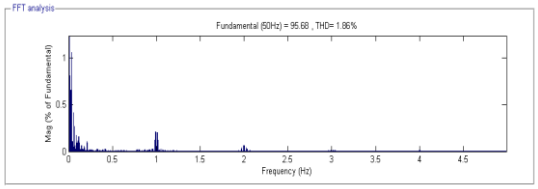


Figure 15: Total Hormonic Distorted waves

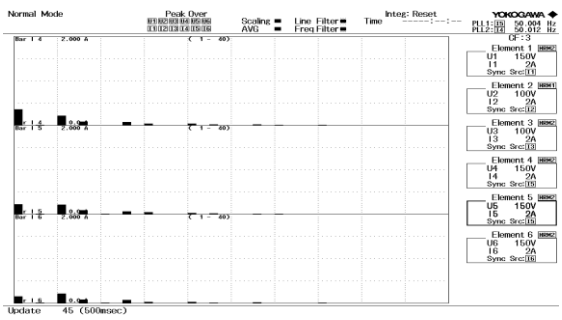


Figure 16: Under various Harmonic Condition



Figure 17: Vairous Total Harmonic Distortion

Table 3: Comparison of traditional SVPWM and modified SVPWM scheme

S.No	SVPWM	Values	Modified SVPWM	Values
1	Hybrid Dc voltage	100V	Hybrid Dc voltage	100V
2	Output voltage	90.25V	Output voltage	95.68V
3	Restive load	10 Ω	Restive load	10 Ω
4	switching frequency	10kHZ	switching frequency	10kHZ
5	Output current	1A	Output current	0.9A
6	THD	7.85%		1.86%
7	IGBT	IRF264	IGBT	IRF264
8	FPGA	Spartan 6E	FPGA	Spartan 6E

Figure 16 shows the simulation result of total harmonics distortion for Modified SVPWM and figure 17 shows the experimental result of THD for Modified SVPWM. The figure 18 shows the experimental result of THD for various levels. From the comparison shown in table 3 clearly states that the modified SVPWM scheme is the best choice for hybrid system and the simulation and experimental results yield too.

CONCLUSION

The topology of modified SVPWM for hybrid system is reported the simulation result and experimental result revels that the modified SVPWM is the more comfort for hybrid power generation. This system can be tied with grid interface too; the experimental result revels that the total harmonic distortion will be less compared with traditional SVPWM. The experimental setup is carried out on the FPGA – Spartan 6E plat form and the result of the two cases were compared.

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