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IMPLEMENTATION OF DSTATCOM UNDER STIFF SOURCE CONDITION IN SINGLE PHASE AND THREE PHASE POWER SYSTEM

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Abstract: Loads connected to a stiff source cannot be protected from voltage disturbances using a distribution static compensator (DSTATCOM). In this proposed work, it is intended to provide fast voltage regulation at the load terminal during voltage disturbances and will protect critical loads. In addition, during normal operation, the generated reference load voltages will allow control of the source currents. Consequently, DSTATCOM will inject reactive and harmonic components of load currents to make source power factor unity. Simulation and experimental results will be presented to verify the efficacy of the proposed control algorithm and multifunctional DSTATCOM.

Key Words: Distribution static compensator (DSTATCOM), Multifunctional, Power factor, Stiff source, Voltage regulation.

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INTRODUCTION

A distribution static compensator (DSTATCOM) can mitigate several power quality problems. There are two modes of operation. In current control mode (CCM) [2]-[4], it injects harmonic and reactive components of load currents to make source currents balanced, sinusoidal and in phase with load voltages. In voltage control mode (VCM) [5]-[6], it regulates load voltage at a constant value. This protect sensitive loads from voltage disturbances such as swells, sag, fluctuations and transients. These two modes have different objective which cannot be achieved simultaneously.

Based on the distance between source and load, a source is termed as stiff or nonstiff. If the distance is long, then source is termed as nonstiff and has high feeder impedance, whereas if the distance is very small, then source is termed as stiff. When a load is connected to nearly a stiff source, feeder impedance will be negligible [2]-[3], [8], [9]. Under these circumstances, DSTATCOM cannot provide sufficient voltage regulation at the load terminal [9].

In present work, this problem is addressed while ensuring that, during normal operation, the advantages of current control mode are retained. A new control-algorithm-based DSTATCOM topology is proposed for voltage regulation even under stiff source.

To achieve this, a suitable external inductor is conneted in series between the load and the source point. A DSTATCOM connected at the load terminal provides voltage regulation by indirectly regulating the voltage across the external inductor. This voltage indirectly controls the current drawn from the source. Simulation and experimental results will be presented.

II. LITERATURE REVIEW

Power quality improvement using FACTS devices is the latest area of interest amongst the power system researchers. Some of the research work and literature are as given below:

C. Kumar and M. K. Mishra (2014) proposed a multifunctional DSTATCOM to operate in voltage control mode under stiff source. [1] A. Bhattacharya and C. Chakraborty (2011) proposed an improvement of the dynamic performance of a shunt type active power filter. In proposed topology, the predictive and adaptive properties of artificial neural network (ANNs) are used for the fast estimation of compensating current..[2]

J.Liu, P. Zanchetta,M. Degano, and E. Lavopa (2012) presented the design and implementation of shunt active filter (SAF) for aircraft power networks using an accurate wide- band current control method based on Iterative Learning Control (ILC).This work introduces useful design strategies to increase the error-decay speed and improve the robustness of the SAF control system by using a hybrid P-type ILC controller.[3]

Q.-N. Trinh and H.-H. Lee (2013) proposed an advanced control strategy to enhance performance of shunt active power filter (APF).[4] M. K. Mishra, A. Ghosh and A. Joshi (2003) presented the operating principles of a distribution static com pensator (DSTATCOM) that is used to maintain the voltage of a distribution bus. [5] A. Camacho, M. Castilla, J. Miret, J. Vasquez, and E. Alarcon-Gallo (2013) proposed control scheme which prevents disconnection while achieving the desired voltage support service.[6]M. Moradlou and H.Karshenas (2011) discussed calculation of the optimum rating for two dynmic voltage restorers (DVRs) when used in an interline DVR (IDVR) structure.[7]

S. Srikanthan and M. K. Mishra (2010) proposed a carrier-based pulse width modulation control for an inverter-chopper circuit in order to regulate the capacitor voltages to their reference values.[8] J. Barros and J. Silva (2010) presented an optimal predictive controller for a multilevel converter-based dynamic voltage restorer (DVR), which is able to improve the voltage quality of sensitive loads connected to the electrical power network.[9]

III. DSTATCOM CONFIGURATION

A neutral point-clamped voltage source topology (VSI) topology is chosen which provides independent control of each leg of the VSI [5]. A single-phase equivalent circuit of DSTATCOM in a distribution network is shown in Fig.1. The VSI is represented by µVdc. It is connected to the load terminal through an LC filter (Lf - Cfc). The load terminal is connected to the point of common coupling (PCC) through an external series inductor Lext. Vdc is the voltage maintained across each dc capacitor, and µ is a control variable. Its value can be +1 or -1, depending upon switching state. Loads have both linear and nonlinear elements with balanced or unbalanced features. Load and source currents are represented by il and is, respectively. vs and vt are source and load voltages,respectively. Ifi, ift and ifc are currents through VSI, DSTATCOM and Cfc, respectively.

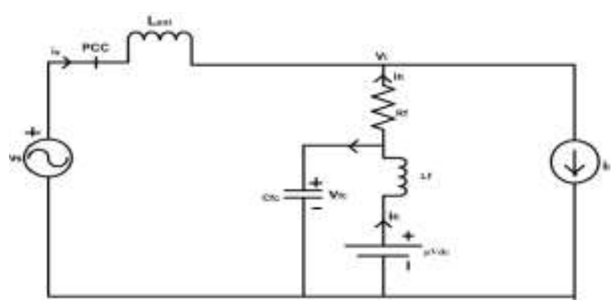

Fig.1 – Single-phase equivalent circuit of DSTATCOM in a distribution network.

IV. SELECTION OF EXTERNAL INDUCTOR

Under normal operation, external impedance (Zext) does not have much importance, whereas it plays a critical role during voltage disturbances. The value of external impedance is decided by the rating of the DSTATCOM and amount of sag to be mitigated.

V.PROPOSED CONTROL ALGORITHM

The propoed topology aims to provide fast voltage regulation at the load terminal during voltage disturbances, while retaining the advantages of CCM during normal operation. First, the currents that must be drawn from the source to get advantages of CCM will be computed. Using these currents, the magnitude of voltages that need to be maintained at the load terminal will be computed. If this voltage magnitude lies within a permissible range, then the same voltage is used as reference voltage to provide advantages of CCM. If voltage lies outside the permissible range, it is a sign of voltage disturbance, and a fixed voltage magnitude is selected as reference voltage.

A two loop controller, whose output is load angle ɗ, is used to extract load power and VSI losses from the source. Finally, a discrete model is derived to obtain switching pulses.

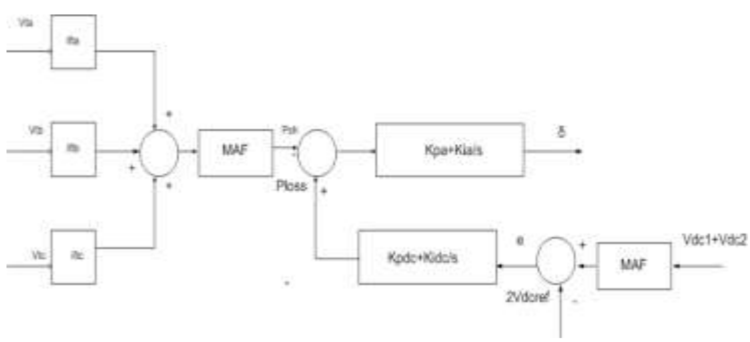

Fig 2 - Controller to calculate ɗ and Ploss

VI.CONCLUSION

A new control algorithm based multifunctional DSTATCOM has been proposed to protect the load from voltage disturbances under stiff source. An external series inductance of suitable value can be connected between source and the load to achieve this.In addition, instantaneous reference voltage is controlled in such a way that the source currents are indirectly controlled, and the advantages of CCM operation are achieved while operating in VCM for a permissible range of source voltage.

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REFERENCES

1. C. Kumar and M. K. Mishra (2014), 'A Multifunctional DSTATCOM Operating Under Stiff Source, IEEE Trans. Ind. Electron., vol. 61, no. 7, pp. 3131–3135, July. 2014.

2. A. Bhattacharya and C. Chakraborty, "A shunt active power filter with enhanced performance using ANN-based predictive and adaptive controllers," IEEE Trans. Ind. Electron., vol. 58, no. 2, pp.421–428, Feb. 2011.

3. J. Liu, P. Zanchetta, M. Degano, and E. Lavopa, "Control design and implementation for high performance shunt active filters in aircraft power grids," IEEE Trans. Ind. Electron., vol. 59, no. 9, pp. 3604–3613, Sept.2012.

4. Q.-N. Trinh and H.-H. Lee, "An advanced current control strategy for three- phase shunt active power filters," IEEE Trans. Ind. Electron., vol. 60, no. 12, pp. 5400–5410, Dec. 2013.

5. M. K. Mishra, A. Ghosh, and A. Joshi, "Operation of a DSTATCOM in voltage control mode," IEEE Trans.Power Del., vol. 18, no. 1, pp. 258–264, Jan.2003.

6. A. Camacho, M. Castilla, J. Miret, J. Vasquez, and E. Alarcon-Gallo, "Flexible voltage support control for three-phase distributed generation inverters under grid fault," ," IEEE Trans. Ind. Electron., vol. 60, no. 4, pp. 1429–1441, Apr. 2013.

7. M. Moradlou and H. Karshenas, "Design strategy for optimum rating selection of interline DVR," IEEE Trans.Power Del., vol. 26, no. 1, pp. 242–249, Jan.2011.

8. S. Srikanthan and M. K. Mishra, " DC capacitor voltage equalization in neutral clamped inverters for DSTATCOM application," IEEE Trans. Ind. Electron., vol. 57, no. 8, pp. 2768–2775, Aug. 2010.

9. J. Barros and J. Silva, "Multilevel optimal predictive dynamic voltage restorer," IEEE Trans. Ind. Electron., vol. 57, no. 8, pp. 2747–2760, Aug. 2010.

10. F. Gao and M. Iravani, " A control strategy for a distributed generation unit in grid-connected and autonomous modes of operation," ," IEEE Trans.Power Del., vol. 23, no. 2, pp. 850–859, Apr.2008.