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A HIGH FREQUENCY LINK SINGLE STAGE PWM INVERTER FOR HIGH FREQUENCY AC VOLTAGE USING CYCLOCONVERTER

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Abstract:

This paper presents a single-stage bidirectional high frequency transformer (HFT) link DC/AC converter topology for a three-phase adjustable magnitude and frequency PWM AC drive. This type of converters find wide range of applications including UPS systems, drives involving renewable energy sources (Solar, Fuel cell) and energy storage systems (typically low voltage DC to high voltage PWM AC). HFT results in reduction in cost and weight along with a considerable increase in power density. Adverse effects of common-mode voltage are well known in this kind of applications. The proposed topology along with a modulation technique reduces common-mode voltage to practically zero and generates high quality output voltage waveform comparable to Conventional Space Vector PWM (CSVPWM). A source based commutation method, presented in this paper, to commute the energy stored in the leakage inductance of the HFT resulting in the following advantages. No need for any auxiliary circuits with passive components Almost complete recovery of the leakage energy Soft switching of the output side converter for all load conditionsn Minimization of common-mode voltage switching due to commutation

Keywords: Common-mode voltage, High-frequency transformer, leakage commutation, PWM inverter.

1. INTRODUCTION

Transformers are typically used to connect systems at different voltage levels and to provide galvanic isolation often necessary for safety. Replacement of a line frequency transformer with a high frequency transformer leads to a large reduction in weight and cost. Due to high power density, high frequency link inverters may find a wide range of applications including un-interruptible power sources (UPS), distributed power generation from renewable energy sources like solar and wind (connecting HVDC grid to offshore wind generators), energy storage systems (battery interfaced grid tied inverters), vehicle to grid applications, fuel cell powered electric motor drives and also in space and naval applications where a compact solution is necessary. A conventional system involves a three stage power conversion (DC- high frequency AC-DC-adjustable frequency AC) and requires intermediate passive elements leading to reduced reliability, efficiency and power density. A single phase version of this topology can be found in. In this topology, additional SNUBBER circuits involving passive components are required for the proper commutation of leakage energy. In a new topology has been proposed where the secondary side H-bridge rectifier is replaced with a three-phase diode bridge and the primary side converter is modified to incorporate a bank of three HFTs. In this topology, along with a novel hybrid modulation strategy, proper commutation of leakage energy has been achieved without any additional

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circuits and partial soft- switching is obtained in the input side converter for an essentially unidirectional active power flow. The soft switching range is extended in.

In the other type a single phase to three phases CYCLO-converter (CHFT) is used to directly connect the secondary of the HFT to load, Fig. 2. The CYCLO-converter first rectifies the high-frequency AC and then generates three phase PWM AC similar to a two level inverter For both of these topologies it is known that it is possible to switch the primary side H bridge at zero current by applying a zero state in the output side converter. Modulation strategies have been proposed for partial or complete soft switching of the secondary side converter and auxiliary circuits are used for the commutation of leakage energy. In a source based commutation of the leakage energy has been proposed that obviates need of additional circuits. This idea has been extensively applied to single-phase high frequency link inverters.The adverse effects (shaft voltage build up, bearing currents and EMI issues) of switching common-mode voltage in a two level inverter have been extensively studied in the context of PWM AC drives. One solution to this problem is the use of active or passive common-mode filter. It is well known that modulation based schemes for common- mode voltage elimination that do not require extra filter circuits usually results in the reduction in the quality and the range of the output voltage. Dual inverter based topologies with a single DC link for an open-end winding machine (with usual and parallel phase windings) is presented in for the elimination common-mode voltage. The problem of ground leakage current in PV and battery connected inverters is well known This paper presents a single stage high-frequency link inverter topology with a modulation strategy that leads to suppression of the common-mode voltage. Three wire nature of the AC side connection also avoids flow of the additional circulating currents. Power flow is completely bidirectional. A source based commutation technique similar to has been outlined those results in complete recovery of leakage energy without any additional circuits along with minimization of common-mode voltage switching due to commutation

2. PROPOSED SYSTEM

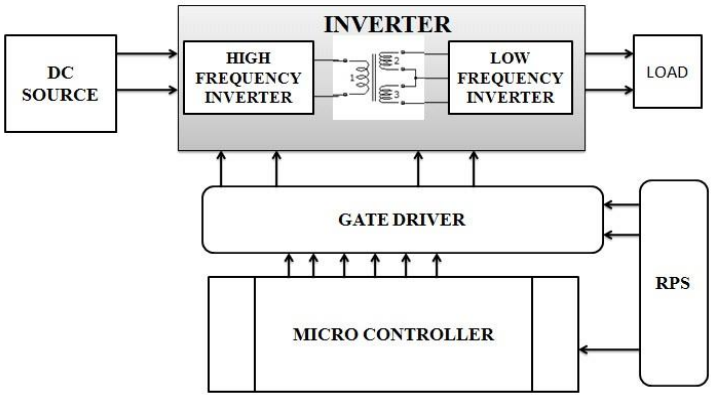

Fig.1. Block Diagram

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As well as the Junction Field Effect Transistor (JFET), there is another type of Field Effect Transistor available whose Gate input is electrically insulated from the main current carrying channel and is therefore called an Insulated Gate Field Effect Transistor or IGFET. The most common type of insulated gate FET which is used in many different types of electronic circuits is called the Metal Oxide Semiconductor Field Effect Transistor or MOSFET. Some topologies can be used to make different types of AC output wave forms (square wave, modified square wave, or sine wave), or even work in an off-grid application with a battery, or a battery less grid-tied RE application. The difference is in the details—the quantity, type, and arrangement of transistors, capacitors, transformers, and inductors; and the sophistication of the control system utilized.The worldwide for our High Frequency Inverters**.** Enclosed with simple and easy-to-use design and control features, our inverters are user-friendly. They are equipped to use low voltage with fast and reliable motor spindles. They have adjustable modulation for a smooth and synchronize process as per the desired result. Being eco-friendly, our inverters are damage free, noise-free and require low- maintenance. Efficient to give good and reliable results, our **H**igh Frequency Inverters can be availed by the clients at economic prices. They can be tailored according to the designs, illustrations and other technical requirements of the clients.

3. CIRCUIT DIAGRAM:

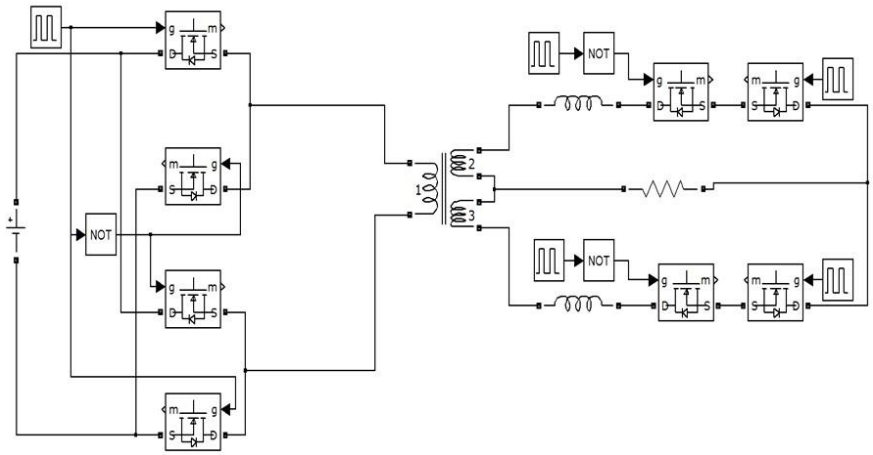

Fig.2. Circuit diagram

A set of transistors first converts the DC source into a low-voltage AC wave form. The transistors are switched on and off about 120 times per second during each AC cycle—also referred to as switching at 120 Hertz. A low-frequency transformer steps up the low AC voltage to the required 120 VAC. This topology is one of the simplest inverter designs, but is limited to producing square-wave and modified square-wave AC output waveforms (see "Inverter Basics" in *HP134* for more information on AC wave forms).output—fairly

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easy to accomplish, and therefore much cheaper. Plus, they offered low losses. Early square-wave inverters were later replaced with an improved "modified" square-wave inverter design, which improved performance and appliance compatibility while using the same basic inverter topologies. Because of the low power quality, these inverters cannot be connected to a utility grid.

4. SIMULATION TOOLS:

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB engines incorporate the LAPACK and BLAS libraries, embedding the state of the art in software for matrix computation. MATLAB is a high- level language and interactive environment that enables to perform computationally intensive tasks faster than with traditional programming languages such as C, C++, and FORTRAN.

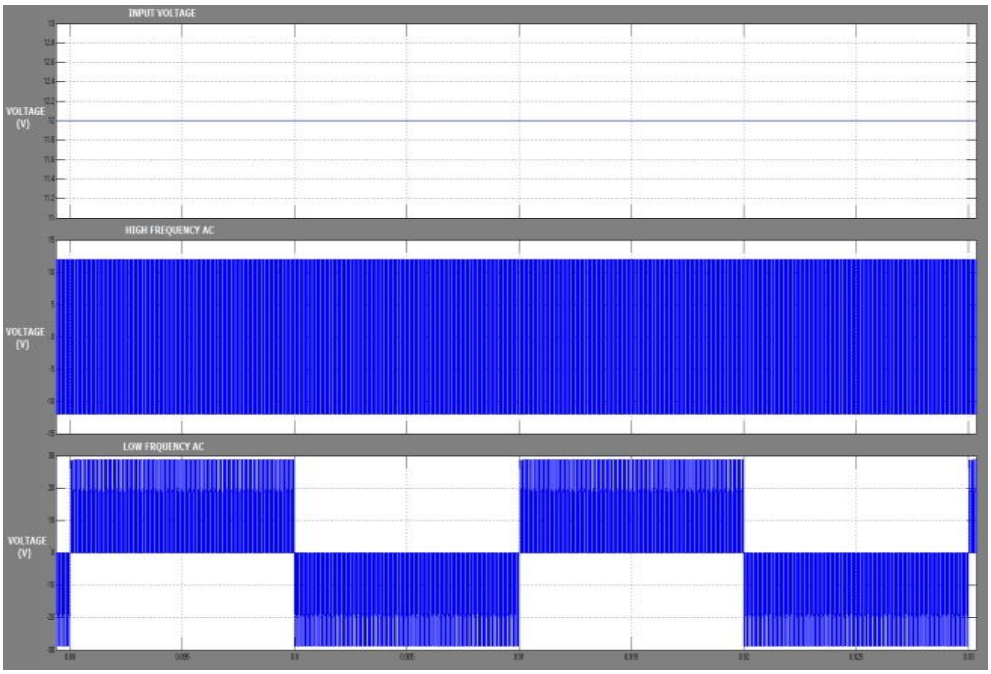

Fig.3. Simulation Diagram

The proposed HFT link inverter has been implemented as an open loop *f* drive .A four-pole induction machine with a dc generator load has been run with a reference frequency, *fref*, of 40 Hz and *V f* =3, shows the three-phase motor line currents. The measured shaft speed is 1172 r/min (Synchronous speed is 1200 r/min and slip is 2.3%.). MATLAB has evolved over a period of years with input from many users. In university environments,

it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high- productivity research, development, and analysis.

CONCLUSION:

In this project, a converter topology along with a control technique for a high frequency AC-link DC/AC converter for three phase PWM drive has been proposed. The proposed topology has the following advantages

1) Single stage all silicon solution with bidirectional power flow

2) Galvanic Isolation and voltage matching with high power density and low cost due to high frequency transformers

3) Reduced common-mode voltage switching (zero during power transfer and switches only once in a sampling cycle during commutation)

4) High quality output voltage profile comparable to
CSVPWM

5) Almost complete recovery of the leakage energy without using any auxiliary circuit

6) Soft switching of the output side converter (potentially high voltage and slow speed). The converter has been analyzed in detail. The presented experimental and simulation results verify the converter's operation and confirm the stated advantages. One of the short comings of this topology is that it has more number of switches particularly in the DC side. This is a promising solution for compact low voltage; renewable energy source fed modern PWM AC drives..

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