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# Induction Motor Fed by Γ Z- Source Inverter

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***Abstract: The main focus is on the losses that occur in an Induction motor and to select a suitable Inverter that feeds the Induction motor. Various analysis are performed on the different types of Inverters and on completion of those analysis, the Gamma Source Inverter has better performance characteristics is chosen to fed the Induction motor. This project also deals with the possibility of energy savings in Induction motor. The modeling of Gamma source inverter has been presented using MATLAB/SIMULINK. The normal Impedance-source Inverters are Inverters with voltage-buck-boost capability that cannot be achieved by the traditional Inverters. Their boost capability is introduced by shorting their phase legs without causing damages. Impedance-source inverters are therefore less prone to false triggering caused by electromagnetic interference. Present Impedance-source inverters are, however, burdened by their low modulation ratio at high input-to-output gain. Such low modulation usually leads to high-voltage stresses across the components and poor spectral performance at the inverter output. To avoid these problems, Inverters with coupled transformers have been introduced, but they usually lead to high turns ratio, and hence many winding turns, at high gain. An alternative would then be the asymmetrical Γ-source Inverters proposed in this paper, whose Gain is raised by lowering their turns ratio toward unity. The input current drawn by the proposed inverters is smoother and, hence, more adaptable by the source. Theories and experimental results have been presented in this paper for validating the concepts proposed.***

## I. INTRODUCTION

Inversion is the conversion of DC power to AC power at a desired output voltage or current and frequency. A static Inverter circuit performs this transformation. The terms Voltage-Fed and Current-Fed are used in connection with inverter circuits.A voltage-fed inverter is one in which the dc input voltage is essentially constant and independent of the load current drawn. The inverter specifies the load voltage while the drawn current shape is dictated by the load.A current-fed inverter (or current source inverter) is one in which the source, hence the load current is predetermined and the load Impedance determines the output voltage. The supply current cannot change quickly. This is achieved by series dc supply Inductance which prevents sudden changes in current. The load current magnitude is controlled by varying the Input DC voltage to the large Inductance,hence inverter response to load changes is slow. Being a current source, the inverter can survive an output short circuit thereby offering fault ride-through properties. Voltage control may be required to maintain a fixed output voltage when the DC Input voltage regulation is poor, or to control power to a load. The inverter and its output can be single-phase, three-phase or multi-phase. Variable output frequency may be required for AC motor speed control where, in conjunction with Voltage or Current control, constant motor flux can be maintained. Inverter output waveforms are usually rectilinear in nature and as such contain Harmonics which may lead to reduced Load efficiency and performance. Load harmonic reduction can be achieved by either filtering, selected harmonic reduction chopping or pulse-width modulation. The quality of an Inverter output is normally evaluated in terms of its harmonic factor, $\rho$, distortion factor, $\mu$, and total harmonic distortion, *thd*.

### *A. Voltage Source Inverter*

The word ‘INVERTER’ in the context of power-electronics denotes a class of power conversion (or power conditioning) circuits that operates from a dc voltage source or a dc current source and converts it into ac voltage or current. The ‘inverter’ does reverse of what AC-to-DC ‘converter’ does **(refer to AC to DC converters)**. Even though Input to an inverter circuit is a dc source, it is not uncommon to have this DC derived from an AC source such as utility ac supply. Thus, for example, the primary source of Input power may be utility AC voltage supply that is ‘converted’ to DC by an AC to DC converter and then ‘Inverted’ back to AC using an Inverter. Here, the final AC output may be of a different frequency and magnitude than the Input AC of the utility supply. The simplest DC voltage source for a VSI may be a battery bank, which may consist of several cells in series-parallel combination. Solar photovoltaic cells can be another DC voltage source. An AC voltage supply, after rectification into DC will also qualify as a DC voltage source. A voltage source is called stiff, if the source voltage magnitude does not depend on load connected to it. All voltage source inverters assume stiff Voltage supply at the Input.

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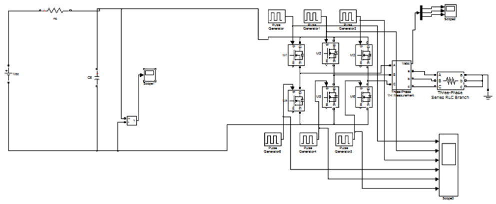

Fig.1 Voltage Source Inverter

Some examples where voltage source inverters are used are: uninterruptible power supply (UPS) units, adjustable speed drives (ASD) for ac motors, electronic frequency changer circuits etc. Most of us are also familiar with commercially available Inverter units used in homes and offices to power some essential AC loads in case the utility AC supply gets interrupted. In such inverter units, battery supply is used as the input DC voltage source and the Inverter circuit converts the DC into AC voltage of desired frequency. The achievable magnitude of AC voltage is limited by the magnitude of Input (DC bus) voltage. In ordinary household inverters the battery voltage may be just 12 volts and the inverter circuit may be capable of supplying AC voltage of around 10 volts (rms) only. In such cases the inverter output voltage is stepped up using a transformer to meet the load requirement of, say, 230 volts.

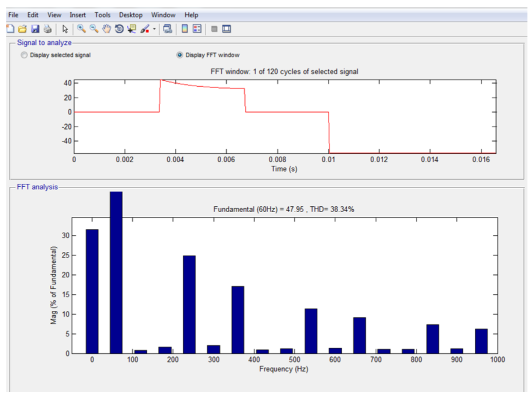


Fig.2 FFT Analysis Of Voltage Source Inverter

### B. Current Source Inverter

For the VSI, as the full form denotes, the output voltage is constant, with the output current changing with the load − type, and/or the values of the components. But in the CSI, the current is nearly constant. The voltage changes here, as the load is changed. In an Induction motor, the developed torque changes with the change in the load torque, the speed being constant, with no acceleration/deceleration. The Input current in the motor also changes, with the Input voltage being constant. So, the CSI, where current, but not the voltage, is the main point of interest, is used to drive such motors, with the load torque changing

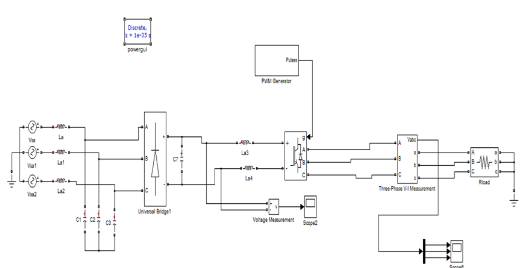

Fig.3 Current Source Inverter

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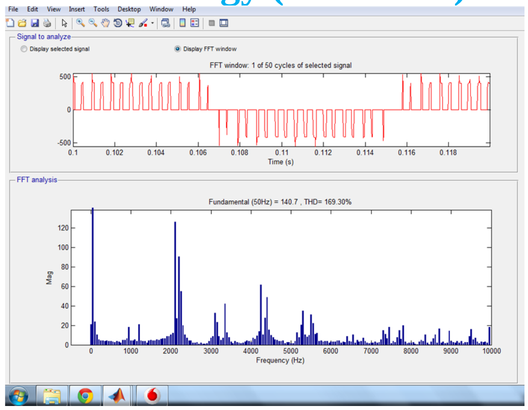


Fig.4 FFT analysis of CSI

*C. Z-Source Inverter*

To overcome the disadvantage faced by conventional VSI And CSI disadvantages a new concept was developed in year 2002 by Dr. F.Z. Peng. This involves combination of VSI and CSI to form a cross coupled network of Two Inductors and Two Capacitors, known as Impedance Network. Normally, three phase inverters have 8 vector states (6 active states and 2 zero states). But ZSI along with these 8 normal vectors has an additional state known as the Shoot Through State, during which the switches of one leg are short circuited. In this state, energy is stored in the Impedance Network and when the Inverter is in its active state, the stored energy is transferred to the load, thus providing boost operation. Whereas, this shoot through state is prohibited in VSI.

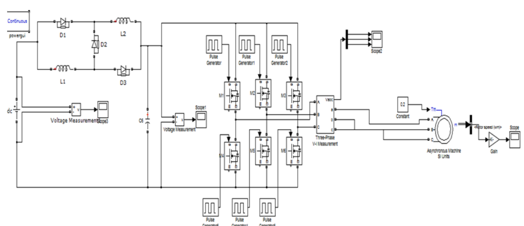

Fig.5 Z-Source Inverter

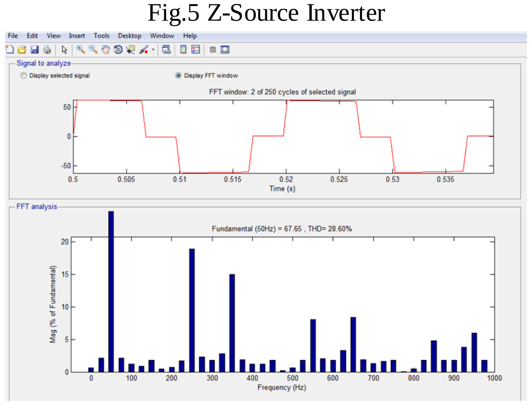


Fig.6 FFT Analysis of ZSI

On the above comparision between VSI,CSI AND ZSI, Z-Source Inverter has some advantages than the conventional one Their boost capability is introduced by shorting their phase legs without causing damages.Impedance-Source Inverters are therefore less prone to false triggering caused by electromagnetic interference. Present impedance-source inverters are, however, burdened by their low Modulation Ratio at High Input-to-Output gain. Such low modulation usually leads to High-Voltage Stresses across the

components and poor spectral performance at the Inverter Output.To avoid these problems, Inverters with Coupled Transformers have been introduced, but they usually lead to high turns ratio,

and hence many winding turns, at high gain. An alternative would then be the Asymmetrical Γ-source Inverters proposed in this paper, whose Gain is raised by lowering their turns ratio toward unity. The Input current drawn by the proposed Inverters is smoother and, hence, more adaptable by the source.

### *D. Trans Z-Source Inverter*

Alternatively, the source can be shifted fully to the upper or lower inductor only. The asymmetrical network thus formed then has different stress distributions among its components.Its capacitor voltages will however be the lowest among the three placement options. Another Interesting attempt is to couple the two Inductors on a single core, which, to a great extent, resembles a two winding transformer.

The thought of changing the winding turns ratio is then Introduced to raise the Inverter Voltage Gain and Modulation ratio. Doing so allows one capacitor to be removed too with the resulting circuits named as *T*-source or trans-*Z*-source inverters (collectively referred to as trans-*Z*-source inverters from here onward). Similar theory can be applied to the embedded or quasi-*Z*-source inverters, but the topologies formed will no longer have a continuous input current. The present concerns faced by the trans-*Z*-source inverters can therefore be summarized as discontinuous Input Current and high turns ratio or many winding turns at high gain.

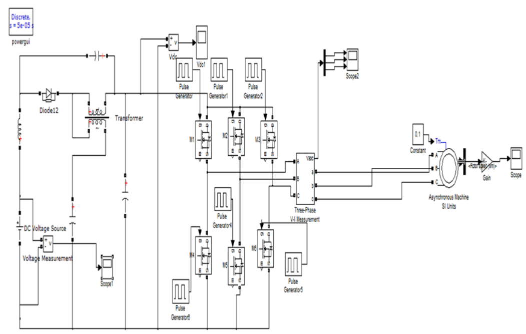

Fig 7.Trans Z-Source Invereter

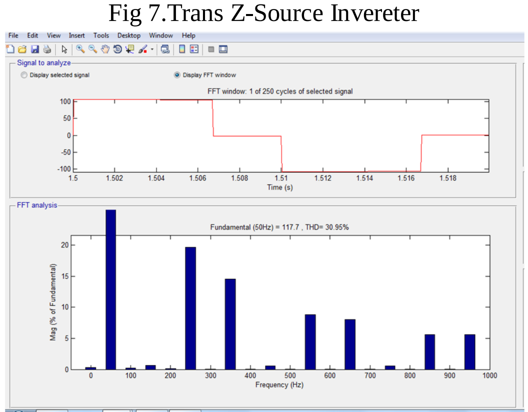

Fig 8.FFT Analysis Of Trans-ZSI

To avoid the aforementioned two limitations while not compromising other favorable features, a new family of Asymmetrical Γ-source Inverters is proposed in this paper. The proposed Inverters use one coupled transformer, one inductor, and two capacitors, which are more than components used by the Trans- *Z*-Source Inverters. The components used are, however, the same if a Low-Pass Filter is included with the latter for Input Current Filtering. Unlike the trans-*Z*-source inverters though, Gain and modulation ratio of the asymmetrical Γ-source inverters are raised by lowering their transformer turns ratio $n\Gamma$ rather than increasing it. The Input current drawn by the proposed Inverters is also smoother and, hence, less disturbing to the source. Aside from high current stress, the Trans-*Z*-source inverters are burdened by two other constraints. The first is their chopping input current caused by their input diode or six-switch inverter bridge. The second is their accompanied high turns ratio, and hence many winding turns, at high gain. These limitations are addressed while describing the proposed asymmetrical Γ-source inverters. The asymmetrical Γ-source inverters proposed here are shown in Fig. In common, they use one coupled transformer, two capacitors, and an inductor, which are nearly the same as the traditional *Z*-source inverter shown in Fig. 1 except for the coupled transformer. Comparing with the Trans-*Z*-source inverters, the number of components used is the same if an external second-order *LC* filter is added in shunt with the source for filtering purposes. Adding the external filter would, however, not raise the Trans-*Z*-source gain and hence would not solve the second concern of high turns ratio at high gain. The Asymmetrical Γ-source Inverters would, on the other hand, have their Gain raised and turns ratio lowered at high gain. Respective details are described as follows. The asymmetrical Γ-source Inverters proposed here are shown in Fig.9 In common, they use one coupled Transformer, Two capacitors, and an Inductor, which are nearly the same as the Traditional *Z*-Source Inverter shown in Fig. except for the coupled transformer. Comparing with the Trans-*Z*-Source Inverters, the number of components used is the same if an external second-order *LC* filter is added in shunt with the source for filtering purposes. Adding the external filter would, however, not raise the trans-*Z*-source gain and hence would not solve the second concern of high turns ratio at high gain. The Asymmetrical Γ-source Inverters would, on the other hand, have their Gain raised and turns ratio Lowered at high gain. Respective details are described as follows.

The first asymmetrical Γ-source Inverter proposed is shown in Fig. 9 where the coupled transformer and capacitor clearly form a Γ-shape. Operation of this Γ-source inverter is similar to the traditional *Z*-source and trans-*Z*-Source Inverters That means it can assume the usual eight non-shoot-through active and null states, and the unique shoot-through state needed for voltage boosting. It can therefore be controlled by the same modulation parameters and method but has some unique features revealed upon studying their states and equivalent circuits shown in above Fig

The Γ-shaped network can be shorted without damages, whose corresponding equivalent circuit and shoot-through expressions can be found in by the following equation, respectively:

$vW1 = vW2 + VC1$ (1)
$VC2 + V\mathrm{dc} = Vl$ (2)
$vW1 = n\Gamma\, vW2$ (3)
$iC2 = -I\mathrm{dc}$ (4)
$-iC1 = iW1 = iW2 = iW2/n\Gamma + Im.$ (5)

When returned to its non-shoot-through state, its equivalent circuit and governing expressions would change to those shown by the following equation, respectively:

$VC1 + vW2 - vW1 = \hat{v}i$ (6)
$vW1 + VC2 = 0$ (7)
$VC2 + V\mathrm{dc} = vL + \hat{v}i$ (8)
$iC2 = iW1 - iW2 - I\mathrm{dc}$ (9)
$iC1 = -iW2.$ (10)

Averaging its winding and inductor voltages per switching cycle to zero then results in those same voltage expressions in (6), except for two modified inductor voltage expressions listed as follows:

Beginning with the shoot-through circuit shown in Fig. 5(a),it is triggered by turning on two switches from the same phase leg. The short circuit thus formed then naturally causes input diode *D* to reverse bias and capacitors *C*1 and *C*2 to release their stored energy to the transformer and inductor.

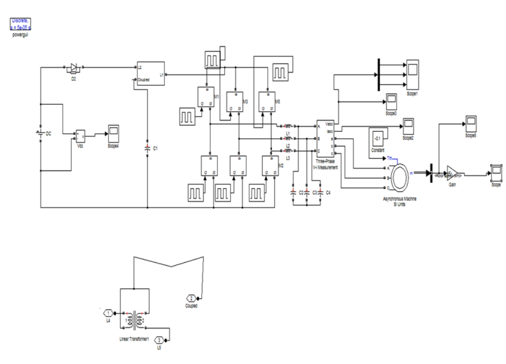

Fig9.Simulation Diagram of Gamma Source inverter

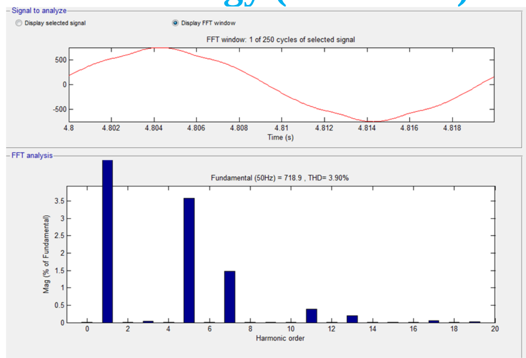


Fig 10.FFT Analysis of Gamma Source inverter

## II. CONCLUSION

In this paper fast fourier transform(FFT) analysis are perfomed on different types of inverter.FFT analysis are mostly performed to find out Total Harmonic Distortion(THD) in the output voltage. If thd content in the output voltage of inverter is high it may leads to core loss and the motor may become overheat.to achieve higher efficiency in induction motor the inverter which has lesser thd value in its output voltage must be choosed.here the gamma source inverter has less thd value.if it is choosen to fed the induction motor losses will be reduced and gives good efficiency and the energy will be saved.

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