POWERING INDUCTION MOTORS WITH PWM INVERTERS AUTOMATED MOTOR DRIVING: MODELING AND APPLICATION

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ABSTRACT: This paper demonstrates how to use an inverter to power a three-phase induction motor utilizing pulse width modulation (PWM). For driving induction motors, a system with seven switches and active current-shaping algorithms is optimal. The boost converter's output can be used to generate electricity by the inverter. In addition, the surge converter improves power factor. The boost converter enables the drive to function normally even when the input voltage is low.

***Key Words* -** PWM, Boost Converter, VSI and Induction Motor.

1. INTRODUCTION

PWM converter systems can be used in a variety of applications. Power systems, electric drives, UPSs, power systems, electric vehicles, reactive power compensators, active power filters, and power systems all use these technologies. Voltage source converters are frequently used to convert direct current (DC) to alternating current (AC). Both batteries and diode rectifiers can provide DC power. What are the components of a PWM inverter powered by a standard voltage source? Among these are the rectifier, DC-link, pulse width modulation (PWM) inverter, control circuit, and load. In current voltage source inverters, pulse width modulation is used to generate AC voltages with the magnitude, frequency, and waveform of sine waves. The input-output characteristics of the PWM inverter system must be taken into account while designing and implementing an appropriate control algorithm. Time domain and harmonic analysis are important techniques for comprehending and modeling power exchange systems.

2. THREE PHASE PWM INVERTER

Figure 1 depicts the application of three-phase PWM inverters. Inverters are electronic devices that convert direct current to alternating current. PWM inverters give a high level of power control with a waveform that is extremely near to sinusoidal. A 120-degree angle change has an effect on phase voltage and current. Three-phase pulse width modulation (PWM) inverters may generate a wide variety of controlling signal patterns. A three-phase amplifier with eight distinct operating modes is being studied. Each arrangement displays the status of the switch. Other modes, besides 0 and 7, hinder the passage of electric current and prevent it from reaching a load. Models 1-6 have more fluid movement. It can then construct two circuits with equivalent functionality: mode 1 corresponds to modes 2 and 4, and mode 3 corresponds to modes 5 and 6. To connect a voltage source to an alternating current (AC) source, inductance is used. This allows for voltage control in the form of a sinusoidal current, regardless of whether the voltage is reversed or corrected. Single-phase to three-phase or three-phase to single-phase conversion is possible with inverter-fed drive systems. Figure 2 depicts one of these setups. These devices are coupled by a pulse generator.

The use of anti-parallel diodes in the three-phase bridge design results in an instantaneous phase-leg-short when the inverter is turned on. Because of this, gate waves can align with a standard voltage source inverter (VSI). However, the DC link switch must always be in the on position. With the use of pulse-width modulation (PWM) inverters, more electromagnetic interference (EMI) signals can enter and exit the system. A Line Impedance Stabilization Network (LISN) was implemented after an electromagnetic interference (EMI) test. The inverter's input

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voltage waveform contained both high-frequency and fundamental components. High-frequency broadcasts, sometimes known as ringing signals, are considered to be disruptive noise. The Line Impedance Stabilization Network (LISN) is responsible for locating ringing phone noises. Whatever the state of the PWM inverter, its switching components cause noisy interruptions.

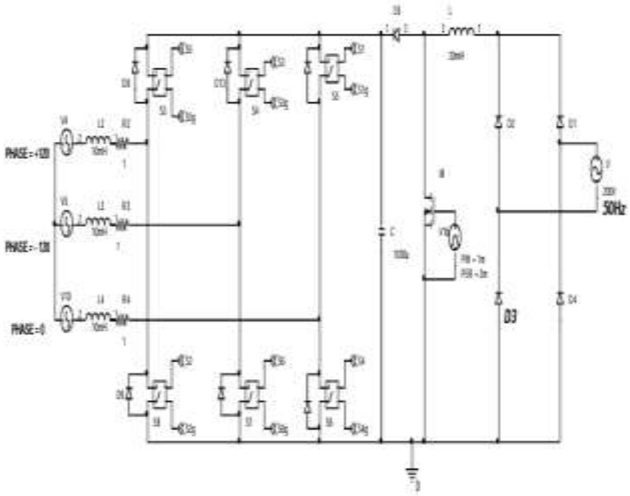

Fig. 1 A converter is being considered for use in converting a single-phase to a three-phase electrical system.

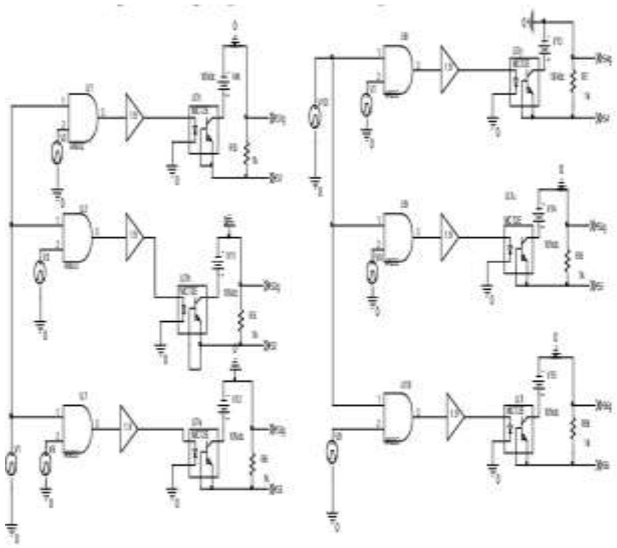

Fig. 2 How Impulse Generators Function

3. VOLTAGE SOURCE INVERTER

Figure 3 depicts three-phase rectifiers, boost converters, and inverters. The stator receives the three-phase output of a star-connected induction motor. Power devices are widely regarded as perfect since they can generate and sustain an open circuit in the absence of energy. This is referred to as blocking mode. Use these methods to compute the phase voltages from the line voltages in a balanced three-phase system. Line voltages will be expressed as phase voltages in a three-phase system with an ABC phase sequence.

$$V_{ab} = V_{as} - V_{bs} \quad (1)$$

$$V_{bc} = V_{bs} - V_{cs} \quad (2)$$

$$V_{ca} = V_{cs} - V_{as} \quad (3)$$

Line voltage voltage indicators are Vab, Vbc, and Vca, whereas phase voltage voltage indications are Vas, Vbs, and Vcs. Equation (1) is obtained by subtracting equation (3).

$$V_{ab} - V_{ca} = 2V_{as} - (V_{bs} + V_{cs}) \quad (4)$$

A three-phase total is not possible in three-phase systems.

$$V_{as} + V_{bs} + V_{cs} = 0 \quad (5)$$

In relation to formula (4), equation (5) implies that the line voltages Vab and Vca can be differentiated.

$$V_{ab} - V_{ca} = 3V_{as} \quad (6)$$

The strength is determined by the era.

$$V_{as} = \frac{V_{ab} - V_{ca}}{3} \quad (7)$$

Many phase number properties for variables b and c are the same.

$$V_{bs} = \frac{V_{bc} - V_{ab}}{3} \quad (8)$$

$$V_{cs} = \frac{V_{ca} - V_{bc}}{3} \quad (9)$$

The phase voltages are stepped six times and follow a sine wave pattern. These occurrences happen every 120 degrees and are triggered by line voltages as well as line-to-line voltages. The Fourier components of these periodic voltage waves are as follows:

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Vol-09 Issue-9 No. 1 September 2019

$$V_{ab}(t)=\frac{2\sqrt{3}}{\pi}V_{dc}\left(\sin\omega_s t-\frac{1}{5}\sin 5\omega_s t+\frac{1}{7}\sin 7\omega_s t-\ldots\right) \quad (10)$$

$$V_{bc}(t)=\frac{2\sqrt{3}}{\pi}V_{dc}\left\{\sin(\omega_s t-120^\circ)-\frac{1}{5}\sin(5\omega_s t-120^\circ)+\frac{1}{7}\sin(7\omega_s t-120^\circ)\ldots\right\} \quad (11)$$

$$V_{ca}(t)=\frac{2\sqrt{3}}{\pi}V_{dc}\left\{\sin(\omega_s t-120^\circ)-\frac{1}{5}\sin(5\omega_s t-120^\circ)+\frac{1}{7}\sin(7\omega_s t-120^\circ)\ldots\right\} \quad (12)$$

Based on the line voltages and the amount of Vdc, the phase voltages exhibit a 30 degree phase shift. The fundamental component of inverter-fed AC motor drives generates power, which must be validated in a steady condition. The root mean square phase voltage for a basic six-step pattern is

$$V_{ph}=\frac{V_{ab}}{\sqrt{2}}=\frac{2}{\pi}\cdot\frac{V_{dc}}{\sqrt{2}}=0.45\,V_{dc} \quad (13)$$

Regardless of the type of control employed on the induction motor transmission, the input values remain constant. When certain requirements are met at the border, we can assess steady-state success. To evaluate steady-state induction motor propulsion systems, pulse-width modulation (PWM) voltage sources are used. PWM can be created using a number of techniques, including the space vector, sampled-asymmetric, sine-triangle, and trapezoidal-triangle methods. Without the requirement for dynamic simulations, the boundary-matching methodology is an excellent method for determining the steady-state current vector in electrical systems. This method is particularly useful because it may be used in both half-wave and full-wave configurations. In the first stage, R4 is assigned the value 1. Part D1 is then associated with MUR150, R3, and a one-digit number. S4 and L2 are connected by nodes s4 and s1, as well as a 10mH inductance in the third phase. D2 is then connected to MUR150 with a value of 0. Add a 10 mH inductance to L3 and connect it to node s3. The reference 0 then connects the node S1 to the node S6. D3 is linked to MUR150 and a 1000 u capacitor in the seventh stage. R2 is then linked to S5 using the digit 1. M1 is eventually related to D5, V1b, and IRFP460 by references 3, 1, and 0. -The power is 100 microunits, the period is 2 meters, and the time delay is 1 meter. The phase is 0 degrees and is represented by a plus symbol. For S6, L4, and MUR150, they are 10, 1, 2, and s2 millihenries, for a total of 20 millihenries.

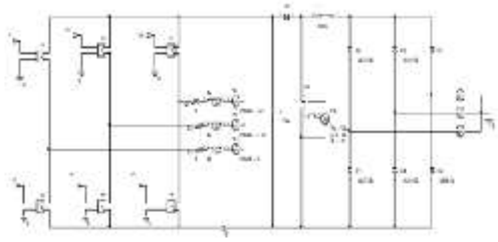

Fig. 3 A three-phase converter power system is being considered.

4. SIMULATION RESULTS

In a three-phase inverter-fed drive, a diode rectifier converts low-voltage alternating current (AC) to direct current (DC). The boost converter was serviced. The voltage and frequency of direct current (DC) to alternating current (AC) are varied via a three-phase pulse width modulation (PWM) converter. The Pulse Width Modulation (PWM) converter powers the three-phase induction motor. Figures 4 and 5 depict the line-to-line and phase voltages, respectively. The data for the single-phase-to-three-phase converter is shown in Figure 6, and the Fourier spectrum is shown in Table 1. Inverters that convert three phases to three phases have voltage and current patterns for each phase. This is seen in Figures 7 and 8. The Fourier spectrum of the converter system is depicted in Figure 9, and its statistics are listed in Table 2.

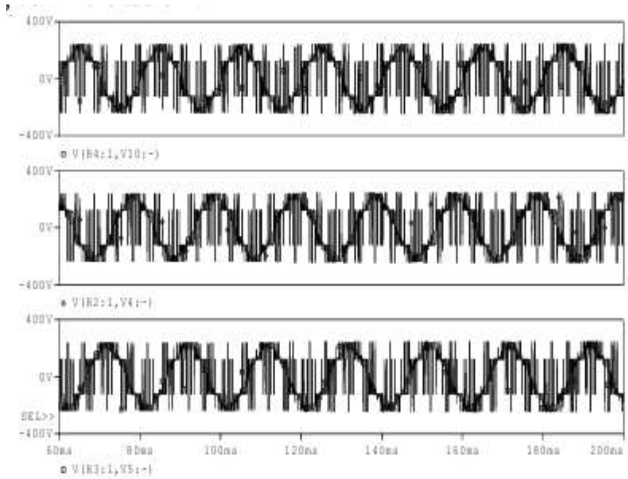

Fig. 4 The voltage at which an electrical system or component ceases to function is known as the phase-out voltage.

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Vol-09 Issue-9 No. 1 September 2019

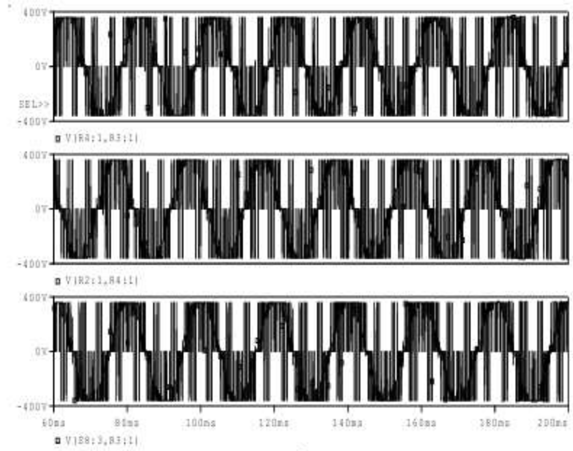

Fig. 5 the energy emitted by the lines.

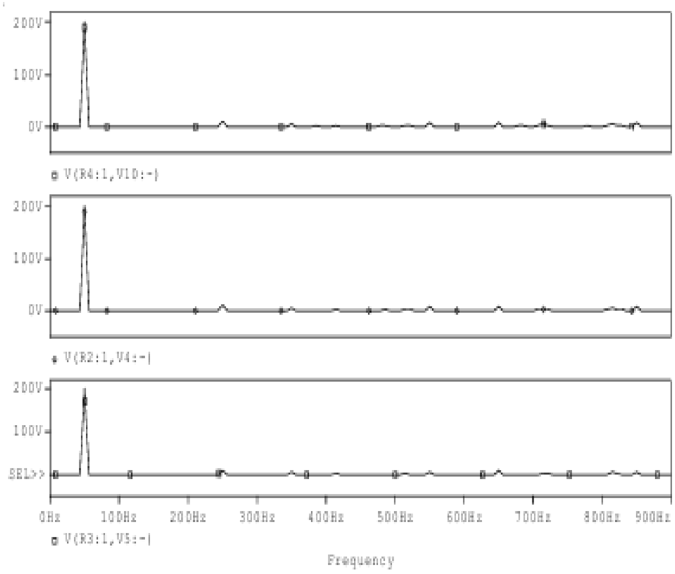

Fig. 6 The Fourier Transform can be used to turn a function of time into a function of frequency.

TABLE.1

DC COMPONENT = -2.953419E+00

HARMONIC NO	FREQUENCY (HZ)	FOURIER COMPONENT	NORMALIZED COMPONENT	PHASE (DEG)	NORMALIZED PHASE (DEG)
1	5.000E+01	1.514E+01	1.000E+00	-4.681E+01	0.000E+00
2	1.000E+02	9.157E-01	6.050E-02	-7.788E+01	1.575E+01
3	1.500E+02	6.239E+00	4.122E-01	-8.906E+01	5.138E+01
4	2.000E+02	4.353E+00	2.876E-01	-5.235E+01	1.349E+02
5	2.500E+02	9.376E-01	6.195E-02	9.447E+01	3.285E+02
6	3.000E+02	3.976E+00	2.627E-01	-5.688E+01	2.240E+02
7	3.500E+02	4.072E+00	2.690E-01	1.489E+02	4.766E+02

TOTAL HARMONIC DISTORTION = 6.336107E+01 PERCENT

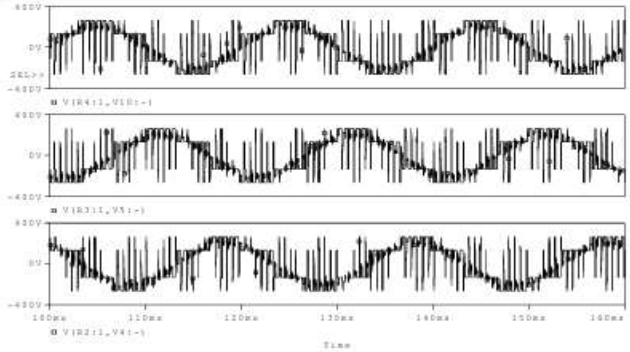

Fig. 7 The voltage source's waveform.

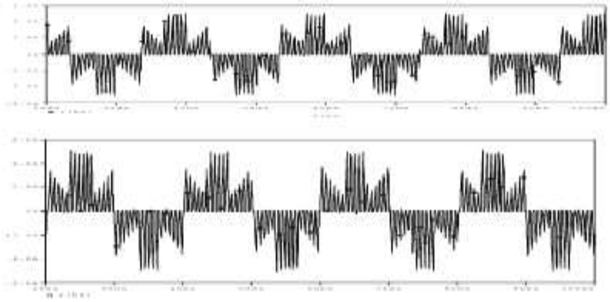

Fig. 8 how the outcome now displays.

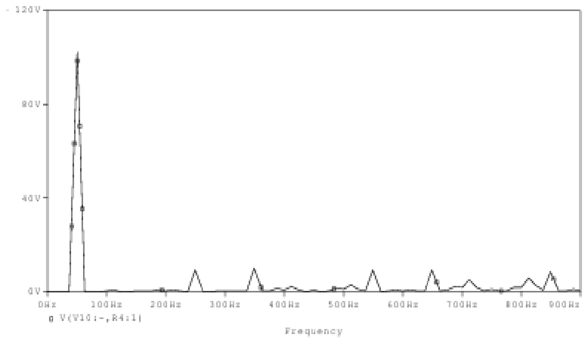

Fig. 9 The Fourier Transform is seen in Figure 9.

TABLE.2

DC COMPONENT = -2.212318E-02

HARMONIC NO	FREQUENCY (HZ)	FOURIER COMPONENT	NORMALIZED COMPONENT	PHASE (DEG)	NORMALIZED PHASE (DEG)
1	5.000E+01	1.371E+00	1.000E+00	-2.774E+00	0.000E+00
2	1.000E+02	1.347E-01	9.822E-02	-9.393E+01	-8.838E+01
3	1.500E+02	2.533E-03	1.848E-03	-8.632E+00	-3.092E-01
4	2.000E+02	1.317E-01	9.608E-02	-9.812E+01	-8.703E+01
5	2.500E+02	5.547E-01	4.046E-01	-1.322E+01	6.550E-01
6	3.000E+02	4.663E-02	3.401E-02	-1.081E+02	-9.145E+01
7	3.500E+02	4.681E-01	3.414E-01	-2.165E+01	-2.230E+00

TOTAL HARMONIC DISTORTION = 5.480105E+01 PERCENT

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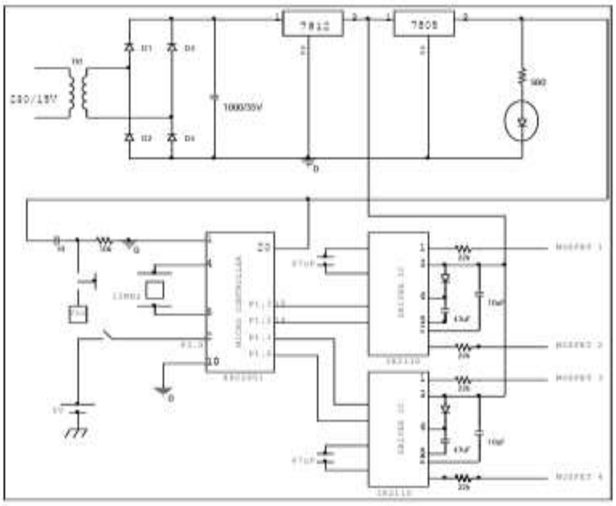

Fig. 10. A control system is a collection of tools or methods used to command, govern, or modify the behavior of a system or an individual.

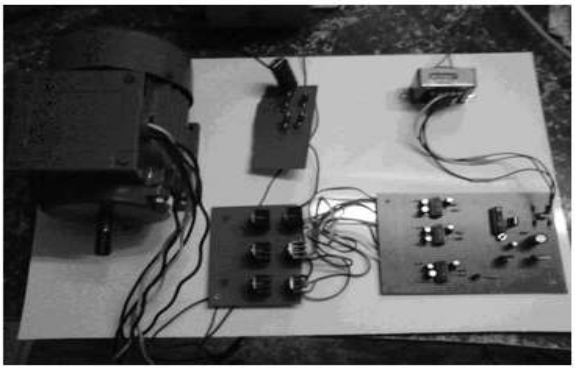

Fig 11. Hardware refers to the physical components or equipment used in computers and other technological endeavors. It goes over the actual instruments.

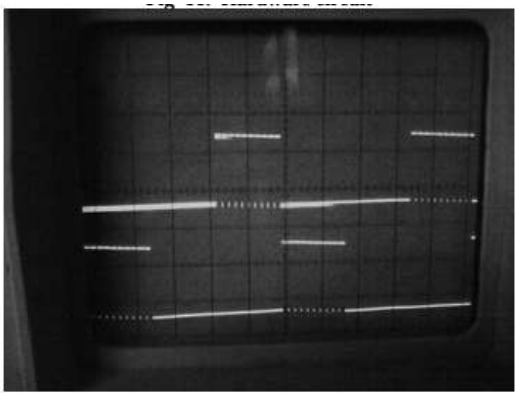

Fig 12. Space-traveling waves produce oscillograms.

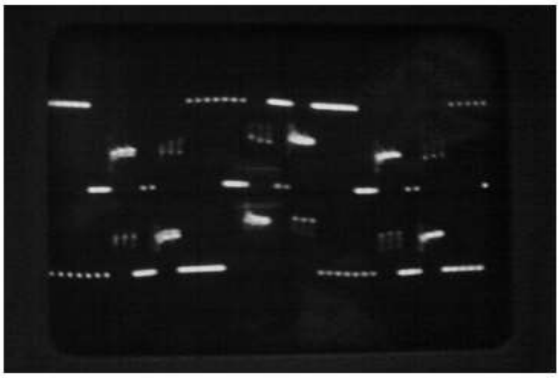

Fig 13. The voltage phase oscillogram.

5. CONCLUSION

Circuit models were created for inverter systems that operate on single-phase, three-phase, and three-phase to three-phase voltages. A voltage source inverter-driven induction motor drive was also investigated. The circuit model demonstrates the operation of an induction motor using a three-phase pulse width modulation (PWM) amplifier. Both the single-phase to three-phase inverter system and the three-phase to three-phase inverter system have formulas and test data. The frequency spectrum will be displayed if these conditions are met. Harmonic distortion of 5% was found in three-phase to three-phase inverter systems. Harmonic distortion in single-phase systems was determined to be 6.3%, which was slightly higher. A boost converter was recommended in this study to address the problem of insufficient input power in an inverter-fed DC motor driving system. An induction motor with a 1 kW generator is used for testing and construction. The program's results are identical to those observed in reality.

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