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A Review on Single Phase to Three Phase Transformer and Three Phase to Five Phase Transformer Comparison

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Abstract: Transformers are often combined with phase converters to build an electrical system that delivers proper power to three-phase equipment. While transformers have many properties, their basic application is in changing the voltage of electrical power. The primary and secondary windings of three single-phase transformers can be connected in different configurations to meet specific 3-phase system requirements. For single-phase transformers with equal transformation ratio of the phase windings, the ratio of the line voltages and their phase relations depends on the winding connection. This paper presents two types of conversions in the transformer which are single phase to three phase converter and three phase to five phase converter. For the single phase to three phase conversion the convertor takes single phase supply and converts it into three phase supply. The single phase supply is first converted into dc supply by using rectifier again dc supply of rectifier is given to inverter. For conversion of three phase to multiphase the three-phase supply is taken from the grid and a static phase transformation system to done to get a multiphase supply from the available three phase supply.

Key words: Single phase, three phase, five phase, multiphase, transformer, converter

Literature Survey:

Naung Cho Wynn et al. (2008) proposed a new single phase to three phase converter topology for small industries is presented in this paper: Phase converter, include this paper, is a new technology that supplies three phase power from a single phase source to power inductive, resistive and capacitive loads with distinct advantages over any existing converter technology. The converter consists of DC power supply, a MOSFET Hex-bridge, integrated gate drive IC, and a DSP to generate the switching signals. The switching signals generated are a unique version of selective harmonic elimination, which produces a consistent starting point for the switching functions, independent of the number of harmonics eliminated This converter covers the basis of induction motors and different types of other motors. They are ideal for farms, workshops, garages and large building etc.

Euzeli Cipriano dos Santos et al. (2012) described Single-phase to three-phase conversion using power electronics converters is a well-known technology, especially when the configurations and control strategies already established in the technical literature are considered. Regarding the configurations conceived over the years, it can be observed two main tendencies: 1) configurations with a reduced number of components; and 2) configurations with an increased number of components. The search for topologies with a reduced number of components was the trend over a long period of time. This can be, in part, explained by the high cost of the power switch when compared to the capacitor used in the dc-link bus. Then, the converter leg was sometimes substituted for the midpoint capacitor. However, as far as the price of the semiconductor was going down, such tendency has been changed, and now the configurations with an increased number of components do appear as an interesting option, especially in terms of reliability, efficiency, and distortions improvement. A comprehensive review of the two possibilities (reduced and increased number of components) has been considered in this paper. Also, the single-phase to three-phase ac–ac direct conversion configurations and those which aim to reduce the dc-link voltage fluctuation have been included. The goal of this paper is to provide a complete range on the status of single-phase to three-phase power conversion technologies to professionals and researchers interested in this topic.

Koundinya Lanka et al. (2012) described the first five-phase induction motor drive system was proposed in the late 1970s for adjustable speed drive applications. Since then, a considerable research effort has been in place to develop commercially feasible multiphase drive systems. Since the three-phase supply is available from the grid, there is a need to develop a static phase transformation system to obtain a multiphase supply from the available three-phase supply. Thus, this paper proposes a novel transformer connection scheme to convert the three phase grid supply to a five-phase fixed voltage and fixed frequency supply. The proposed transformer connection outputs five phases and, thus, can be used in applications requiring a five-phase supply. Currently, the five-phase motor drive is a commercially viable solution. The five-phase transmission system can be investigated further as an efficient solution for bulk power transfer. The connection

scheme is elaborated by using the simulation and experimental approach to prove the viability of the implementation. The geometry of the fabricated transformer is elaborated in this paper.

Mr. Merugu Mysaiah et al. (2012) proposed a novel transformer connection scheme to convert the three phase grid supply to a five-phase fixed voltage and fixed frequency supply. The proposed transformer connection outputs five phases and, thus, can be used in applications requiring a five-phase supply. Currently, the five-phase motor drive is a commercially viable solution. The five-phase transmission system can be investigated further as an efficient solution for bulk power transfer. The connection scheme is elaborated by using the simulation and experimental approach to prove the viability of the implementation. The geometry of the fabricated transformer is elaborated in this paper.

Shaikh Moinoddin et al. (2012) proposed Multiphase (more than three-phase electric power) electric drive system is the focus of a significant research in the last decade. Multiphase power transmission system is also investigated in the literature because multiphase transformers are needed at the input of rectifiers. In the multiphase power transmission and multiphase rectifier systems, the number of phases investigated is a multiple of three. However, the variable speed multiphase drive system considered in the literature are mostly of five, seven, nine, eleven, twelve, and fifteen phases. Such multiphase drive systems are invariably supplied from power electronic converters. In contrast, this paper proposes technique to obtain seven-phase output from three-phase supply system using special and novel transformer connections. Thus, with the proposed technique, a pure seven-phase sine-wave voltage/current is obtained, which can be used for motor testing purposes. In addition, a seven-phase power transmission and rectifier system may benefit from the proposed connection scheme. Complete design and testing of the proposed solution is presented. Analytical analysis, simulation, and experimental verifications are presented in the paper.

SUNIL KUMAR J et al. (2013) proposed that there is rapid development in the power system applications in early from the 19th century in many areas like transmission, distribution and power system appliances. In the year 1970 there is rapid development in the sector of machines. In late 1970 the first five phase induction motor drive system was proposed the world. Since there is huge research attempts has been placed to develop the multiphase drive systems. The three-phase supply is available from the grid; there is a need to develop a static phase transformation system to obtain a multiphase supply from the available three phase supply. So this paper suggests a novel transformer connection idea to convert the three phase grid supply to a five phase fixed voltage by maintaining the constant frequency supply. Now days the use of five phase motor dive is ever-increasing in commercial purpose and in future also. To satisfy these there are having solutions first, implementation of six phase transmission. To implement this we have to change the three phase to six phase. This paper proposes the implementation of three phase to five phase transformer has been proposed. The five-phase transmission system can be investigated further as an efficient solution for bulk power transfer. The modeling of the five phase transformer is proposed and it is simulated in the Matlab environment.

Arvind K.Yadav et al. (2015) presented a simple converter topology for driving a load with a single-phase ac supply. Using only six active switch IGBT's. The converter supplies balanced output voltages at rated frequency, the proposed topology permits to reduce the rectifier switch currents, the harmonic distortion at the input converter side, and presents improvements on the fault and control approaches are supported by test results. The convertor takes single phase supply and converts it into three phase supply with the help of thyristors. The single phase supply is first converted into dc supply by using rectifier again dc supply of rectifier is given to inverter where IGBT's are used and converts the dc supply again into three phase ac supply. The experimental result showed that sinusoidal waveform produced remained approximately constant with increase in load and the developed hardware has satisfactory converted the single phase power to three phase power supply.

K. Mouli et al. (2015) described The first five-phase induction motor drive system was proposed in the late 1970s for adjustable speed drive applications. Since then, a considerable research effort has been in place to develop commercially feasible multiphase drive Systems .Multiphase (more than three phase) systems are the focus of research recently due to their inherent advantages compared to their three-phase counterparts. The multiphase motors are invariably supplied by ac/dc/ac converters. This is a special transformer connection scheme to obtain a balanced five-phase supply with the input as balanced three phases. The fixed voltage and fixed frequency available grid supply can be transformed to the fixed voltage and fixed frequency five-phase output supply. Since input is a three-phase system, the windings are connected in a usual fashion. Three separate cores are designed with each carrying one primary and three secondary coils, except in one core where only two secondary coils are used. Six terminals of primaries are connected in an appropriate manner resulting in star and/or delta connections and the 16 terminals of secondaries are connected in a different fashion resulting in star or polygon output. The connection scheme of secondary windings to obtain a star output. The turn ratios are different in each phase. The choice of turn ratio is the key in creating the requisite phase displacement in the output phases. The construction of output phases with requisite phase angles of 72 between each phase is obtained using

appropriate turn ratios. The designed transformation turns ratio can be achieved by simply multiplying the gain factor in the turn ratios. A five-phase induction motor under a loaded condition is used to prove the viability of the transformation system. It is expected that the proposed connection scheme can be used in drives applications and may also be further explored to be utilized in multiphase power transmission systems.

B. Muthuvel et al. (2016) proposed a new approach of simulation and hardware design and implementation of multi-phase power conversion using matrix converter. It includes the simulation and hardware design of 3 phase to 5 phase power conversion under open loop configuration. In simulation side, the converter is modeled with mathematical expressions and the performance of the matrix converter is evaluated using RL load. The entire matrix converter circuits are modeled with MATLAB/SIMULINK. The mathematical expressions relating the input and output of the five phase matrix converters are implemented by using simulink block set. The duty cycles of the matrix converter bidirectional switches are calculated using Modified venturini algorithm for maximum voltage transfer ratio. In hardware side, the power circuit was realized by bi directional IGBT switches so as to achieve high switching speed and low on state conduction losses with reduced THD. The performances of the multi-phase matrix converter are evaluated using R Load. The matrix converter bidirectional switches are controlled by the Field Programmable Gate Array (FPGA) controller. It includes the Xilinx Spartan 3A DSP processor which is developed by the Xilinx incorporation.

Nor Azizah Mohd Yusoff et al. (2016) described that transformers are able to step up or step down an output voltage from their input. It also can be used to directly supply an electrical motor when a constant frequency operation is required. Here, the research is focusing on designing a three-to-five phase transformer that acts as static phase converters for supplying a balance five-phase load. The designing process of the transformer is described based on the graphical phasor diagram that is flexible and easy to be implemented. At the end, the performances of the designed transformer are evaluated using a static and dynamic load. The designed three-to-five phase transformer is able to maintain a balance five phase voltage for several type and level of load as shown in experimental result.

Priyaka Nage et al. (2017) et al. (2017) described a three to seven phase AC multiphase transformers to converted into DC power through modelling and simulation. A new technique of pure seven-phase Sine-wave of fixed current/voltage and frequency is obtained now we have also used for R-L load and motor testing purposes. Here complete modelling has been simulated by using MATLAB Software. Multi-winding transformer block was taken from the sim-power system block library and turn ratios set in the dialog box then simulated. The whole modelling/design and simulation of the proposed work is presented in this paper. Seven phase transmission line system can be developed for the generation of bulk power transfer. As per need of the induction motor under a loaded condition is used for the viability of transformation system. In seven phase's, each phases shifted from the order by 51.42° (360°/7) and got the Sine-wave current/voltage. The novel scheme connection was expanded by using the modelling and simulation approach to prove the viability of the implementation and this type of transformer is required in aerospace engineering, railway engineering and automobile engineering applications.

Conclusion: This paper describes various methods for conversion of single phase to three phase transformer and three phase to five phase transformers. The authors have used various methods for the respective conversions. The conversion from single phase to three phase and three phase to five phase is done in order to reduce the total harmonic distortion in the signal. The total harmonic distortion (THD) is a measurement of the harmonic distortion present in a signal and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency. After going through various literature papers it has been found that multiphase transformers are better in reduction of the total harmonic distortions than three phase transformers.

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