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The AC-DC bridge converter simulated in MATLAB software

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ABSTRACT
The proposed AC-DC bridge converter is simulated in MATLAB software with Simulink window and calculated parameter in terms of total harmonic distortion (THD). The proposed AC-DC full bridge converter is operated in 60 Hz supply frequency, three phases 600 V, 30 MVA and IGBT switch. The proposed converter is providing 1.20% total harmonic distortion (THD). The proposed converter is 52.75% reduce total harmonic distortion (THD) compared to previous converter. In switched capacitor technique, the capacitors c1 & c2 and load resister r1 and r2 are parallel. Switch off period, positive to neural terminal of three level bridge output is connecting to the capacitor c1 & load resister r1 and Switch on period, negative to neural terminal of three level bridge output is connecting to the capacitor c2 & load resister r2. Both capacitors reduce the ripple during the positive and negative cycle and gives direct voltage.

Key words- Switching Capacitor, Total Harmonic Distortion, MATLAB Software, Simulink Window

1. INTRODUCTION

Three-phase AC-DC converters have a wide range of applications, from small converter to large high voltage direct current transmission systems. They are used for electrochemical processes, many kinds of motor drives, traction equipment, controlled power supplies and many other applications. From the point of view of the commutation process, they can be classified into two important categories: line-commutated controlled converters and force-commutated pulse width modulated converters.

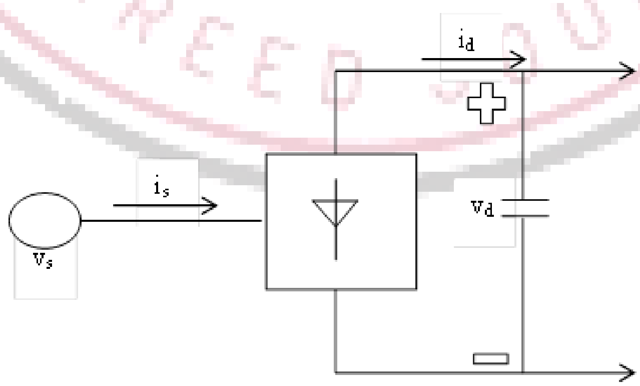

Figure1.1: Circuit diagram of a rectifier

1.1 MULTIPULSE CONVERTERS

Multi pulse converters are converters providing more than six pulses of DC voltage per cycle from AC input, or the converter having more steps in AC input current than that of six pulse bridge rectifier supply current. Bridge rectifier is the basic block required for AC- DC conversion, however, full- wave and half wave rectifier are also used to up 120kW ratings. Phase shifting transformers are used to derive multiple phase supply from three phase AC mains using different combinations of transformer windings such as star, delta, zigzag, fork, polygon, etc. The Multi Pulse Converters (MPC) are classified into different types. They are 6 Pulse Converters, 12 Pulse Converters, 18 Pulse Converters and 24 Pulse Converters. Based on the harmonic reduction techniques MPC can be classified as Filters, PWM rectifiers and Multi pulse converters. The three phase Multi Pulse Converter can also be classified into uncontrolled and uncontrolled. It can be further classified into isolated, non-isolated, bridge and full wave converters. Figure 1.2 shows the classification of AC-DC converters based on harmonic reduction techniques.

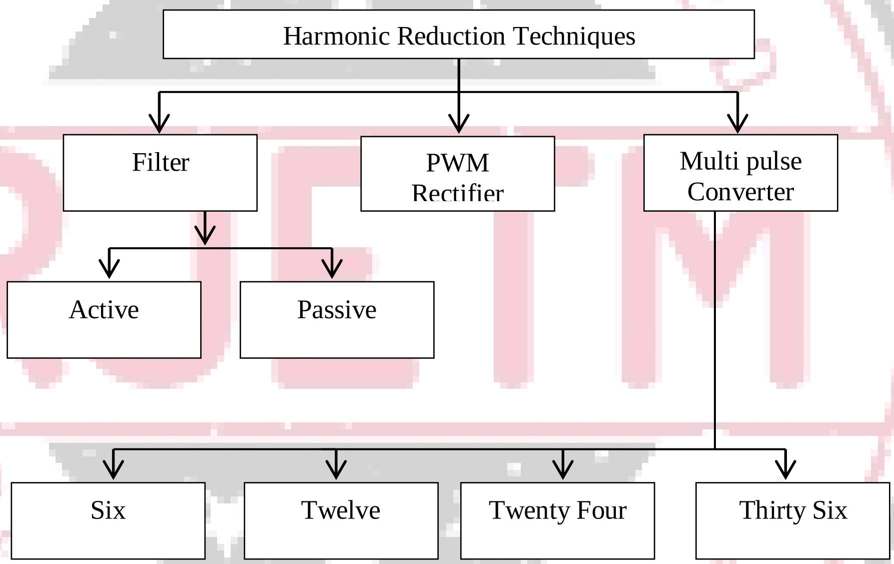

Figure 1.2: Various harmonics reduction techniques

Based on the principle of operation, Figure 1.3 shows the various configurations of multi pulse AC-DC converters.

With the development of more electric aircraft, the aviation power capacity is increasing. Meanwhile, power electronic devices have been more widely used in aircraft power system, which brought harmonic, reactive and imbalance problems to aircraft grid. These problems will seriously affect the quality of the aircraft power supply, degrade performance and service life of power generation equipment and electrical equipment, and even threaten the safe operation of the entire aircraft electrical system. Therefore, to solve the aircraft grid harmonic, reactive and unbalanced problems, and ensure the quality of aircraft power supply system, the maintenance of the maintain the stability and reliability of the power system has become a hot issue in aircraft power research. Harmonic has the variety and complexity in advanced aircraft and current harmonic reduction methods are insufficient. The source and harm of aircraft grid harmonic, the current common harmonic reduction methods and its problems are to be analyzed.

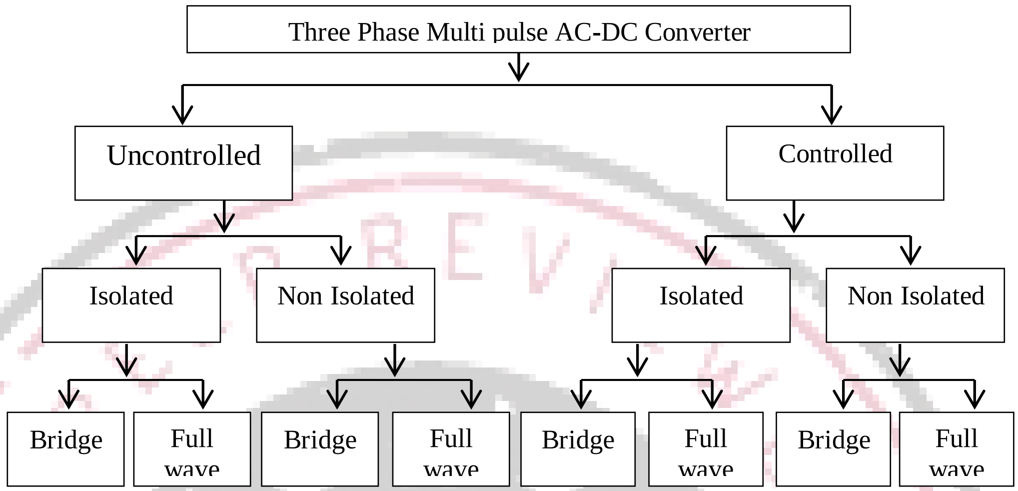

Figure 1.3: Multiple converter configurations

2. *AC/DC CONVERTER USING SWITCHING TECHNIQUE*

The circuit is composed of sinusoidal mains voltage Vin, four switches S1, S2 ,S3 and S4, coupled inductors Np and Ns, diodes Da, Db, De, Dd, D1, D2, D3 and D4, two capacitors C, and C2,two secondary diodes D5 and D6, output diode Do, and output capacitor Co and load Ro are shown in Figure 2.1. The turn's ratio of the coupled inductor n is equal to Ns Np.

However a known delay is introduced between turn-off of one switch and the tum on of the other switch of the same leg to avoid simultaneous conduction of any two switches from the same leg. The gate drives of both legs, S1, S4 or S2, S3 are complementary.

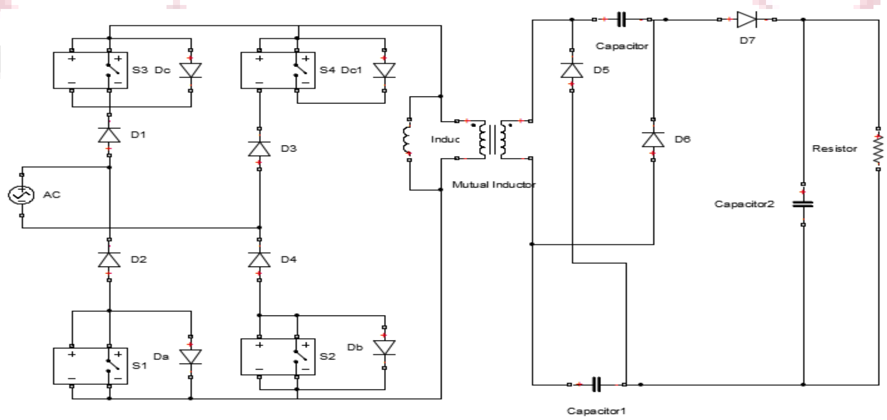

Figure 2.1: Circuit of Proposed Converter using Switching Capacitor Technique

The use of switches with low resistance RDS (ON) is to reduce the conduction loss of the entire circuit. The parallel charged current is not inflow. The proposed converter utilized the concept of switched-capacitor technique ie, two capacitors can be charged in parallel and discharged in series to achieve a high step-up gain. Thus, capacitors on the secondary sides CI and C2 are charged in parallel and are discharged in series by the switches are turned OFF and turned ON is shown in Figure 3.1. Duty cycle D is defined as the time when SI and S2 are both ON during the first half cycle or when S3 and S4 are both ON during the second half cycle. The principle is that, when the switches are turned ON, the energy stored in magnetic inductor and the coupled-inductor-induced voltage on the secondary and the induced voltage makes VL2, Vc" and VC2 release energy to the output in series.

3. *MODE OF OPERATION*

This section presents three modes of operation of the proposed converter. Operation and the waveforms of the proposed AC-DC converter in positive half cycle and in negative half cycle are same. Only the difference is that in positive half cycle the two switches SI and S4 are ON and the diodes DI and D4 are in forward biased. But in negative half cycle the two switches S2 and S3 are ON and the diodes D2 and D3 are in forward biased. The modes of operation and the current flow path of each mode of the circuit in positive half cycle are discussed in this section.

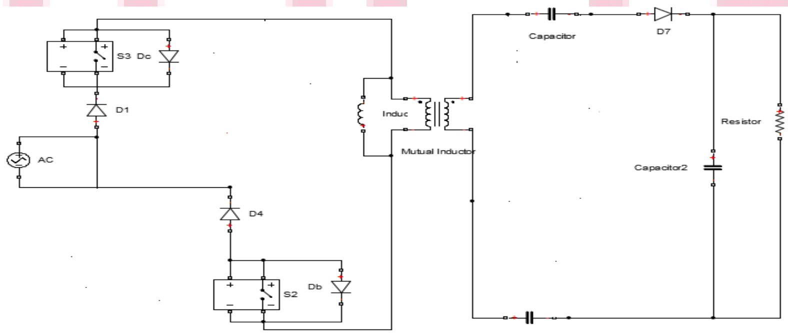

Figure 3.1: Circuit operation in mode-I

Mode 1: Figure 3.1 shows the mode I operation. Here the two switches SI and S4 are ON. The magnetizing current will increase linearly. The two secondary capacitors CI and C2 are discharged in series. Diodes DI and D4 and the output diode Do will be in forward biased. The secondary diodes Ds and D6 will be in reverse biased. Vin, V Cl, V C2 which are connected in series, discharge to high-voltage output capacitor Co and load R. This mode ends at the time t=tl.

Mode II: mode 11 shows in Figure 3.2. Here SI and S4 are in off condition and the input voltage pass through the parasitic capacitor The energy of magnetizing inductor Lm transfers to capacitors Cl and C2 and charged in parallel. The diodes DI, D4 and the secondary diodes Ds and D6 and output diode Do will be forward biased the output capacitor CO provides energy to the load R. This mode ends at the time t=t2.

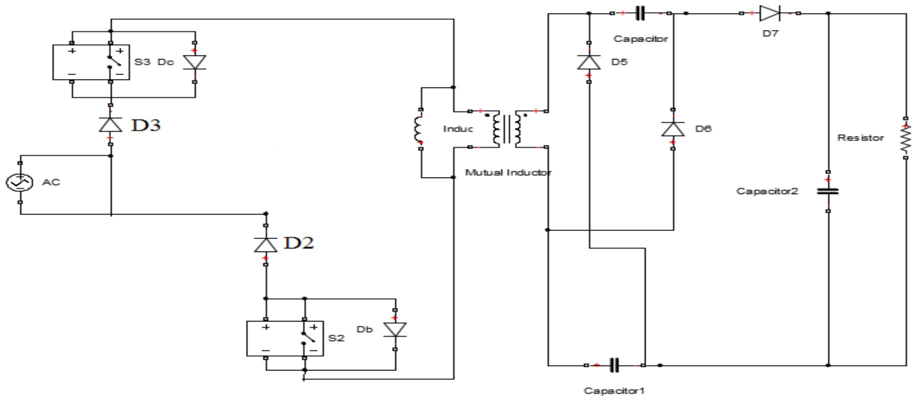

Figure 3.2: Circuit operation in mode-II

4. RESULTS

The development and advances in the technology of power semiconductor devices have revolutionized their application in industrial applications, the chief of which is the control of electric drives. It has become very essential to control the AC voltage and frequency with an application dictated performance requirements in ASD applications. There are several solid state power conversion topologies are available for performing AC-AC conversion.

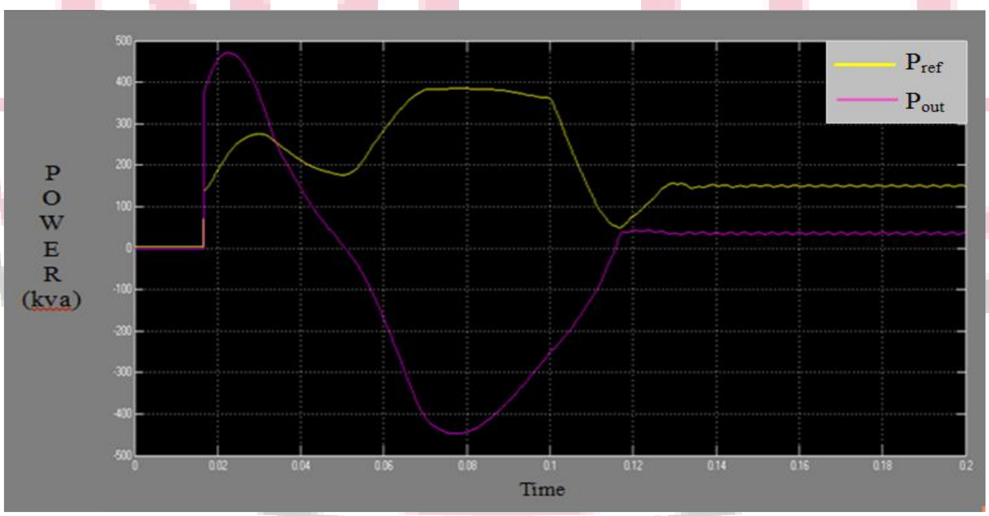

Figure 4.1: Output Power Waveform of the AC/DC Three Level PWM Converter

The primary purpose of power electronic converters is to process the power employing static switches to get a desired output from an available input. This modulation of output power is envisaged through control signals that are applied to the switching devices. However, it is seen that the output is contaminated with a wide range of harmonics. The formulation of control strategies will therefore have to be efficient to enable the converters in realizing the dictated performance.

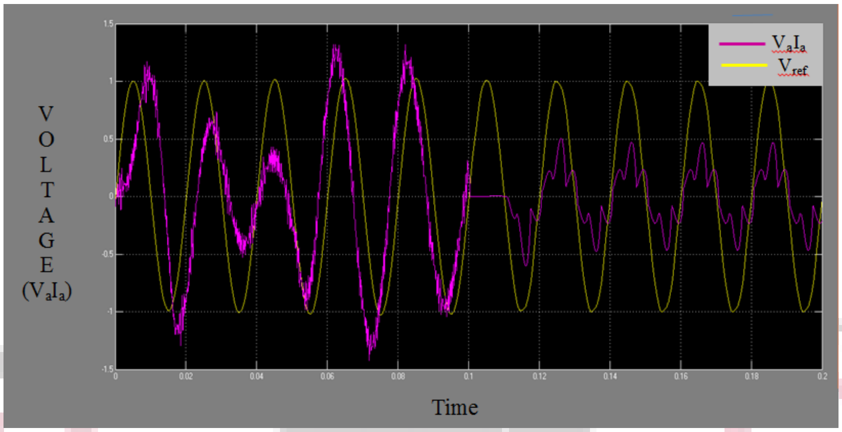

Figure 4.2: Output Single Phase Waveform of the AC/DC Three Level PWM Converter

With this technique sinusoidal input currents and ideally smoothed dc voltage may simultaneously be obtained, resulting in significant reduction of both ac and dc filters. Input power factor control is also achieved together with full regulation of the output voltage. A simplified scheme using only three unidirectional switches is also studied, capable of similar performances in a reduced range of operation. The behavior of the converter is analyzed, even in non-ideal conditions, and design criteria are derived.

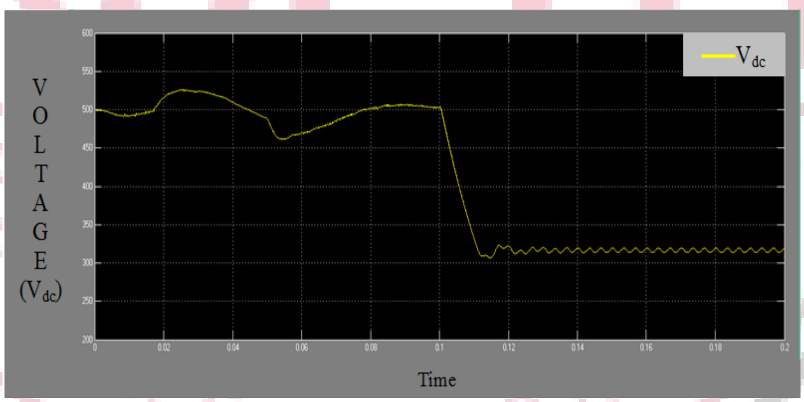

Figure 4.3: Output Direct Voltage Waveform of the AC/DC Three Level PWM Converter

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