

# A REVIEW ON Z-SOURCE INVERTER FED INDUCTION MOTOR

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**Abstract:** In this research paper, a study on primarily based on vector managed Z-source inverter. Vector control lets in the manage of inverter fed induction motor, similar to control of one after the other excited DC motor which is as comparatively simpler. It is viable that it is the best among all of the manipulate strategies for variable speed packages. It proposed method enormously reduces the complexity and value when we compared with conventional structures.

**Keywords:** Voltage Source Inverter (VSI), Current Source Inverter (CSI), Z-Source Inverter (ZSI), Vector Control.

## I. INTRODUCTION TO Z-SOURCE INVERTER

A Z-deliver converter is a completely unique impedance network, called Z-supply impedance network that matches the converter crucial circuit to the strength supply. A Z-supply inverter is confirmed in Fig 1.1. Although the traditional inverters used for power manipulate of ASDs are voltage source inverter (VSI) and current source inverter (CSI) which consists a diode rectifier front quit, DC hyperlink and Inverter Bridge, as proven in Fig.1.2. Voltage supply inverter and the contemporary supply inverter are characterized by using way of incredibly low efficiency simply due to switching losses and giant EMI generation. The top and the decrease devices of every section leg cannot be switched on the equal time, in any other case, a shoot occur and destroy the devices.

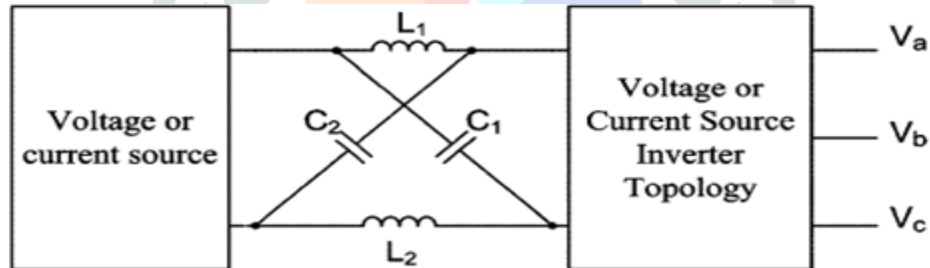


Fig: 1.1: General Block Diagram Representation of Z-Source Inverter.

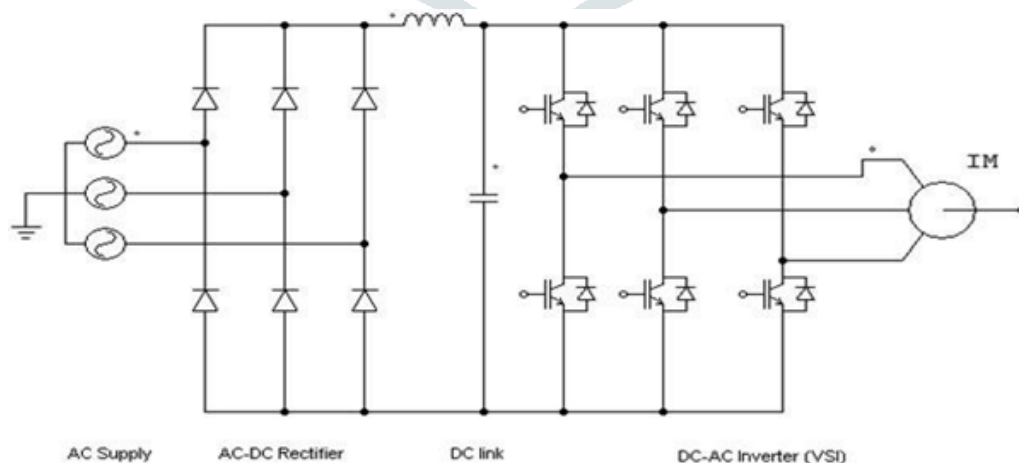


Fig: 1.2: A Conventional VSI Drive with Front end Rectifier

Z-supply inverter advantageously uses the shoot by the usage of states to beautify the DC bus voltage by manner of gating on each the top and the lower switches of the identical segment leg [1]-[3]. The shoot thru mode permits simultaneous conduction of gadgets in same segment leg. That is the motive; a Z- source inverter can boost or dollar voltage to a favored output voltage, it's extra or a whole lot much less than the DC bus voltage. In addition reliability of the inverter may be very quiet advanced due to the reality now the shoot via can now not destroys the circuit. A Z-supply inverter primarily based induction motor pressure offers a low price and very relatively green, unmarried degree shape for dependable operation [4].

The conventional inverters are modern source inverter (VSI) and voltage deliver inverter (CSI). It consists of a diode rectifier front end, inverter bridge and DC link. The DC hyperlink voltage is extra or much less equal to as a minimum one.35 times the line voltage, and the voltage supply inverter is a buck converter that may high-quality produce an AC voltage limited with the useful resource of the DC link voltage, so voltage deliver inverter and modern-day supply inverter are characterized by using alternatively low overall performance due to switching losses and massive EMI generation. The voltage supply converter is broadly used however have the subsequent conceptual and theoretical limitations and boundaries [8]:

- The AC output voltage is restrained below and the AC output voltage can't exceed the DC bus voltage or the DC bus voltage ought to be extra than the AC enters voltage. Therefore, the voltage deliver inverter is a dollar inverter for DC-to-AC strength conversion and the voltage supply converter is a boost rectifier for AC to DC strength conversion. For packages wherein over strain is suited and the to be had DC voltage is limited, a similarly DC-DC decorate converter is needed to benefit a favored ac output. The extra energy converter degree will increase best systems price and lower the performance.
- The decrease and better devices of each segment leg can't be switched on simultaneously each via EMI noise or with the aid of the use of cause. Otherwise, a shoot could arise and damage the gadgets. The lifeless-time to dam each of better and reduce gadgets wants to be furnished in voltage source converter, motives waveform distortion and so forth.
- The output of LC filter is needed to provide a sinusoidal voltage that as compared with the modern supply inverter causes extra energy loss and extra manage complexity.

However, the current Source converter has the following conceptual and theoretical obstacles and difficulty and limitations [8].

- The output voltage of AC has to be more than the actual DC voltage, this is used to feeds the DC inductor or DC voltage produced will continuously smaller than the enter voltage of AC. Hence, the modern deliver inverter is a boost inverter honestly for DC to-AC energy conversion and the modern-day deliver converter is a greenback rectifier for AC-to-DC strength conversion. For any applications in which a highly voltage range is suitable, then a in addition DC-DC dollar converter is needed.

At least one of the pinnacle gadgets and one of the decrease gadgets must be gated on and maintained on at any time. Otherwise, an open circuit of DC inductor may occur and may damage the devices. Waveform distortion is also feasible if Overlap time for secure modern commutation is needed within the modern-day-day supply converter.

In extra, both of the voltage source converter and current source converter have the following common or main problems:

- They can be both a boost and a buck converter. They cannot be a buck-boost converter i.e. the output voltage range is limited to either more or smaller than the enter voltage.
- The primary circuit isn't interchangeable. In other phrases, neither the voltage source converter most important circuit may be used for the present day supply converter and nor vice versa.
- In terms of reliability they are vulnerable to EMI noise.

## II. FUNDAMENTAL OF Z-SOURCE INVERTER

The Z-source inverter is used to overcome the problems within the traditional inverters in reality. It makes use of a completely specific impedance network coupled with the inverter's important circuit to energy supply. The AC voltage is rectified to DC voltage via manner of the rectifier. Rectifier output of DC voltage fed to the impedance network that includes equal capacitors and same inductors. The network inductors are related in collection hands and capacitors are related in diagonal hands. This impedance network is used to decrease or boom the input voltage. This community additionally acts as a second order filter and it ought to required less inductance and plenty less capacitance [9]. The inverter most important circuit consists of six switches.

These inverters use a completely unique impedance network actually that coupled most of the converter circuit and strength supply, to offer that homes that cannot be find out with schematic cutting-edge source and voltage source inverters [4]. Now specific characteristic of Z supply inverter is- the output of AC voltage can be any wide variety that exists amongst 0 and Infinity irrespective of DC voltage. That is, Z-supply inverter is an inverter that has a big type of voltage Control.

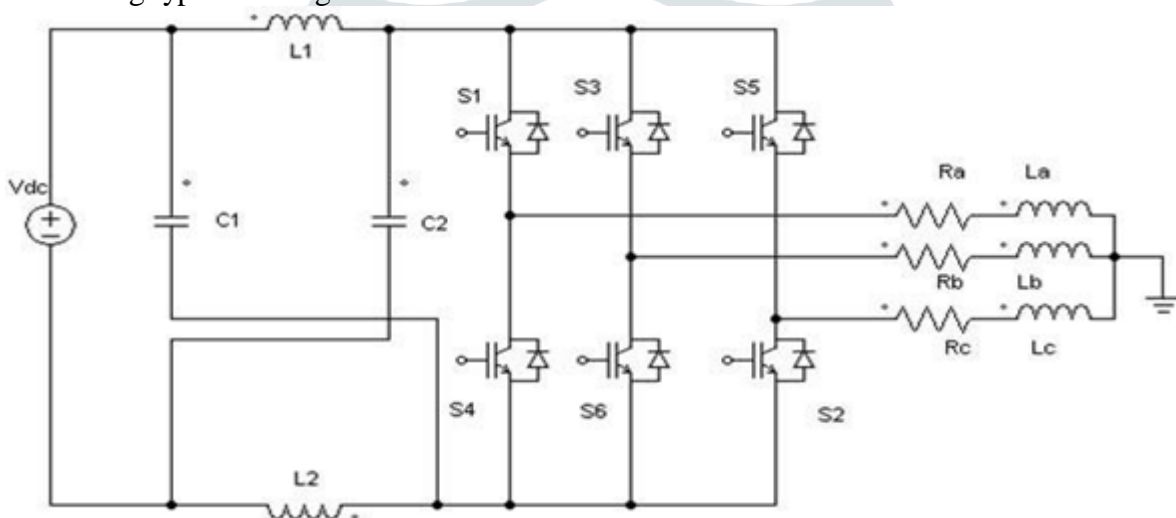


Fig2.1 Z-Source Inverter with RL Load

To describe the running precept and manage of the Z source inverter in Fig.2.1, allow us to do not forget the traditional three-segment voltage source inverter shown in Fig 2.2 Which has six lively vectors.

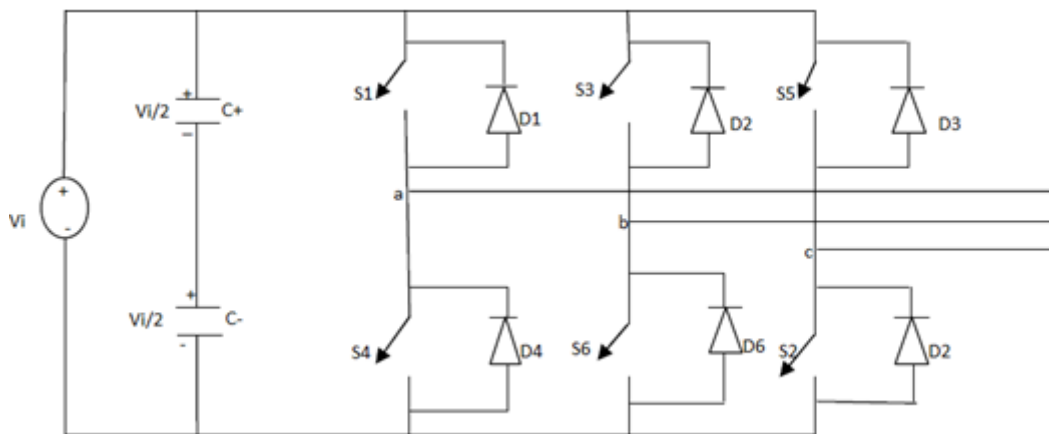


Fig 2.2 Three Phase VSI Topology

When the DC voltage is struck at some stage in two zero vectors and load, a zero nation is produced. When the higher 3 (or decrease three) switches are grew to come to be on at the equal time, shorting the output terminals.

## Z-SOURCE INVERTER FED THREE PHASE INDUCTION MOTOR DRIVE

A Z-supply inverter fed induction motor pressure machine has 4 important components: a diode rectifier, a Z-supply (containing two series inductors and identical, diagonally connected capacitors), an inverter bridge and a three section induction motor load. The diode rectifier fed by using the 415 V AC line produces approximately 560 V DC at the DC hyperlink, which is kind of 1.35 instances the road to line input voltage beneath the belief of heavy load. For small drives with no good sized inductance, the line current becomes discontinuous and the DC voltage is toward 1.41 instances the line to line voltage, the low output voltage importantly limits our output strength this is directly proportional to the rectangular of the voltage. It may be very unwanted for lots applications because the inverter and the force system are to be outsized for the specified electricity. The voltage sags can disturb or smash an induction motor power system and shut down the process and vital hundreds.

The DC capacitor in the induction motor drive is a relatively small energy storing element, which can't hold DC voltage above the operating level under such voltage sags. Ride via capability is the severe hassle especially for the automobiles riding touchy loads. The harmonic and inrush contemporary from the diode rectifier can damage the line. Actually low power factor is likewise a subsequent problem of an induction force. Recently evolved Z-supply inverter offers the solution for the above issues [11]-[12]. The structure of a Z-source inverter fed induction motor force is shown within the Fig. 2.3

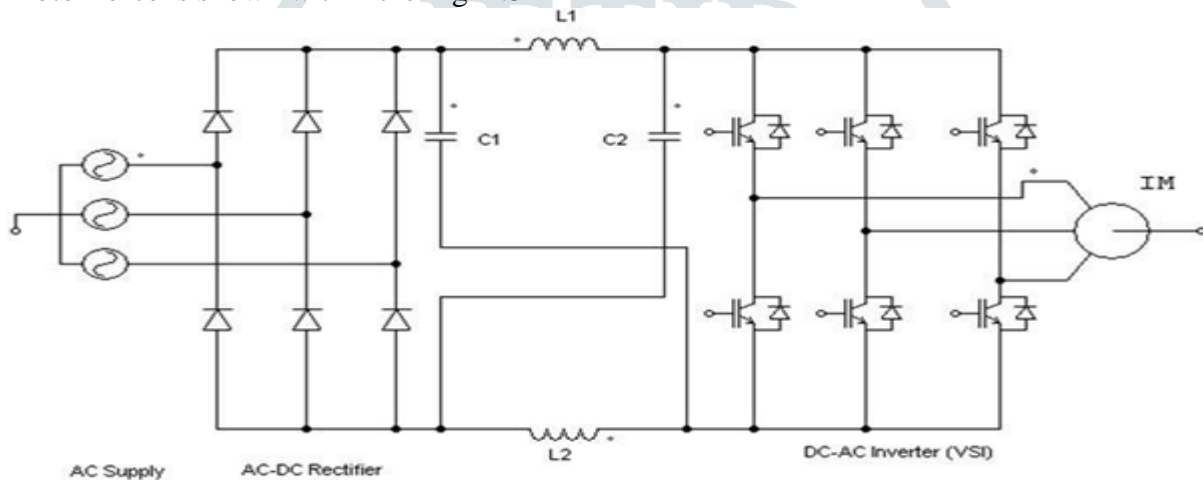


Fig 2.3 Z-Source Inverter Fed Induction Motor Drive

## MAIN FEATURES OF Z-SOURCE INVERTER AND ITS ADVANTAGES

1. The equal switching frequency is six instances more than the switching frequency of the number one inverter, which greatly reduces the preferred inductance of the Z-deliver community.
2. The Z-deliver inverter is a dollar-enhance inverter, function that conventional voltage deliver inverter and modern-day-supply inverter can't offer. All traditional PWM schemes may be used to govern Z-supply inverter and their theoretical enter output dating nonetheless keep.
3. The electric scheme is clear-cut and efficient, so the charge is decreased and efficiency is progressed. This new idea may be implemented to the complete spectrum of energy conversion.
4. By controlling the shoot-thru obligation cycle, the inverter device the use of IGBTs, offer ride-via functionality all through voltage sags.
5. It simply reduces the line harmonics, improves power factor, increases reliability and extends output voltage range.

## Z-SOURCE INVERTER LIMITATIONS OR DISADVANTAGES

A limitation is that Z-supply inverter has decrease common switching device strength in low improve ratio variety (1-2). In cases whilst a low voltage is used and a boost ratio a whole lot better than 2 is wanted, the DC-DC boosted PWM inverter is the best configuration.

As disadvantage, the identified right-half-plane (RHP) zero in its control-to-output transfer function can't be eliminated by adjusting the Z-source parameters as discussed in [13]. This RHP zero causes the inverter output to dip before rising when a step increase in reference is triggered within the controller. For eliminating the RHP zero, numerous classical techniques are given which are reported in [14]–[16].

### III. INTRODUCTION TO VECTOR CONTROL

The simple goal of the vector manage scheme is, to be able, to manipulate the electromagnetic torque of induction motor in a fashion that's equal to a one after the other excited DC gadget. Vector control is likewise referred to as field-oriented manage that enables control over both the excitation flux- linkages and the torque-generating modern-day in a decoupled fashion. Still, most effective the rotor-flux- oriented manage yields complete decoupling. It illustrate to the induction motor operation in a synchronously rotating  $d^e - q^e$  reference body this is aligned with one of the motor fluxes, usually the rotor flux [5]. In this fashion of operation, manager of the torque and flux is decoupled such as the d- Axis element of the stator modern-day controls the rotor flux value. And the q-axis component controls the output torque [6]. The tool terminal phase currents  $i_a$ ,  $i_b$ ,  $i_c$  and are transformed to and with the resource of three section to 2 section transformation. These are converted to synchronously rotating reference frame through three-unit vector components.

Vector control scheme depends on the sphere attitude, labeled as follows-

1. Direct or feedback control.
2. Indirect or feedback forward control

In this dissertation paintings oblique vector manage is used, that is based on reconstruction (estimation) procedures using terminal quantities along with voltage and currents in a motor model to calculate the flux position. The speed blunders, with the help of a PI speed controller, is transformed into a torque controlling present day thing  $i_q$ s of the stator cutting-edge. This modern-day aspect is used to modify the torque at the side of the slip pace [7].

Induction cars are rugged, less expensive, green and requires less renovation. In spite of those advantages the motor possesses a hard torque speed traits i.e. Its velocity is nearly consistent with the torque and subsequently it's miles typically a regular pace device. However, many programs want variable velocity operations. The controlling and riding to the induction motor expeditiously are essential issues in conscious global of these days power area. Various induction motor control strategies are in exercise today, which might be discussed in this bankruptcy.

### IV. CONTROL TECHNIQUES

Lots of speed control techniques carried out by modern-age Variable Frequency Drive are mainly partitioned in three categories as given below:

- Scalar Control (V/f Control)
- Direct Torque Control (DTC)
- Vector Control (Indirect Torque Control)

The various control strategies for the control of inverter fed induction motor have provide good steady-state but poor dynamic response, which results that the air-gap flux linkage deviate from its set values, not only in magnitude but also in phase. This oscillation in the air gap flux linkage results in oscillations in electromagnetic torque and hence in speed oscillations [24].

Individually activated DC drives are easier in control because they independently control the flux that is when maintained constant, leads to an independent control of torque. But AC induction motor drive requires a coordinated control of stator current's magnitude, frequency and their phases making it a complex control. The control of an induction motor can be carried out in same way as in DC motor by resolving the stator current

phasor along the rotor flux linkage, which can be achieved by vector control.

This type of control is also known as Field Oriented Control, Flux Oriented Control or Indirect Torque Control. By using field orientation (Clarke-Park transformation), three-phase current vectors are altered to a two-dimensional rotating reference frame ( $d \text{ } q$ ) from a three-dimensional stationary reference frame. The "d" component represents the flux producing component of the stator current and the "q" component represents the torque producing factor.

These two dissociated parts can be independently controlled by passing through different PI controllers then PI controllers output are transformed back to the three-dimensional stable reference plane using the opposite of the Clarke-Park transformation. This manipulate simulates a one at a time excited DC motor version, which affords an outstanding torque pace curve. The transformation from the static reference frame to the rotating reference frame is done and controlled with reference to a particular flux linkage space vector (i.e. stator flux linkage / rotor flux linkage / magnetizing flux linkage). Generally, there are three possibilities for such type of selection and that is the reason why three different vector controls exist.

These are given as below:

- Stator flux oriented control
- Rotor flux oriented control
- Magnetizing flux oriented control

As the torque producing factors or parts in this type of control is controlled only after transformation is done. And it is not the main input, such control is also known as "indirect torque control". The most ambitious and in the end, the limiting feature of the field orientation, is the techniques whereby the flux angle is calculated or measured or expected. Depending on the technique of measurement, the vector manages is separated into two subclasses: *direct and indirect vector control*.

In direct vector manipulate, the flux dimension is carried out by using the flux sensing coils or the Hall devices. It provides to more hardware price and further, measurement isn't always too accurate. Therefore, this technique is not a great control technique. The greater not unusual method is oblique vector manage. In this technique, the measurement of flux attitude cannot take at once, but it is calculated from the equivalent circuit fashion and from measurements of the rotor speed, the stator voltage and current.

## ADVANTAGES OF VECTOR CONTROL

- 1) Stable operation with large motors.
- 2) Better performance at current limit with improved slip control.
- 3) Decrease in the losses of the machine.
- 4) Excellent speed control with inherent slip compensation.
- 5) High torque at low speeds.
- 6) Increase in the overall performance of the motor.

## DISADVANTAGES OF VECTOR CONTROL

- i) The control algorithm is heavily complex as compared to other control strategies.
- ii) It needs a comparatively fast processor to implement at the required switching frequency.
- iii) Parameter detuning causes high torque and flux magnitude errors.
- iv) The equipment required for vector control of induction motor is very costly.

## CONCLUSION

The Z-source inverter follows a few concepts that cannot be furnished via conventional VSI and CSI. The Z-supply converter overtakes the conceptual and unreal obstacles and barriers of the conventional VSI and CSI and gives a novel strength conversion idea. The Z-source idea may be without difficulty applied to ASD systems. The Z-supply rectifier/inverter device can create an output voltage that is higher than the AC input voltage is the function that is absent inside the traditional converters.

In this financial ruin indirect vector manage method became discussed. It indicates that after vector control technique is implemented on induction motor and gives ease on top of things similar to the control of one after the other excited DC machine. It is compared by the use of different manipulate strategies like scalar and direct torque manage and determined to be higher and additional effective than other strategies.

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