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Modified static VAR compensator using a large value AC capacitor

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ABSTRACT

To overcome some of the limitations of conventional static VAR compensators (SVCs) which are widely used for reactive power compensation, a modified SVC (MSVC) has been proposed. MSVC uses a large value AC capacitor. The large value AC capacitor is realized using unipolar DC capacitors and power semiconductor devices. Unlike the conventional SVCs, the proposed MSVC does not require additional shunt passive filters for harmonic filtering. MSVC has been verified through analysis and simulation. A practical implementation of MSVC has been realized and tested.

1. Introduction

Static VAR compensator (SVC) using thyristor switched capacitor (TSC) and thyristor controlled inductor (TCI) schemes have traditionally been used for reactive power compensation [1–3]. TSC and TCI schemes have a major disadvantage that they generate current harmonics. Therefore, additional shunt passive filters (SPFs) are required to filter the harmonics. SPFs comprising of capacitor and inductor have been traditionally used to filter the harmonic currents generated by nonlinear loads. In SPFs, the value of capacitor and inductor are selected to offer minimum impedance at the tuned harmonic frequency. The low impedance path allows the selected harmonic current to flow through it. SPF can filter out one harmonic frequency effectively, for which it is tuned. In practical applications SPF have many disadvantages, such as, influence of source inductance on the compensation characteristics, series and parallel resonance with the source and the load, overloading of the SPFs with the increase in harmonic currents, requirement of different SPFs for filtering different harmonics and so on.

Active power filters (APFs) have been widely investigated [4–11] to overcome the limitations of SPFs. APFs are also used for reactive power compensation in addition to harmonic filtering. APFs are effective for small nonlinear loads, but are not feasible and cost effective for large rated nonlinear loads. Their installation and running costs are high, since they require high performance voltage (or current) source inverters. Hybrid APFs can improve the compensation characteristics of SPFs with smaller rated APFs [12–17]. However, implementation of a hybrid APF system typically requires a high bandwidth pulse width modulated inverter. Hence, applications of the existing hybrid APF systems are also limited up to a certain power range of nonlinear loads. For higher rated nonlinear loads; TSC, TCI and SPF are still used for reactive power compensation and harmonic filtering.

SPF using a large value AC capacitor has been reported to overcome the limitations of conventional SPFs [18]. It comprises of a series and parallel tuned LC tank circuit. DC capacitors and power semiconductor devices have been used in the said SPF to realize large value AC capacitor. In contrast to AC capacitors, DC capacitors are available in higher values at nominal supply voltages and above. Among the DC capacitors, aluminium electrolytic and metallized polypropylene DC link capacitors are available in higher values at nominal supply voltages and above. However, the aluminium electrolytic capacitors of higher capacitance values have significantly lower current rating, high equivalent series resistance (R_{ESR}) and high self inductance (L_{ESL}) [19]. Where as, the metallized polypropylene DC link capacitors of higher capacitance values are available in higher current ratings and have low R_{ESR} and L_{ESL} [20] compared to aluminium electrolytic capacitors.

In this work, the conventional SVC has been modified for harmonic filtering in addition to reactive power compensation with only one additional inductor in series with the large value AC capacitor. The large value AC capacitor along with the inductor forms the SPF which not only filters the harmonics generated by the TCI but also the harmonics present in the line. When the capacitance value is large in SPF, it filters out several harmonics with only one set of SPF tuned at lowest harmonic frequency [18].

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