INTERNATIONAL JOURNAL OF TECHO-ENGINEERING

ISSN : 2057-5688

TWO STAGE GRID CONNECTED PHOTO VOLTAIC SYSTEM WITH UPQC APPLIED TO MICROGRID

YERPULA NARENDAR*, G. NAVEEN**, P. RAJENDAR***

PG SCHOLAR*, ASSOCIATE PROFESSOR**, ASSOCIATE PROFESSOR & HOD***

DERAPRTMENT OF EEE, JOGINPALLY B.R. ENGINEERING COLLEGE (AFFILIATED TO JNTUH, HYDERABAD), YENKAPALLY(V), MOINABAD(M), R.R. DIST, HYDERABAD – 500 075.T.S

ABSTRACT: This paper proposes a single-stage three-phase four-wire grid-connected photovoltaic (PV) system operating with a dual compensating strategy and feedforward control loop (FFCL). Besides injection of active power into the grid, the PV system op-erates as a unified power quality conditioner (UPQC), suppressing load harmonic currents and compensating reactive power. Fur-thermore, regulated, balanced, and harmonic-free output voltages are provided to the load. Since the PV-UPQC is based on a dual compensation strategy, the series converter operates as a sinusoidal current source, whereas the parallel converter operates as a sinu-soidal voltage source. Thus, seamless transition can be achieved from the interconnected to the islanding operation modes, and vice versa, without load voltage transients. Moreover, to overcome problems associated with sudden solar irradiation changes, fast power balance involving the PV array and the grid is obtained, since the FFCL acts on the generation of the series inverter cur-rent references. As a result, the dynamic responses of both inverter currents and dc-bus voltage are improved. Detailed analysis in-volving the active power flow through the inverters is performed allowing proper understanding of the PV-UPQC operation.Exper-imental results are presented to evaluate both dynamic and static performances of the PV-UPQC tied to the electrical distribution system.

KEYWORDS: Unified Power Quality conditioner (UPQC), Feedback Control Loop (FFCL), Photovoltaic (pv) system

I. INTRODUCTION The production of electrical energy from renewable energy sources (RES) has grown a lot in recent decades, mainlydue to increased demand for electricity, as well as the global intensive efforts to overcome the harmful environmental impacts caused by pollutant energy sources, such as oil, coal, natural gas, and others. Distributed generation (DG) systems based on RES have con-tributed to find new modern solutions for planning conventional power systems [1]. Inserted in this scenario, solar energy has emerged as a promising RES due to its abundance across the earth s surface. In particular, by means of photovoltaic (PV) cells, PV panels have been properly designed to produce energy by converting sunlight into electricity.Normally, grid-connected PV systems can be deployed by means of single-stage (S-S) or double-stage (D-S) power con-version [2], [3] S-S PV systems are usually composed of only a grid-tied inverter (dc/ac converter) [4] [9]. In this case, the PV array is directly connected to the dc-bus of the grid-tied in-verter. On the other hand, in D-S PV systems, an additional dc/dc converter is placed between the PV array and the inverter [10]-[12]. In this configuration, the maximum power point tracking (MPPT) is performed by the dc/dc converter [11]. Considering SS-PV systems, the task to perform the MPPT is assumed by the grid-tied inverter, combined with the advantage of achieving more efficiency when compared to DS-PV systems [7], [8]. In both the mentioned PV system topologies, the dc/ac converter controls the amplitude of the currents injected into the grid, in order to guarantee the balance between the power produced to the PV array and that absorbed by the grid.In most applications, PV systems are connected to the elec-trical distribution system, as well as microgrids where local generation is carried out [1], [13], [14]. Besides energy pro-duction, and according to a suitably adopted control strategy, PV systems can also carry out other roles in a microgrid, such as active filtering and/or reactive power compensation. In other words, PV systems can perform tasks similar to those performed by conventional parallel active power filters (P-APF) [11], [15],[16].In this paper, an S-S 3P4W grid-connected PV system with combined operation with a unified power quality conditioner (UPQC) is presented. The power circuit of the system, which is denominated PV-UPQC, is composed of two back-to-back con-nected neutral-point clamped (NPC) inverters. Thereby, seriesparallel active power line conditioning, as well as injection of active power into the grid and load can be simultaneously per-formed. As a result, apart from the role of P-APF (load har-monic suppressing and reactive power compensation), the PV-UPQC system is also able to provide regulated, balanced, and harmonic-free output voltages.

II. LITERATURE REVIEW

[1]. B. Singh and J. Solanki, Load compensation for diesel generator- based isolated generation system employing DSTATCOM, Jan./Feb. 2011.This paper presents the control of distribution static synchronous compensator (DSTATCOM) for reactive power, harmonics and unbalanced load current compensation of a diesel generator set for an isolated system. The control of DSTATCOM is achieved using least mean square-based adaptive linear element (Adaline). An Adaline is used to extract balanced positive-sequence real fundamental frequency component of the load current and a proportional-integral (PI) controller is used to

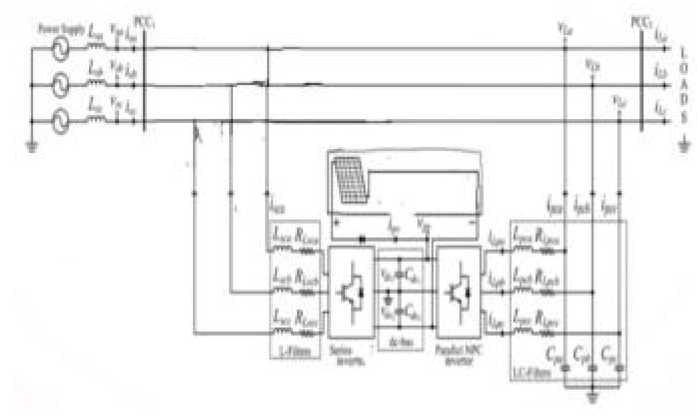
ISSN : 2057-5688

maintain a constant voltage at the dc-bus of a voltage-source converter (VSC) working as a DSTATCOM.

[2]. R. Gupta, A. Ghosh, and A. Joshi, Characteristic analysis for multisampled digital implementation of fixed-switching-frequency closedloop modulation of voltage-source inverter, Jul. 2009.In this paper, a fixedswitching-frequency closed-loop modulation of a voltage-source inverter (VSI), upon the digital implementation of the modulation process, is analyzed and characterized. The sampling frequency of the digital processor is considered as an integer multiple of the modulation switching frequency. An expression for the determination of the modulation design parameter is developed for smooth modulation at a fixed switching frequency. The variation of the sampling frequency, switching frequency, and modulation index has been analyzed for the determination of the switching condition under closed loop.

[3]. B. T. Ooi, J. C. Salmon, J. W. Dixon, and A. B. Kulkarni, A threephase controlled-current PWM converter with leading power factor, Jan. 1987 Experimental tests performed on a three-phase bipolartransistor controlled-current PWM power modulator show that it can operate with near-sinusoidal currents at 60 Hz with a 360- degree power angle range. Because of its capability to operate with leading power factor and good waveform, the PWM converter is a promising alternative to the thyristor Graetz bridge.

II. PROPOSED SYSTEM SYSTEM DESIGN The complete power circuit scheme of the proposed S-S 3P4W grid-tied PV system is composed of two back-to-back connected NPC inverters and their respective passive filtering el-ements, and three single-phase coupling transformers employed to connect the series NPC inverter to the grid.The distributed generation source, without storage, is composed of a PV array, which is formed by a single string with twenty series-connected PV panels, making possible the direct connection between the PV array and the dc-bus of the inverters.



CONCLUSION This paper proposed an S-S 3P4W grid-tied PV system, performing the tasks of a UPQC operating with a dual compensating strategy, as well as the FFCL. The system named PV-UPQC was built by means of two back-to-back connected three-level NPC inverters. Along with providing active power from the PV arrangement, the PV-UPQC system was able to perform series-parallel power-line conditioning. Thereby, both static and dynamic performances of the system were experi-mentally evaluated under distorted/disturbed grid voltage con-ditions, including sags, unbalances, and harmonics. Apart from series compensation, suppression of load harmonic currents, as well as compensation of load reactive power were carried out, such that an effective power factor correction was achieved. The effectiveness of the FFCL acting on the series converter current references was properly evaluated under sudden solar irradiation changes. The proposed PV-UPQC system represents a promising solution to be applied to DG systems, as well as ac microgrids.

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