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Improving the power quality by reducing the harmonics in dc drives

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ABSTRACT

Power Quality (PQ) has become an important topic of discussion and research, especially in a deregulated environment. As per IEEE 519 std. Latest innovative ideas to make the life easier using the technology depends upon the application of power electronics in turn about power quality. With increasing quantities of non-linear loads being added to electrical systems, it has become necessary to establish criteria for limiting problems from system voltage degradation. This paper presents the power quality problems, issues, related international standard, effect of power quality problem in different apparatuses and methods for its correction, which is actually a technology management. This is important for design engineers and researchers in power quality to know the international standards used for power quality. Semiconductor switching devices which are generally used in converter circuits produce significant harmonic voltages as they chop voltage waveforms during the transition between the conducting and cutoff stages. The diode bridge rectifiers/converters are considered as a major contributor to the power system harmonics and the consequences are varying from components overheating to communication interference. Our work links the field of electrical power conversion and electrical drives (DC), . We extend our work to higher pulse converters (up to 48 Pulse) and determine the power quality parameters in each case. Various reduction methods like LC Passive Filters, Shunt Active Filter, Sinusoidal Pulse Width Modulation are applied in each case and a clear comparison before and after application of techniques will be brought out.

Keywords:

IEEE 519,
Power quality,

THD.

1. INTRODUCTION

The term power quality is rather general concept. Broadly, it may be defined as provision of voltages and system design so that user of electric power can utilized electric energy from the distribution system successfully, without interference on interruption Power quality is defined in the IEEE 100 Authoritative Dictionary of IEEE Standard Terms as The concept of powering and grounding electronic equipment in a manner that is suitable to the operation of that equipment and compatible with the premise wiring system and other connected equipment Utilities may want to define power quality as reliability . From the Power Quality market or industry perspective, it is any product or service that is supplied to users or utilities to measure, treat, remedy, educate engineers or prevent Power Quality issues, problems and related items.

2. HARMONIC ANALSYSIS:

For the purposes of harmonic analysis, the dc drive loads can be represented as sources of harmonic currents. The system looks stiff to these loads and the current waveform is relatively independent of the voltage distortion at the drive location. This assumption of a harmonic current source permits the system response characteristics to be evaluated separately from the dc drive characteristics. The representation of the drives as harmonic current sources is shown

Analysis of the system response is important because the system impedance vs. frequency characteristics determine the voltage distortion that will result from the dc drive harmonic currents. A simplified version of the situation is shown in Figure

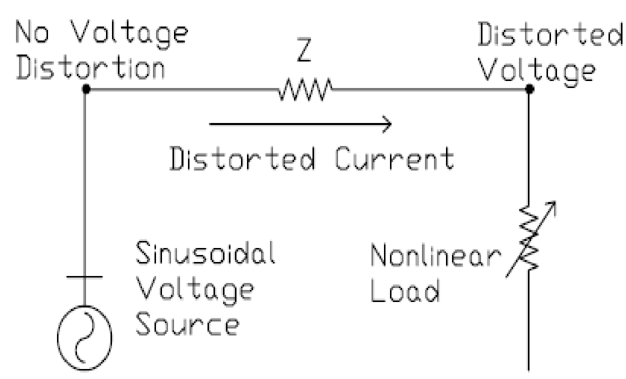

Figure 1: Non Linear Load

If the system is infinitely strong (no impedance), there will never be any voltage distortion. It is the harmonic currents generated by the dc drives passing through the system impedance that causes voltage distortion. Filters are the means used to control the system response.

Power electronics researchers have always studied many novel control techniques to reduce harmonics in such waveforms. The Fourier series expansion of this output voltage waveform is

$$V(\omega t)=4V_{dc}/\pi \left(\sum_{n=1,3,5...}^{\infty} \frac{\sin(nwt)}{n} \times (1-2\cos(n\theta_1)+2\cos(n\theta_2)-2\cos(n\theta_3)) \right) \quad (1)$$

Given a desired fundamental voltage, the problem here is to find the unknown switching angles

$$1-2\cos(\theta_1)+2\cos(\theta_2)-2\cos(\theta_3) = -m \quad (2)$$

$$1-2\cos(5\theta_1)+2\cos(5\theta_2)-2\cos(5\theta_3) = 0 \quad (3)$$

$$1-2\cos(7\theta_1)+2\cos(7\theta_2)-2\cos(7\theta_3) = 0 \quad (4)$$

$$m \approx V_1 / (4V_{dc}/\pi) \quad (5)$$

This is a system of three transcendental equations in three unknowns. This is the case which is used to eliminate 5^{th} and 7th harmonics.

3. POWER QUALITY PROBLEMS & ISSUES

A recent survey of Power Quality experts indicates that 50% of all Power Quality problems are related to grounding, ground bonds, and neutral to ground voltages, ground loops, ground current or other ground associated issues. Electrically operated or connected equipment is affected by Power Quality. Determining the exact problems requires sophisticated electronic test equipment. The following symptoms are indicators of Power Quality problems. Piece of equipment miss operates at the same time of day. Circuit breakers trip without being overloaded. Equipment fails during a thunderstorm.

4. Shunt Active Filters

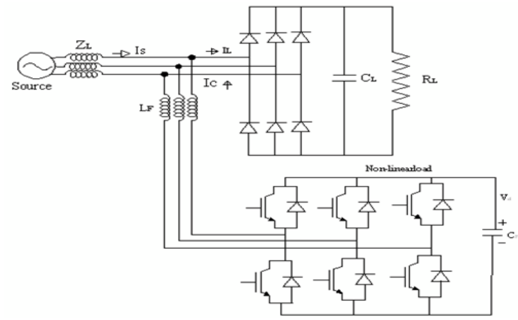

Figure2: Shunt active filters

The filter presents good dynamic and steady-state response and it can be a much better solution for power factor and current harmonics compensation than the conventional approach (capacitors to correct the power factor and passive filters to compensate for current harmonics). Besides, the shunt active filter can also compensate for load current unbalances, eliminating the neutral wire current in the power lines. Therefore, this active filter allows the power source to see an unbalanced reactive non-linear load, as a symmetrical resistive load. The proposed low-cost solution allows the use of a large number low-power active filters in the same facility, close to each problematic load (or group of loads), avoiding the circulation of current harmonics, reactive currents and neutral currents through the facility power lines. This solution reduces the power lines losses and voltage drops, and avoids voltage distortions at the loads terminals

5. Multi pulse converters

Adjustable speed AC drives are mainly made up of two power sections, i.e., a rectifier section and an inverter section. The AC source voltage is converted into a DC voltage by the rectifier circuit, and then the DC voltage is converted again into a PWM controlled variable voltage AC output by the inverter circuit. The six-diode bridge rectifier is most widely used as an AC-to-DC converter. This diode rectifier has a nonlinear (i.e. non-sinusoidal) load characteristic causing harmonic currents flow into the power source and results in line voltage distortion. The combined higher pulse number will result in lower harmonics in the power line.

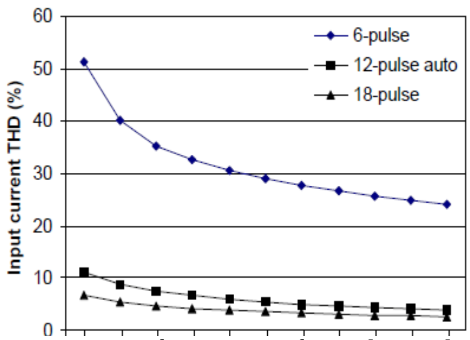

Figure 3: Performance of Multi Pulse Converters

The combined higher pulse number will result in lower harmonics in the power line. It is understood that the individual power supplies will each exhibit 6-pulse input performance, the resulting lower order harmonics (5th,7th) will circulate between it and its phase-offset neighbors.

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Application of Shunt Active Filter for Harmonic Reduction

The below shown are the two figures for 6 Pulse Controlled Converter. Before application of pulse width modulation Signals THDV and After Application of Filter .

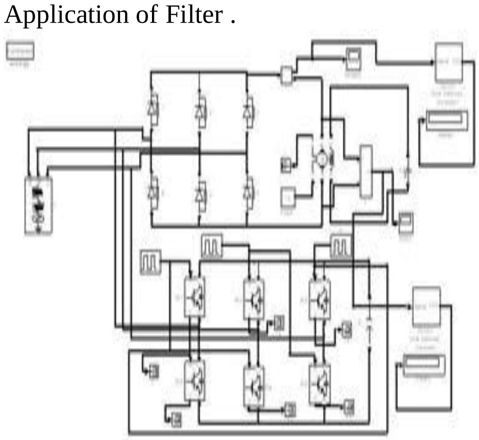

Figure 4: Application of Shunt Active Filter to 6 Pulse Converter. After Application of Filter, THDV = 2.074, THDI = 0.9047

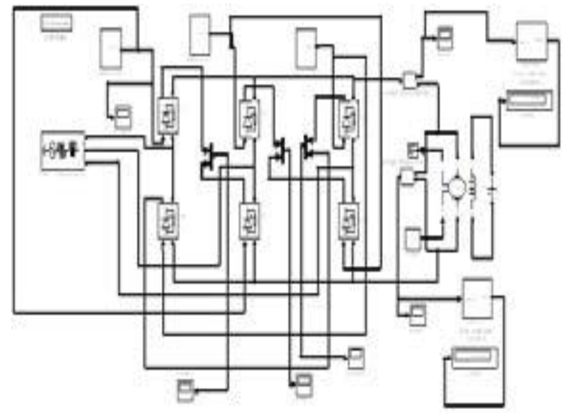

Figure 5: Block Diagram of 6 Pulse Controlled Converter. Before application of PWM Signals THDV = 1.462, THDI = 0.4179

The below showed figure are the results for 6 pulse converter before and after the application figures the results for above diagrams .this are the main FFT results for 6 pulse of filters ,from this we are known THD values.

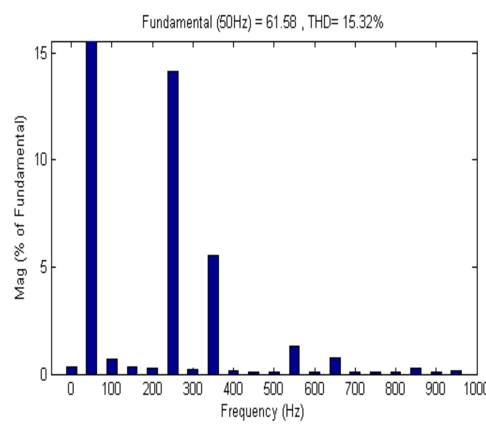

Figure 6: Before application of Filter

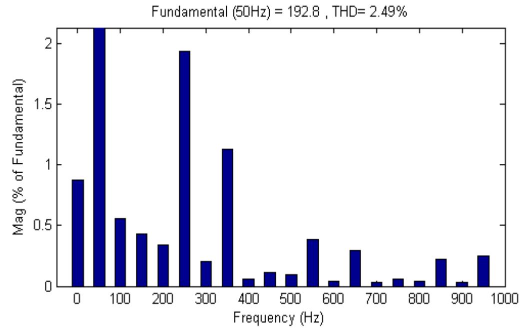

Figure 7 :After Application of Filter,

Rating of motor(in HP)	THDI	THV
5	3.11	1.511
10	3.71	2.138
20	2.76	1.657
30	2.56	1.66
40	2.46	1.58

Table1:6 Pulse converter

Rating of motor(in HP)	THDI	THDV
5	2.47	1.07
10	2.45	1.08
20	2.3	1.06
30	2.2	1.22
40	1.9	1.04

Table:48 Pulse converter

6. Conclusion:

Power Quality related issues, standards concerned with power quality are discussed in detail and various suppression techniques are thus simulated. All the reduction techniques do have its own area of application. Owing to IEEE 519 Std, suitable technique can be adopted. Passive Filters are cheaper and Shunt Active Filters are found to be advantageous than other reduction techniques. Selective Harmonic Elimination Technique can be used to suppress dominant harmonics and thus lower the THD of entire system. With increase in pulse number, the quality of power is found to improve.

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5. MATLAB Version 7.0.1 (R2007b)

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