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Comparative Analysis of Total Harmonic Distortion for Welding Load

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ABSTRACT

In today's era power quality is the main issue mainly for welding load which includes the problems like total harmonic distortion, voltage sags, voltage swells, voltage distortions etc. In this paper we will discuss about the Total Harmonic Distortions for the welding load by using the simple modular dc-dc converter, modular bridge dc-dc converter and by using the Z- Source Converter using Dynamic Voltage Restorer and will try to find out the best possible solution for reducing the Total Harmonic Distortions. Harmonics are basically the disturbances caused by the nonlinear voltage or current by the equipment due to use of modern electronic power supplies. Power quality analysis of welding business for harmonic distortion has been carried out using MATLAB Simulink.

Keywords: Total Harmonic Distortion (THD), Dynamic Voltage Restorer (DVR), Z- Source Inverter (ZSI), GTO, insulated gate bipolar transistor IGBT, variable frequency devices VFD

I. INTRODUCTION

In this fast developing technology world, high current and low voltage welding power supply, with more efficiency has been used in the industries in present era. Welding device supplies high current at low voltage which is in the range of 50 V. A good power quality is always the demand for welding load. As during welding lots of losses takes place which may be due to the total harmonic distortions also. So we have to reduce the THD level for the welding load, using the Modular dc-dc converter, Modular bridge dc-dc Converter [5] and Z-Source Converter using DVR technology.

DVR is the device which is used to resolve the power quality problems. A DVR is a power electronic switching device which consists of either GTO or IGBT, capacitor bank as an energy storage device, injecting transformer, converters, harmonic filters, protection and control system [1]. DVR is designed to inject the dynamically controlled voltage, which is generated with the help of forced commutated converter. SPWM is used to trigger the circuit.

A proficient arc welding practice needs excellent and rapid dynamic control of power flow for good weld quality and efficiency. Present welding machines have the problem of low power factor and high harmonic content [3].

II. METHODS AND MATERIAL

Harmonic Distortions

The power quality drop has been drastically increased in the recent time, due to the harmonics introduced by VFD's and nonlinear loads. Welding transformer with irregular duty cycle has a major contribution towards the increase in the THD level. Harmonic currents are the main reasons which cause equipment overheating and thermal loss of life, mainly in the case of transformer. Harmonic Currents and Voltages are produced by non-linear loads associated with the power supply system. Harmonic distortion is measured in terms of total harmonic distortion (THD).

Harmonic Frequency

Table 1. Harmonic Frequency

Harmonic order	frequencies
Fundamental harmonic order	50
3rd Harmonic order	100

5th Harmonic order	150
7th Harmonic order	200
9th Harmonic Order	250

Causes of harmonic Currents are additional copper losses due to harmonic Currents, increased core losses and increased electromagnetic interference with communication circuits. Causes of harmonic voltage are increased dielectric stress on insulation, electro static interference with communication circuits and resonance between feeder capacitance and winding reactance [2]. The effects of harmonics are effects on the power system itself, effects on consumer load, effects on communication circuits, effects on revenue billing etc.

Proposed power supply for welding load

ZSI based arc welding supply works both as current source inverter as well as voltage source inverter. ZSI consists of an impedance network consisting of inductances and capacitances. In addition to these diode rectifiers, output filters and welding load is connected. The L and C are connected in X shape forming the impedance network [4] which is further connected to the converter. Z source network needs small value of L and C.

Modeling and Simulation

MATLAB SIMULINK is used for demonstrating the performance of Simple modular dc-dc converter, modular full bridge isolated dc-dc converter [5] and Z source inverter.ZSI based DVR is used for improving the Total Harmonic Distortions for welding load. Harmonics are reduced with the help of DVR from source side and constant voltage and current is obtained. The following table gives circuit specifications for modular isolated dc-dc converter, simple modular dc-dc converter and Z Source Inverter.

Table 2 : Circuit specifications of modular full bridge isolated dc-dc converter, simple modular dc-dc converter and Z- Source inverter.

Quantity	Modular full-bridge isolated dc-dc converter	Simple Modular dc-dc converter	ZSI
Input Voltage (Vrms) @ 50 Hz	415 V	415 V	415 V
Inductor of Z- source inverter	-	-	5.8 H
Capacitor of Z- source inverter	-	-	5.5 Mf
Carrier Frequency	2 KHz	2 KHz	2 KHz
Value of inductance of filter	15μH	15μH	15μH
Value of capacitance of filter	10 F	10 F	10 F

III. RESULTS AND DISCUSSION

Simulation results for proposed welding supply containing THD is discussed in this section. Welding loads are nonlinear in nature, therefore THD level is increased and directly affects the power quality in a power distribution system of welding load. Harmonic currents when flows in the distribution network results in high heating of equipment and high voltage distortions. So THD is reduced for obtaining better power quality. THD has been calculated for Simple Modular dc-dc converter i.e 3.71% [5], Modular full-bridge isolated dc-dc converter and ZSI and FFT analysis is shown below.

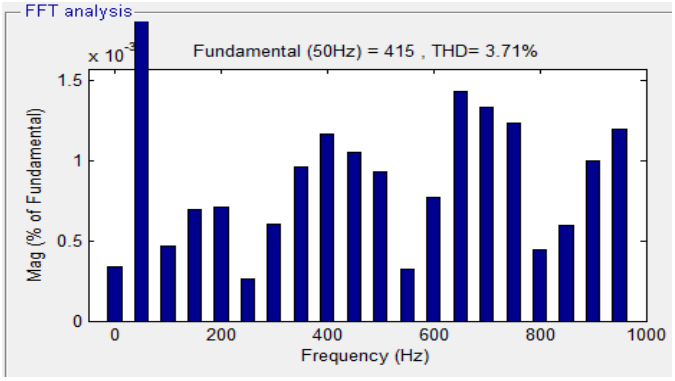

Figure 1: Harmonic Spectrum of Input AC Mains Voltage For Modular full-bridge isolated dc-dc converter at Full Load Condition

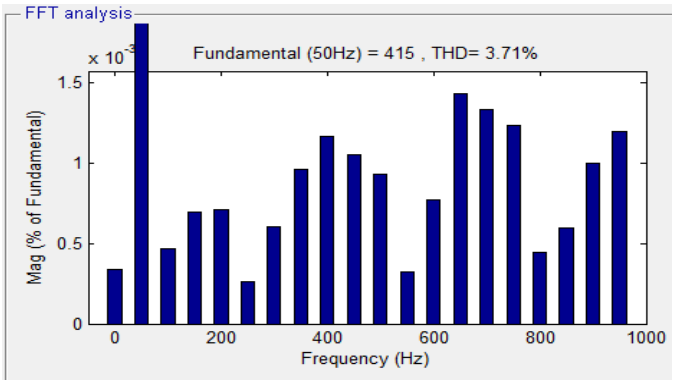

Figure 2 : Harmonic Spectrum of Input AC Mains Voltage For Modular dc-dc converter at Full Load Condition

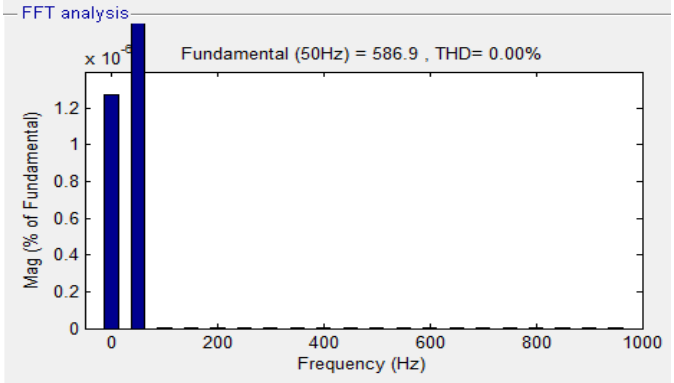

Figure 3: Harmonic spectrum of Input AC Mains for ZSI at Full Load Condition

IV. CONCLUSION

Harmonic studies are becoming an important component of power system planning and design. The functioning of Z-source inverter and Modular dc-dc converter based DVRS for welding load has been tested for THD. The proposed method can balance for most of the voltage faults such as harmonics and voltage distortion on the supply networks. The main advantage of this DVR is that it is inexpensive and its control is quite simple. The DVR tackles both balanced and unbalanced situations devoid of any difficulties and injects the proper voltage component to correct rapidly in the supply voltage to keep the load voltage balanced and constant at the nominal value. By eliminating all harmonics at source side, ZSI has become a cost efficient device and the efficiency has also enhanced. ZSI has no extra voltage stress on power devices. ZSI operates in short circuit conditions also which makes the circuit appropriate for welding applications. ZSI has enhanced the trustworthiness of system because shoot-through has no longer destroyed the inverter. A good voltage regulation is also maintained by using the ZSI. Installing harmonics filters is a must to improve the transformer efficiency.

V. REFERENCES

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