DESIGN AND IMPLEMENTATION OF MULTIFUNCTION DUAL VOLTAGE SOURCE INVERTER FOR GRID CONNECTED SYSTEMS

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ABSTRACT:
This paper presents a twin voltage offer converter (DVSI) theme to reinforce the power quality and dependableness of the micro grid system. The projected theme is comprised of 2 inverters that let the micro grid to exchange power generated by the distributed energy resources (DERs) and in addition to compensate the native unbalanced and nonlinear load. The management algorithms square measure developed based on fast symmetrical part theory (ISCT) to control DVSI in grid sharing and grid injecting modes. The projected theme has accumulated dependableness, lower information measure demand of the most converters, lower worth as results of reduction in filter size, and better utilization of small grid power whereas victimization reduced dc-link voltage rating for the foremost converter. These choices create the DVSI theme a promising risk for micro grid provides sensitive lots. The topology and management rule square measure valid through intensive simulation.

Keywords: *Grid connected inverter, instantaneous symmetrical component theory (ISCT), micro grid, power quality.*

I. INTRODUCTION

Technological progress and environmental concerns drive the facility system to a paradigm shift with further renewable energy sources integrated to the network by suggests that of distributed generation (DG). These decigram units with coordinated management of native generation and storage facilities kind a small grid [1]. terribly} very small grid, power from entirely totally different renewable energy sources like fuel cells, physical phenomenon (PV) systems, and wind energy systems square measure interfaced to grid and hundreds victimization power electronic converters. A grid interactive electrical converter plays a vital role in exchanging power from the tiny grid to the grid and conjointly the connected load [2], [3]. This little grid converter can either add a grid sharing mode whereas supply of native load or in grid injecting mode, by injecting power to the foremost grid. Maintaining power quality is another important aspect that has to be self-addressed whereas the small grid system is connected to the most grid. The proliferation of power physical science devices and electrical hundreds with unbalanced nonlinear currents has degraded the facility quality at intervals the facility distribution network. Moreover, if there is a substantial quantity of feeder ohm resistance within the distribution systems, the propagation of these harmonic currents distorts the voltage at the aim of common coupling (PCC). At identical instant, trade automation has reached to a really high level of sophistication, wherever plants like automobile producing units, chemical factories, and semiconductor industries want clean power. For these applications, it's essential to compensate nonlinear and unbalanced load currents [4]. Load compensation and power injection victimization grid interactive inverters in small grid square measure conferred within the literature [5], [6]. One converter system with power quality improvement is mentioned in [7].

The main focus of this work is to comprehend dual functionalities in Associate in nursing electrical converter which will give the active power injection from a star PV system and to boot works as an active power filter, compensating unbalances and conjointly the reactive power needed by completely different a whole lot connected to the system. In [8], a voltage regulation and power flow management theme for a wind energy system (WES) is planned. A distribution static compensator (DSTATCOM) is used for voltage regulation and to boot for active power injection. The management theme maintains the power balance at the grid terminal throughout the wind variations victimization sloppy mode management.

A multifunctional power convertor for the load unit facility is delineating in [9]. This theme has the potential to inject power generated by WES and to boot to perform as a harmonic compensator. Most of the reportable literature during this space discusses the topologies and management algorithms to produce load compensation capability within the same electrical converter additionally to their active power injection. Once a grid-connected electrical converter is used for active power injection likewise as for load compensation, the convertor capability which is able to be utilized for achieving the second objective is determined by the obtainable fast small grid real power [10]. Considering the case of a grid-connected PV convertor, the gettable capability of the convertor to supply the reactive power becomes less throughout the utmost star Insolation periods [11]. At constant instant, the reactive power to regulate the PCC voltage is extraordinarily lots of needed throughout this era [12]. It indicates that providing multifunctional ties throughout one convertor degrades either the vital power injection or the load compensation capabilities.

This paper demonstrates a twin voltage supply electrical converter (DVSI) theme, within which the ability generated by the small grid is injected as real power by the most voltage supply electrical converter (MVSI) and also the reactive, harmonic, and unbalanced load compensation is performed by auxiliary voltage provide converter (AVSI). This has a bonus that the rated capability of MVSI can constantly be accustomed inject real power to the grid, if adequate renewable power is accessible at the dc link. Within the DVSI theme, as total load power is provided by 2 inverters, power losses across the semiconductor switches of each converter unit reduced. This will increase its liableness as compared to 1 converter with multifunctional capabilities [13]. Also, smaller size normal inverters can operate at high switch frequencies with a reduced size of interfacing inductor; the filter worth gets reduced [14].

Moreover, as a result of the most converters is provision real power, the converter has to track the essential positive sequence of current. This reduces the information measure demand of the foremost converter. The inverters inside the planned theme use 2 separate dc links. Since the auxiliary electrical converter is provision zero sequence of load current, a three-phase three-leg electrical converter topology with one dc storage condenser is employed for the foremost electrical converter. This in turn reduces the dc-link voltage demand of the foremost converter. Thus, the employment of 2 separate inverters inside the planned DVSI theme provides inflated responsibility, higher utilization of small grid power, reduced dc grid voltage rating, less information measure demand of the foremost converter, and reduced filter size [13]. Management algorithms square measure developed by instant symmetrical part theory (ISCT) to regulate DVSI in grid-connected mode, whereas considering non stiff grid voltage [15], [16]. The extraction of elementary positive sequence of PCC voltage is completed by dq0 transformation [17]. The management strategy is tested with a pair of parallel inverters connected to a three-phase four-wire distribution system. Effectiveness of the planned management algorithmic rule is valid through elaborate simulation and experimental results.

II RELATED WORK

1. "Multifunctional VSC Controlled Micro grid Using Instantaneous Symmetrical components Theory".

This paper proposes a control theme to control the micro grid aspect voltage provide device (G-VSC) practice instant symmetrical parts theory. The G-VSC with projected management is commonly utilized.

I) As a two-way power sharing device to manage the ability flow from the dc aspect to the ac aspect and the other way around, supported renewable power out there at the dc link.

II) As associate degree influence quality compensator with the choices of reactive power compensation, load reconciliation, and mitigation of current harmonics generated by nonlinear a whole bunch at the purpose of common coupling, thus sanctioning the grid to produce solely curved current at unity power issue

III) To damp out the oscillations within the G-VSC currents effectively victimization damping filter within the management rule. The mathematical models unit derived and stability aspects unit analyzed very well through the frequency domain approach.

2. "Interactive Distributed Generation Interface for Flexible Micro-Grid Operation in Smart Distribution Systems".

This paper presents associate interactive distributed generation (DG) interface for flexible micro-grid operation inside the smart distribution system environment. beneath the smart grid environment, weight unit units ought to be enclosed inside the system operational management framework, where they can be used to enhance system reliableness by providing backup generation in isolated mode, and to provide appurtenant services (e.g. voltage support and reactive power control) within the grid-connected mode. to meet these requirements, the proposed flexible interface utilizes a fixed power–voltage–current cascaded management structure to attenuate operation shift and is supplied with robust internal model management structure to maximise the disturbance rejection performance among the load unit interface. The planned system facilitates flexible and powerful weight unit operational characteristics like 1) active/reactive power (PQ) or active power/voltage (PV) bus operation inside the grid-connected mode, 2) regulated power management in autonomous micro-grid mode, 3) swish transition between autonomous mode and PV or PQ grid connected modes and the other way around, 4) reduced voltage distortion beneath heavily nonlinear loading conditions, and 5) robust management performance beneath islanding detection delays.

3. "Multifunctional VSC Controlled Micro grid Using Instantaneous Symmetrical Components Theory".

This paper proposes an impression theme to manage the small grid facet voltage–source device (G-VSC) mistreatment fast symmetrical parts theory. The G-VSC with projected management ar usually used 1) as a bifacial power sharing device to manage the ability flow from the dc facet to the ac facet and contrariwise, supported renewable power on the market at the dc link; 2) as associate degree influence quality compensator with the choices of reactive power compensation, load reconciliation, and mitigation of current harmonics generated by nonlinear hundreds at the aim of common coupling, thus sanctioning the grid to produce only sinuous current at unity power factor; and 3) to damp out the oscillations within the G-VSC currents effectively mistreatment damping filter within the management rule. The mathematical models ar derived and stability aspects ar analyzed very well through the frequency domain approach.

4. "Advanced Control Architectures for Intelligent Micro grids".

This paper presents a review of advanced control techniques for micro grids. This paper covers decentralized, distributed, and hierarchical control of grid-connected and islanded micro grids. At first, decentralized control techniques for micro grids are reviewed. Then, the recent developments within the stability analysis of decentralized controlled micro grids square measure discussed.

5. "Grid Interconnection of Renewable Energy Sources at the Distribution Level With Power-Quality Improvement Features".

Renewable energy resources (RES) unit being a lot of and a lot of connected in distribution systems utilizing power electronic converters. This paper presents a very distinctive management strategy for achieving most benefits from these grid-interfacing inverters once place in in 3-phase 4-wire distribution systems. The converter is controlled to perform as a multi-function device by incorporating active power filter utility. The device} can thus be used as: 1) power convertor to inject power generated from RES to the grid, and 2) shunt APF to compensate current unbalance, load current harmonics, load reactive power demand and load neutral current. All of these functions may even be accomplished either one by one or at a similar time. With such a bearing, the combo of grid-interfacing converter and additionally the 3-phase 4-wire linear/non-linear unbalanced load at purpose of common coupling appears as balanced linear load to the grid.

III PROPOSED SYSTEM

3.1 VOLTAGE SOURCE INVERTER (VSI):

The main objective of this section is to counsel a theme that's best appropriate for a given application. Applications is distinguished chiefly supported their power level and thus the switch frequency or by the kind of load. to attain this goal many area vector modulation schemes are thought of. the selection of those schemes was ruled chiefly by the performance criteria represented higher than. Analysis was 1st performed for every of those schemes to develop expressions and generate a series of curves below varied operative conditions. Then the circuit was simulated in SABER to verify the expressions developed and eventually the modulation schemes were tested time period on a model electrical converter to verify the validity of each the analysis and simulation.

The first a part of the thesis deals with three-leg voltage supply inverters (Fig.1.1), that ar commonplace inverters providing three-phase three-wire output. Four area vector modulation schemes ar thought of here. Their performance with relevance for every of the on high of mentioned problems is analyzed over the entire varies of modulation index and for variable load power issue angles. a singular procedure for the calculation of academic degree has in addition been projected. The analysis is verified exploitation simulation and experiments. The second a part of the thesis deals with four-leg voltage supply inverters (Fig.1.2) that ar terribly engaging for applications where three-phase four-wire output is required. This topology famous beneath stood to provide balanced output voltages even below unbalanced load conditions [9, 10]. as a result of the additional leg, the number of topologies that this electrical converter could assume is sixteen that's doubly that of a typical three-leg converter. the method of house vector modulation and duty cycle calculation for this four-leg topology is reviewed first. Then the techniques developed for the analysis of three-leg voltage

Source electrical converter within the first a vicinity of the thesis is utilized to analyze a four-leg voltage offer converter. three house vector modulation schemes ar addressed here. Their performance with relevance academic degree and shift losses is analyzed. The analysis is performed for every balanced and unbalanced load conditions.

For the balanced case, the analysis is performed over the entire vary of modulation index and over variable load power factors. For the unbalanced case two forms of unbalance ar thought of 1) load power issue unbalance 2) load magnitude unbalance. The analysis is verified mistreatment simulation.

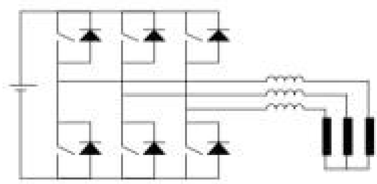

Figure 1: Topology of a three-leg voltage source inverter.

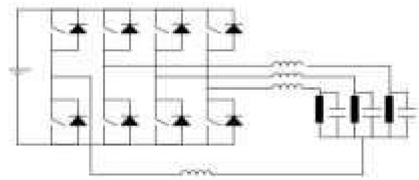

Figure 2: Topology of a four-leg voltage source inverter.

3.2 DUAL VOLTAGE SOURCE INVERTER

A. System Topology

The projected DVSI topology is shown in Fig. 1. It consists of a neutral purpose clamped (NPC) electrical converter to comprehend AVSI and a three-leg electrical converter for MVSI [18]. This are connected to grid at the PCC and activity a nonlinear and unbalanced load. The perform of the AVSI is to compensate the reactive, harmonics, and unbalance parts in load currents. Here, load currents in 3 phases are delineated by terrorist group, i_ (lb,) i_lc and severally. Also, & show grid currents, MVSI currents, and AVSI currents in three phases, respectively. The dc link of the AVSI utilizes a split capacitor topology, with two capacitors and .

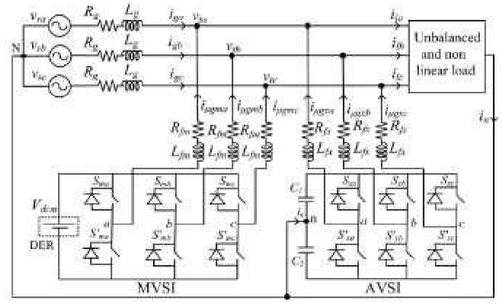

Figure 3: Topology of proposed DVSI scheme.

The DER is often a dc offer or associate degree ac offer with rectifier coupled to dc link. Usually, renewable energy sources like cell and PV generate power at variable low dc voltage, whereas the variable speed wind turbines generate power at variable ac voltage. Therefore, the facility generated from these sources use an influence learning stage before it's connected to the input of MVSI. During this study, DER is being diagrammatical as a dc supply. Associate degree electrical device filter is used to eliminate the high-frequency shift elements generated as results of the shift of power electronic switches inside the inverters [19]. The system thought of throughout this study is assumed to possess some amount of feeder resistance floor cover, and inductance L_g. because of the presence of this feeder ohmic resistance, PCC voltage is affected with harmonics [20]. Section III describes the extraction of basic positive sequence of PCC voltages and management strategy for the reference current generation of 2 inverters in DVSI theme.

B. Design of DVSI Parameters

1) AVSI: The important parameters of AVSI like dc-link voltage ( ), dc storage capacitors (and), interfacing inductance ( ), and hysteresis band (±) are selected based on the design method of split capacitor DSTATCOM topology [16]. The dc-link voltage across each capacitor is taken as 1.6 times the peak of phase voltage. The total dc-link voltage reference (V) is found to be 1040 V.

Values of dc capacitors of AVSI are chosen based on the change in dc-link voltage during transients. Let total load rating is S k VA. In the worst case, the load power may vary from minimum to maximum, i.e., from 0 to S k VA. AVSI needs to exchange real power during transient to maintain the load power demand. This transfer of real power during the transient will result in deviation of capacitor voltage from its reference value. Assume that the voltage controller takes n cycles, i.e., nT seconds to act, where T is the system time period. Hence, maximum energy exchange by AVSI during transient will be nST. This energy will be equal to change in the capacitor stored energy. Therefore

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Where and are the reference dc voltage and maximum permissible dc voltage across during transient, respectively. Here, S =5 kVA, = 520 V, = 0.8 * or 1.2 * , n = 1, and T = 0.02 s. Substituting these values in (1), the dc link capacitance ( ) is calculated to be 2000 μF. Same value of capacitance is selected for .

The interfacing inductance is given by = ——— Assuming a maximum switching frequency ( ) of 10 kHz and hysteresis band ( ) as 5% of load current (0.5 A), the value of is calculated to be 26 mH.

2) MVSI:

The MVSI uses a three-leg inverter topology. Its dc-link voltage is obtained as 1.15 * , where is the peak value of line voltage. This is calculated to be 648 V. Also, MVSI supplies a balanced sinusoidal current at unity power factor. So, zero sequence switching harmonics will be absent in the output current of MVSI. This reduces the filter requirement for MVSI as compared to AVSI [21]. In this analysis, a filter inductance ( ) of 5 mH is used.

C. Advantages of the DVSI Scheme:

The various benefits of the projected DVSI theme over one electrical converter theme with multifunctional capabilities [7]–[9] ar mentioned here as follows:

1) accumulated Reliability: DVSI theme has accumulated reliableness, because of the reduction in failure rate of parts and therefore the decrease in system down time price [13]. during this theme, the full load current is shared between AVSI and MVSI and thus reduces the failure rate of electrical converter switches. Moreover, if one electrical converter fails, the opposite will continue its operation. This reduces the lost energy and thus the down time price. The reduction in system down time price improves the reliableness.

2) Reduction in Filter Size: In DVSI theme, this equipped by every electrical converter is reduced and thus this rating of individual filter electrical

device reduces. This reduction in current rating reduces the filter size. Also, during this theme, physical phenomenon current management is employed to trace the electrical converter reference currents. As given in (2), the filter inductance is determined by the electrical converter change frequency. Since the lower current rated conductor will be switched at higher change frequency, the inductance of the filter will be lowered. This decrease in inductance more reduces the filter size.

3) Improved Flexibility: each the inverters ar fed from separate dc links which permit them to work severally, therefore increasing the flexibility of the system. for example, if the dc link of the most electrical converter is disconnected from the system, the load compensation capability of the auxiliary electrical converter will still be utilized.

4) Higher Utilization of small grid Power: DVSI theme helps to utilize full capability of MVSI to transfer the complete power generated by decigram units as real power to ac bus, as there's AVSI for harmonic and reactive power compensation. This will increase the active power injection capability of DGs in small grid [22].

5) Reduced DC-Link Voltage Rating: Since, MVSI isn't delivering zero sequence load current components; one capacitance three-leg VSI topology will be used. Therefore, the dc link voltage rating of MVSI is reduced around by thirty eighth, as compared to one electrical converter system with split capacitance VSI topology.

IV SIMULATION RESULTS

4.1 SIMULATION DIAGRAM

The entire control strategy is schematically represented in Fig.4.1Control strategy of DVSI is developed in such a way that grid and MVSI together share the active load power, and AVSI supplies rest of the power components demanded by the load.

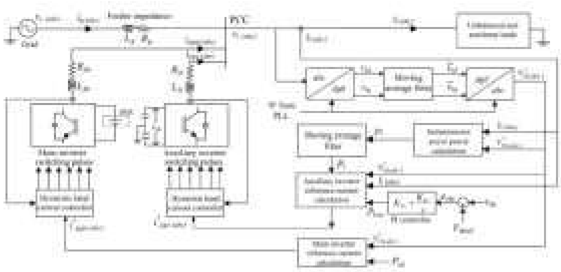
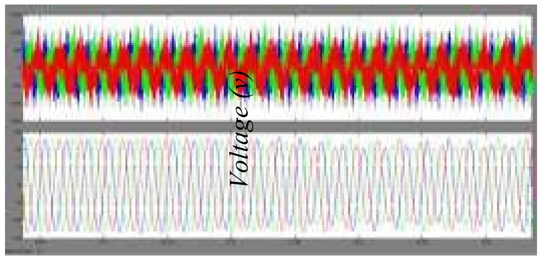
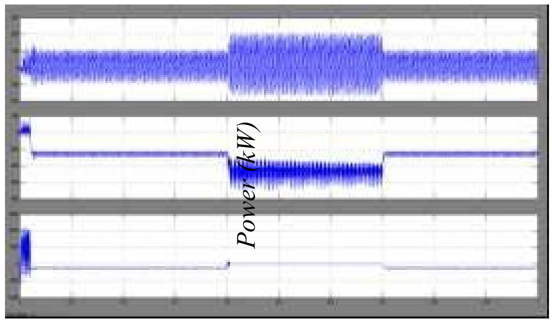


Figure: 4.1.Schematic diagram showing the control strategy of proposed DVSI scheme

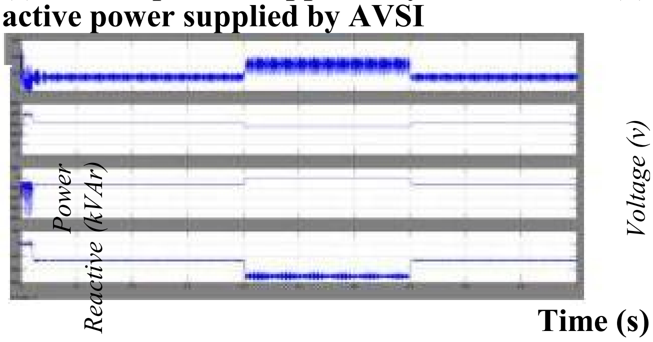


Time (s)

Figure: 4.2. Without DVSI scheme: (a) PCC voltages and (b) fundamental positive Sequence of PCC voltages.

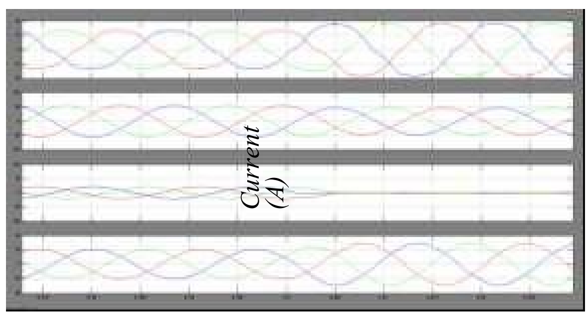


Time (s) Figure: 4.3. Active power sharing: (a) load active power; (b) active power supplied by grid (c) active power supplied by MVSI and (d) active power supplied by AVSI



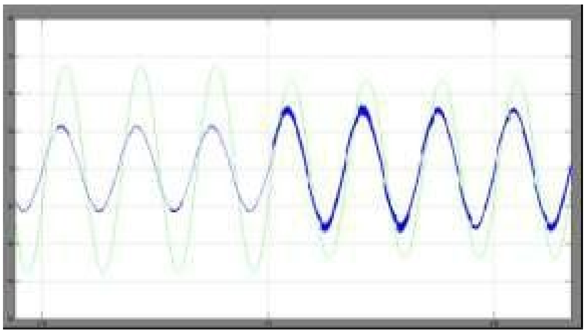
Time (s)

Figure: 4.4.Reactive power sharing: (a) load reactive power; (b) Reactive power supplied by AVSI and (c) reactive power supplied by MVSI.



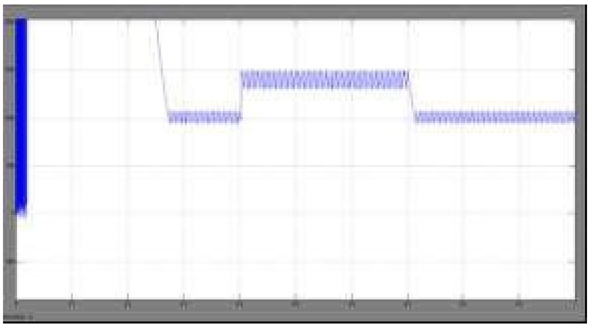
Time (s) Figure: 4.5.Simulated performance of DVSI scheme: (a) load currents (b) grid currents (c) MVSI currents; and (d) AVSI currents.

Current (A)

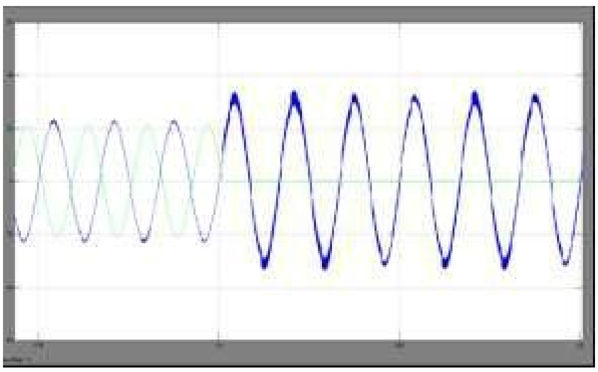


Time (s)

Figure: 4.6.Grid sharing and grid injecting modes of operation: (a) PCC voltage and grid current (phase-a)



Time (s) Figure: 4.7.Grid sharing and grid injecting modes of operation: pcc voltage and MVSI current (phase-a)



Time (s)

Figure: 4.8. DC-link voltage of AVSI

CONCLUSION

A DVSI theme is planned for small grid systems with increased power quality. management algorithms ar developed to urge reference currents for DVSI victimization ISCT. The planned theme has the potential to exchange power from distributed generators (DGs) and in addition to compensate the native unbalanced and nonlinear load. The performance of the planned theme has been valid through simulation and experimental studies. As compared to at least one electrical converter with multifunctional capabilities, a DVSI has several blessings like, increased responsibility, lower worth thanks to the reduction in filter size, and lots of utilization of converter capability to inject real power from DGs to tiny grid. Moreover, the employment of three-phase, three wire topology for the foremost converter reduces the dc-link voltage demand. Thus, a DVSI theme could also be associate degree applicable interfacing selection for small grid activity sensitive hundreds.

FUTURE SCOPE

The Most Advanced Controllers Such As Fuzzy Network, Artificial Neutral Networks and adaptive Instantaneous Power Theory can be used for high power applications. It Can Also used with micro controller based upqc To Make the System More Effective than DSTATCOM.

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