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Stabilized Power AC-DC-AC Converter using polygon transformer

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Abstract-Static power converters are used for many applications, like frequency converters for motors, uninterruptible power supplies (UPS's), general power supplies. This paper analyses the performance of high power static 400Hz supply system used in aircraft ground power units. However, the problem of this system is the harmonics coming from the load current towards the supply. This problem can be overcome by using a way to improve the supply wave. One of those is using novel polygon transformer.

This paper presents combining of stabilized power AC-DC-AC supply using polygon transformer to improve the supply wave and using a passive filter on the output load. The design and simulation of this system has been presented.

In [8], the polygon transformer is connected to achieve 18-pulse AC-DC conversion through phase shifting between the two sets of voltages equal 20° with respect to the supply voltage. The disadvantage of this connection is that realizing feasible values for the tapping portion for step up operation is not possible. Therefore, in the proposed system, a novel idea for the 18 pulse conversion is achieved by phase shifting between voltage sets with 40°.

Keywords- Stabilizing power AC-DC-AC converter, Power quality, Polygon autotransformer, Harmonics elimination.

I. INTRODUCTION

The AC power system harmonic problems are mainly due to the substantial increase of non-linear loads due to technological advances, such as the use of power electronics circuits and devices. These loads draw non-sinusoidal currents from electrical power systems which pass through different impedances in the power systems and produce voltage harmonics. These voltage harmonics propagate in power systems and affect all of the power system components [1].

In recent years considerable effort was aimed at achieving control methods that can maintain a very low THD in presence of non-linear load for critical applications. One such example is the 400Hz inverter used in aircraft applications, also known as ground power unit (GPU) [2]. Since they are used to provide power to the aircraft prior to take-off or after landing, these inverters are subject to strict requirements [3].

The 400-Hz inverters are widely used as the power supply for airplanes, ships, radar and many other types of equipment. As the power rating has always been increasing, 400-Hz high power inverters are in great demand.

In today aircraft industry, electrical aircrafts are increasingly employed to achieve better efficiency, cost reduction and better performance [1-4]. As a result, the number of electrical loads equipped on-board is increasing and the on board power capacity is getting larger. However, most of the DC loads are typically supplied by the uncontrolled diode rectifier converters, causing the power quality problem in the aircraft power system. The high harmonic current distortion and poor power factor would be a major concern when the percentage of total system power processed by uncontrolled rectifiers is high [5].

General problems of harmonics on power systems are presented in more KVAR is drawn from the electrical network leading to poor PF and sudden increase in KVA demand causing power factor penalties, reduced system capacity and increase in energy losses (because harmonics create additional heat, transformers and other distribution equipment cannot carry full rated load) decreasing the system efficiency, excessive temperature rise, vibration, audible noise, protective device malfunction, flickering lights, data corruption and increased maintenance problem (failure of capacitors, contactors) [1].

The bridge rectifier suffers from operating problems [4],[5] such as poor power factor, injection of harmonic currents into the ac mains, equipment overheating due to harmonic current absorption, low rectifier efficiency, input ac mains voltage distortion and malfunction of sensitive electronic equipments etc. In order to prevent the harmonics from affecting the utility lines negatively, an IEEE Standard 519 [6] has been established in 1981 and reissued in 1992 as the "Recommended Practices and Requirements for Harmonic Control in Electrical Power System" giving limits on voltage distortion. Several methods based on the principle of increasing the number of rectification pulses in ac–dc converters have been reported in the literature [7-8], which are simple to implement. These methods use two or more converters, where the harmonics generated by one converter are cancelled by other converter, by proper phase shift. The