CONTROL OF RIPPLE ELIMINATIORS TO IMPROVE THE POWER QUALITY OF DC

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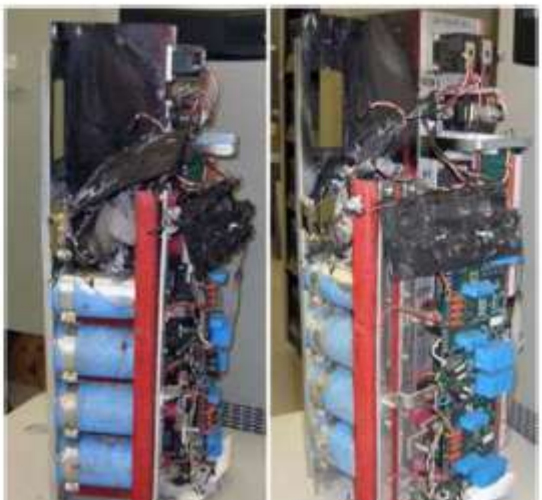
Abstract :The problem of voltage/current ripples has become a primary power quality issue for dc systems, which could seriously degrade the performance on both the source side and the load side and lead to reliability concerns. In this thesis, a single-phase Pulse width modulation-controlled rectifier is taken as an example to investigate how active control strategies can improve the power quality of dc systems, reduce voltage ripples, and, at the same time, reduce the usage of electrolytic capacitors. The concept of ripple eliminators recently proposed in the literature is further developed, and the ratio of capacitance reduction is quantified.

In this thesis, control of ripple eliminators to improve the power quality of DC systems and reduce the usage of electrolytic capacitors is simulated using MATLAB/SIMULINK.A comparative study has been made to take the reference of the auxiliary capacitors. Simulation results show that, to eliminate the ripples in the voltage and current by using ripple eliminator

I. INTRODUCTION

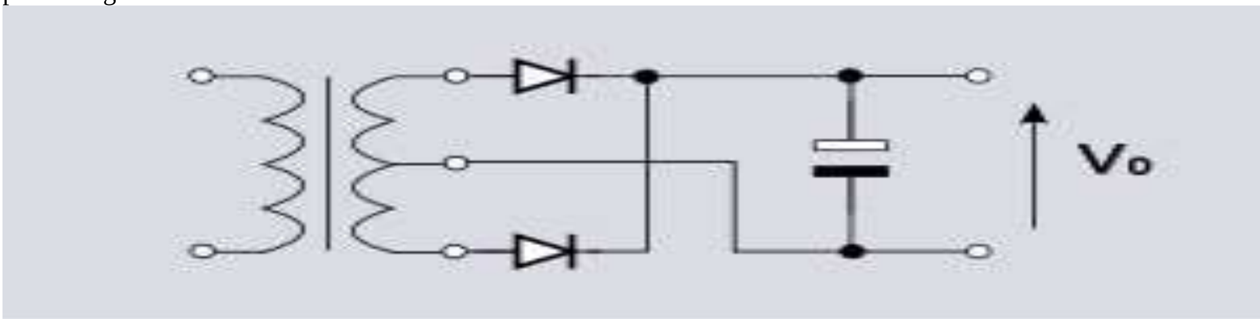
Proliferated renewable energy systems greatly promote the development of DC distributed power system, which enjoys flexible system configurations, high efficiency, and high density power delivery capability such DC systems, ripple power is often not a major concern because a DC current is constant and there is not an issue of phase differences between voltages and currents. However, in many applications like hybrid electrical vehicles and wind power systems, rectifiers and inverters are commonly used and DC voltages are not ideal but have a significant amount of harmonic components. Because of the harmonic components in the voltages and the resulting ripple currents, ripple power has become a major power quality issue in DC systems.

For systems powered by photovoltaic panels, batteries and fuel cells, large ripple currents and ripple voltages could considerably reduce the lifetime and long-term reliability of photovoltaic panels, batteries and fuel cells. During the charging mode of a battery, an external voltage with large ripples could lead to an immoderate chemical reaction. During the discharging mode, ripple currents drawn from a fuel cell can degrade the system efficiency significantly and even make it unstable. Generally, current ripples should be maintained less than 10% of the rated current for batteries. In order to reduce the ripple current and smooth the external voltage on batteries and fuel cells, bulky capacitors or ultra capacitors are often connected in parallel with them. Large electrolytic capacitors are also often needed to level and smooth the DC-bus voltage of inverters and rectifiers. For volume critical and/or weight-critical applications, such as electrical vehicles and aircraft power systems, the volume and weight of electrolytic capacitors could be a serious problem. Because of limited lifetime of electrolytic capacitors, they are one of the most vulnerable components in power electronic systems.



The most common meaning of ripple in electrical science is the small unwanted residual periodic variation of the direct current (DC) output of a power supply which has been derived from an alternating current (AC) source. This ripple is due to incomplete suppression of the alternating waveform within the power supply.

As well as this time-varying phenomenon, there is a frequency domain ripple that arises in some classes of filter and other signal processing networks.



In this case the periodic variation is a variation in the insertion loss of the network against increasing frequency. In this meaning also, ripple is usually to be considered an unwanted effect, its existence

II. Frequency domain ripple

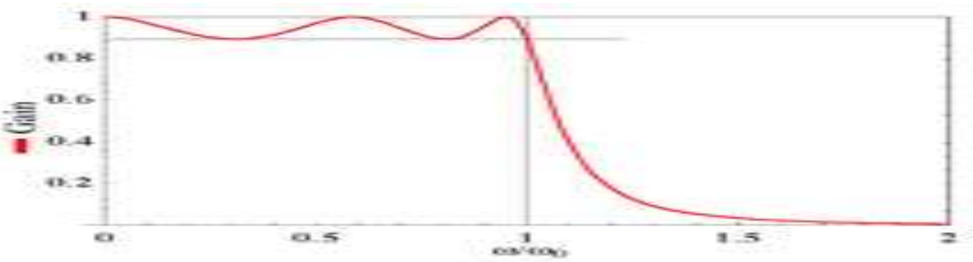


Figure 1.4 Ripple on a fifth order prototype Chebyshev filter

Figure 1.4 shows Ripple in the context of the frequency domain is referring to the periodic variation in insertion loss with frequency of a filter or some other two-port network. Not all filters exhibit ripple, some have monotonically increasing insertion loss with frequency such as the Butterworth filter. Common classes of filter which exhibit ripple are the Chebyshev filter, inverse Chebyshev filter and the Elliptical filter. The ripple is not usually strictly linearly periodic as can be seen from the example plot. Other examples of networks exhibiting ripple are impedance matching networks that have been designed using Chebyshev polynomials.

III.Encryption and Authentication

As the name suggests, CCM mode combines the well-known CBC-MAC with the well-known counter mode of encryption. These two primitives are applied in an "authenticate-then-encrypt" manner, that is, CBC-MAC is first computed on the message to obtain a tag t; the message and the tag are then encrypted using counter mode. One key insight is that the same encryption key can be used for both, provided that the counter values used in the encryption do not collide with the pre-initialization vector used in the authentication.

A proof of security exists for this combination, based on the security of the underlying block cipher. The proof also applies to a generalization of CCM for any size block cipher, and for any size cryptographically strong pseudo-random function (since in both counter mode and CBC-MAC, the block cipher is only ever used in one direction).CCM mode was designed by Russ Housley, Doug Whiting and Niels Ferguson. At the time CCM mode was developed, Russ Housley was employed by RSA Laboratories. A minor variation of the CCM, called CCM

IV.Result:

The concept of ripple eliminators has been further developed to improve the power quality and reduce the voltage ripples in DC systems and, at the same time, reduce the capacitance needed and the usage of electrolytic capacitors. After deriving the reduction ratio of the capacitance required, the focus of this paper is on the design of an advanced control strategy so that the ripple current can be instantaneously compensated. Compared to and some other related research in the literature, this paper has the following unique contributions:

- It has been revealed that the capability of instantly diverting the ripple current away from the DC bus is the key to improve the performance. As a result, ripple eliminators that can be operated in CCM to instantaneouslydivert ripple currents are preferred
- The repetitive control strategy is proposed to control one exemplar ripple eliminator, with the ripple energy provided by a single-phase PWM-controlled rectifier. It instantaneouslycompensates the ripple current on the DC bus so that the voltage ripples on the DC bus can be significantly reduced.

Experimental results have demonstrated that the proposed strategy is valid and offers several times of performance improvement with comparison to a DCM ripple eliminator reported. It has been confirmed that it is important to operate ripple eliminators in CCM to instantaneously track the ripple current so that the DC-bus voltage ripples can be minimised to the greatest extent.