ISSN: 0974-5823 Vol. 7 No. 7 July, 2022)

International Journal of Mechanical Engineering

AC-DC-AC 3-LEVEL PWM CONVERTER

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ABSTRACT

A three-level pulse width modulation (PWM) technique for ac to dc converter is proposed. Three-phase rectifier based on a double boost configuration with power factor correction is used on the input side. Three-phase three-level voltage source inverter based on a diode clamped scheme is employed in order to reduce the harmonic content of the inverter output voltages. On the rectifier side, the hysteresis current controller is used to track the line current command in phase with the mains voltage. A capacitor voltage compensator is adopted to balance the neutral point voltage in order to maintain good quality voltage waveforms on the output of the inverter. On the inverter side, three-level PWM based on sine-triangular comparison is used to reduce the voltage harmonics.

I. INTRODUCTION

Three-phase AC to DC pulse-width modulation (PWM) converters have been widely used in recent years due to their low line current distortion and high power factor. The application of multilevel converters brings further advantages. The higher voltage output with the same device rating, lower harmonic content, and reduced converter losses. The proposed method improves direct power control with space vector modulation applied for a 3-level 3-phase AC to DC neutral point clamped rectifier to achieve constant commutation frequency. The proposed PWM controller also ensures voltage balance in DC-link capacitors using redundant vectors in the Space Vector Modulation block without the need of additional components. Pulse width modulation (PWM) is a powerful technique for controlling analog circuits with a microprocessor's digital outputs. PWM is employed in a wide variety of applications, ranging from measurement and communications to power control and conversion. It is a very efficient means of controlling electrical power because the controlling element (the power transistor) dissipates comparatively little power in switching on and off, especially if compared to the wasted power dissipated by a rheostat in a similar situation.

II. AC–DC RECTIFIER

The circuit diagram of the full-bridge, three-phase, AC–DC rectifier is shown in next page. The power switch generally used in the rectifier is the SCR. The average DC output voltage is given by:

$$\mathrm{Vdc} = \frac{3\sqrt{2}}{\pi} V_L \cos\alpha$$

Where

V_L = line-to-line voltage on the three-phase AC side of the rectifier

α = angle of firing delay in the switching

The delay angle is measured from the zero crossing in the positive half of the AC voltage wave. Equation 11.1 shows that the output DC voltage can be controlled by varying the delay angle α, which in turn controls the conduction (on-time) of the switch. Superimposed on the DC voltage at the rectifier output are high-frequency AC harmonics (ripples). A harmonic filter is, therefore, needed to reduce the AC component of the output voltage and increase the DC component. An L–C filter does this with an inductor connected in series and a capacitor in parallel with the rectified output voltage.

The load determines the DC-side current as:

$I_{dc}=\frac{\text{DC load Power}}{\text{Vdc}}$

In steady-state operation, the balance of power must be maintained on both AC and DC sides. That is, the power on the AC side must be equal to the sum of the DC load power and the losses in the rectifier circuit. The AC-side power is therefore:

$Idc=\frac{\text{DC load Power}}{\text{Rectifier Efficiency}}$

the three-phase AC power is given by:

$P_{AC}=\sqrt{3}V_L I_L \cos\emptyset$

where cos∅ is the power factor on the AC side. With a well-designed power electronic converter, the power factor on the AC side is approximately equal to that of the

load.

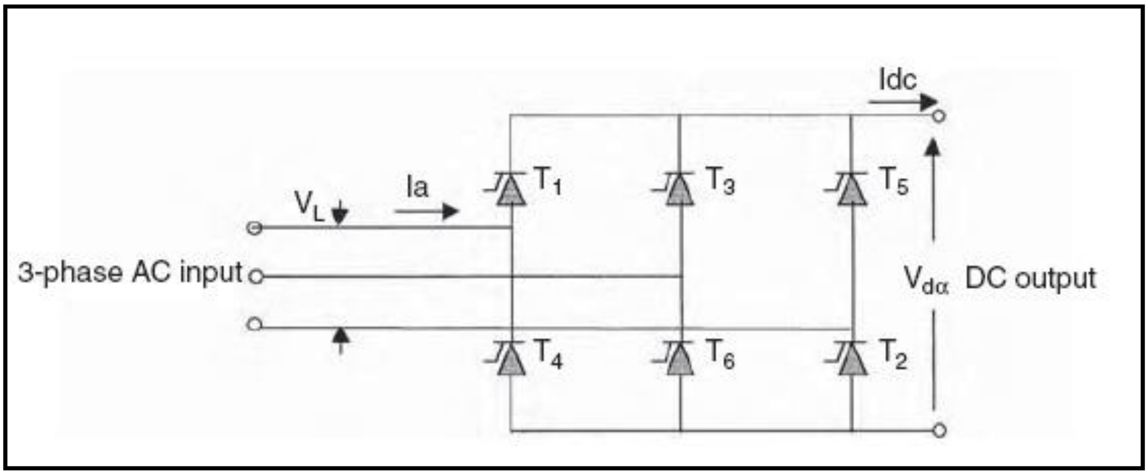
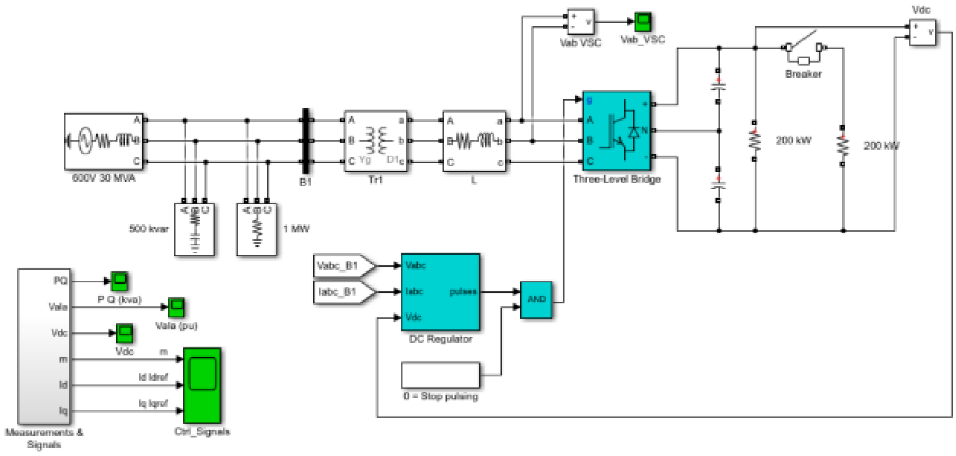


Fig 1: Three-phase, full-bridge, AC–DC controlled rectifier circuit

III. RESULT & DISCUSSION

Result

A 25KV 60 Hz, voltage source feeds a 50 Hz, 50 kW load through an AC-DC-AC converter. The 600V, 60 Hz voltage obtained at secondary of the star delta transformer is given to rectifier circuit which gives dc output voltage. The filtered DC voltage is applied to an IGBT two-level inverter generating 50 Hz. The IGBT inverter uses Pulse Width Modulation (PWM) at a 2 kHz carrier frequency[4][5]. The circuit is discretized at a sample time of 2 us. The load voltage is regulated at 1 pu (380 V rms) by a PI voltage regulator. The first output of the voltage regulator is a vector containing the three modulating signals used by the PMW Generator to generate the 6 IGBT pulses. The second output returns the modulation index. The Discrete 3-Phase PWM Pulse Generator is available in the Discrete Control Blocks library. The voltage regulator has been built from blocks of the Extras/Measurements and Extras/ Discrete Control libraries[3][6][1]. The ac output voltage obtained from IGBT converter is passed to LC filter to remove higher order harmonics .The Multimeter block is used to observe diode and IGBT currents. In order to allow further signal processing, signal.Start the simulation. After a transient period of approximately 50 ms, the system reaches a steady state. Observe voltage waveforms at DC bus, inverter output and load on Scope1. The harmonics generated by the inverter around multiple of 2 kHz are filtered by the LC filter.



AC/DC Three-Level PWM Converter

Fig2.simulation result of Wm in rpm, Tin N-m,I in mA, PWM signal It can be inferred that higher harmonics content at lower voltage can be reduced significantly by using several pulses of equal width at each half cycle ,thus the rms value of the output voltage of the inverter depends upon pulse width in turn modulation index ‘m’.

The advantages of using specified components are as follows: IGBT

It’s a voltage control device, hence the drive circuit is very simple

On state losses are reduced

No commutation circuits are required

It acts as a harmonic compensator LC Filters

In low pass LC filters the inductance offers a high impedance to harmonic voltage

Higher the harmonic number, higher will be the impedance and lower will be the magnitude of output voltage

Capacitance offers shunt path for the harmonic current.

Higher the frequency, lower will be the Xc and more harmonic current will be bypassed[4]

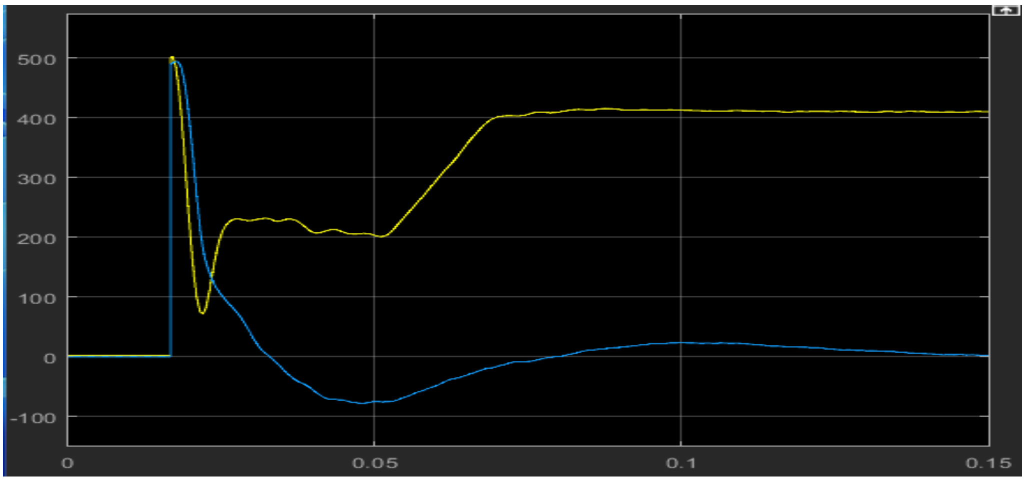


Fig3. Active Power Reactive Power PQ (kva)

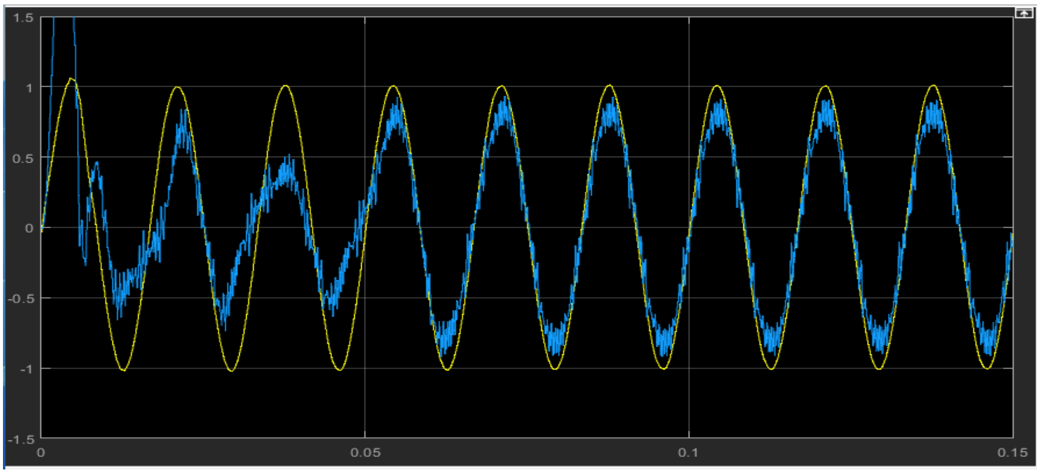


Fig4. Voltage (pu)

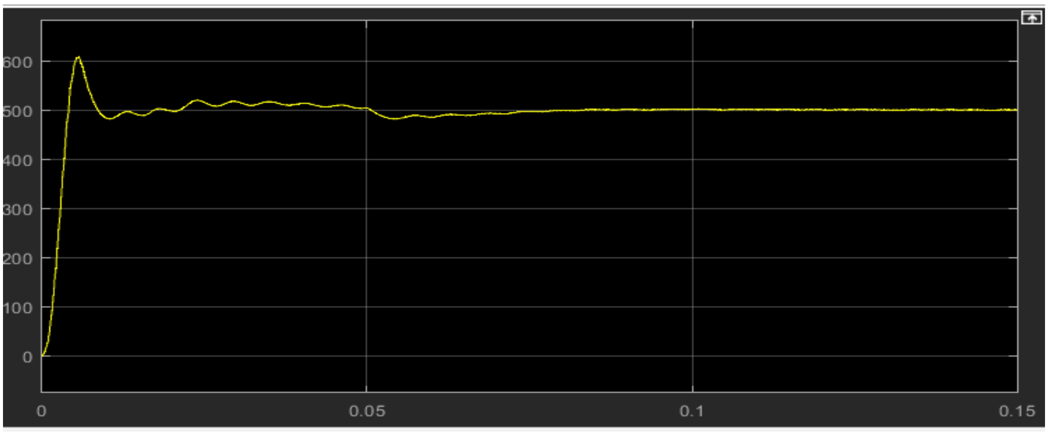
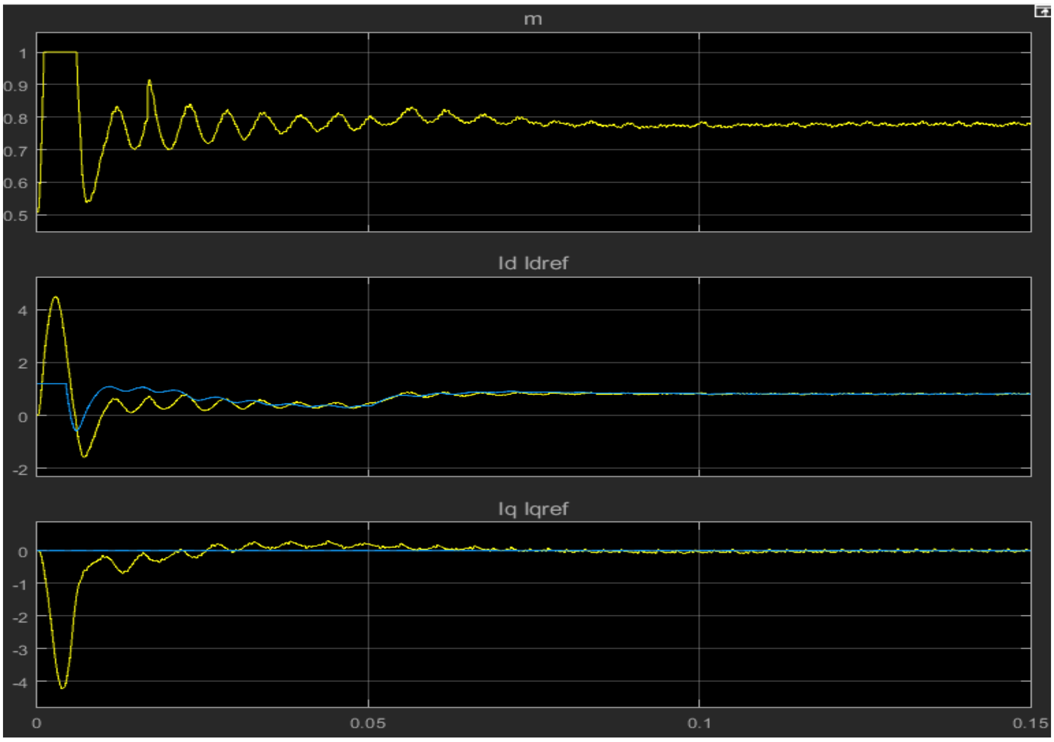


Fig5. DC voltage VDC



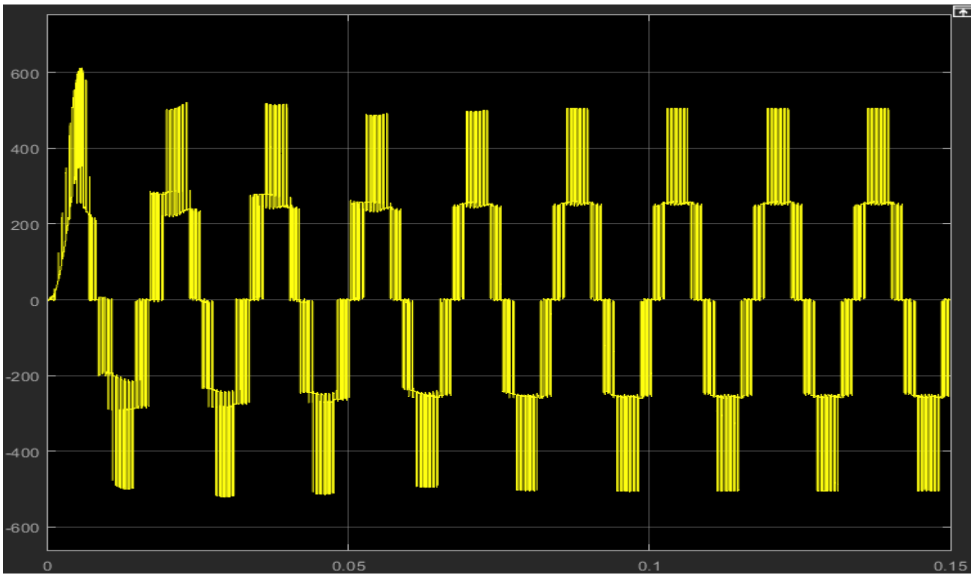


Fig6. Inverter Voltage Vab_vsc

Conclusion

The main objective is achieved, reducing harmonics and ripples during transmission. This approach provides fast synchronous-rectifier, adjustment, robustness to disturbance and the capability to simultaneously optimize multiple parameter. The PWM technique offer brilliant dynamics during the direct line currents tracking. The PWM technique permits the switching pattern to be appreciate on-line. This method regardless of the ease completion is tainted by the unreliable switching frequency accounting for the high current ripple. Dissimilar current organize carrier-based modulation straight impose sufficient converter input PWM voltages to track their reference standards. Therefore, the control system of the synchronous rectifier does not show the high dynamic presentation and the effects of instability are not mechanically compact.

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