An Analysis on the Power Quality Improvement of Wind Connected System through Distributed Power Quality Controller

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Abstract – The impact of the wind turbine in the framework concerning the power quality estimations are the dynamic power, responsive power, variety of voltage ,flash, sounds and electrical conduct in exchanging activity. The power quality issues when wind turbine introduced to matrix side is exhibited here. A Distributed power quality controller (DPQC) is associated at a point of regular coupling with a battery vitality stockpiling framework to correct the power quality issues. The battery vitality stockpiling used to keep up steady genuine power from differing wind power. The produced power can be put away in the batteries at low power request hours. The blend of battery stockpiling with wind vitality age framework will combine the yield wave structure by engrossing (or) infusing responsive power and empower the genuine power stream required by the heap. The DPQC control plot for power quality improvement is recreated utilizing MAT LAB/SIMULINK in power framework square set.

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INTRODUCTION

To have maintainable growth and social advancement, it is important to meet the vitality need by using the sustainable power source assets like wind biomass, hydro co-age and so on. To defensive the circulated power framework by keeping up economic improvement, it is important to tap the sustainable power sources .Now days the power quality is a fundamental client centered measure and is significantly influenced by the activity of a conveyance and transmission organize. There has been a broad growth and fast improvement in the use of wind vitality as of late.

The individual units can be of enormous limit up to 2MW, sustaining in to appropriation arrange, especially with clients associated in closeness. Today in excess of 2800 wind creating turbines are effectively working everywhere throughout the world. In the fixed-speed wind turbine task, all the vacillation in the wind speed are transmitted as changes in the mechanical torque electrical power on the matrix and prompts huge voltage variances. During the typical task, wind turbine delivers a ceaseless variable yield power. These power varieties are primarily brought about by the impact of choppiness, wind shear, and tower-shadow and of control framework in the power framework. In this manner, the system needs to oversee for such changes. The power quality issues can be seen regarding the wind age, transmission and conveyance arrange, for example, voltage saq, swells, glints, sounds and so on.

Anyway the wind generator acquaints aggravations in with the circulation arrange. One of the basic strategies for running a wind creating framework is to utilize the acceptance generator associated straightforwardly to the matrix framework. The acceptance generator has inalienable points of interest of cost viability and strength. Anyway enlistment generators require receptive power for polarization. At the point when the created dynamic power of an acceptance generator can be altogether influenced.

In typical working framework we need a control circuit for the dynamic power creation. For diminishing the aggravation we utilize a battery stockpiling framework. This remunerates the unsettling influence produced by wind turbine. A DPQC has been proposed for improving the power quality. The DPQC in fact deals with the power level related with the business wind turbines. This framework delivers an appropriate voltage level having power quality enhancements. The wind vitality framework is utilized to charge the battery as and when the wind power is accessible.

The essential segments of the DPQC are two voltage source inverters (vsi's) sharing a typical dc

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stockpiling capacitor, and associated with the power framework through coupling transformer. The proposed DPQC control conspire for network associated wind vitality age for power quality improvement has following destinations.

• Two voltage source inverters and associated with the power framework through coupling transformer

• Unity power factor and power quality at purpose of regular coupling transport.

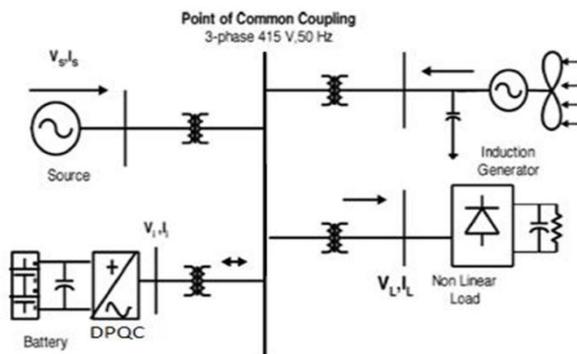• Real and Reactive power bolster just from wind generator and batteries to stack.

Fig.1. Grid connected system for power quality improvement

POWER QUALITY ISSUES

Flawless power quality implies that the voltage is nonstop and sinusoidal having consistent figures of Amplitude and recurrence. Power quality can be communicated as far as physical attributes and properties of power. It is regularly portrayed regarding voltage, recurrence and interferences.

GRID SIDE POWER QUALITY ISSUES

The power quality issues in the lattice side that influence the WEG (Wind Electric Generator) are essentially worried about the quality of voltage that is being provided by the utility.

VOLTAGE VARIATIONS

Voltage variety has suggestions on both genuine and receptive power related with wind ranches. A diminished voltage condition builds the current through the generator, making line misfortunes to increment. Diminishing voltage likewise influences the power factor as the capacitive VAR created out of the introduced capacitor decline as voltage diminishes.

• Voltage Sag/Voltage Dips.

• Voltage Swells.

• Short Interruptions.

• Long length voltage variety

FREQUENCY VARIATIONS

The variety in recurrence influences the power age in WEG to a huge degree changing the streamlined proficiency. Recurrence changes lead to flawed tip speed proportions and decreased streamlined efficiencies. These prompts decline the vitality catch and yield power of wind turbines.

VOLTAGE TRANSIENTS

Huge transient's voltage could be made because of exchanging of capacitors utilizing mechanical switches, which are the fundamental piece of WEG for receptive power pay. These inside created homeless people could result in harm to delicate electronic gadgets of the WEG control framework.

VOLTAGE UNBALANCE

Voltage unbalance is caused because of enormous uneven burdens. The unbalance in voltage causes negative arrangement flows to stream in acceptance machines, causing overheating.

WEG SIDE POWER QUALITY ISSUES

Power quality issues that influence the WEG are mostly worried about the quality of current that is being drawn or created by the WEG's.

REACTIVE POWER CONSUMPTION

Receptive power utilization in a wind homestead is predominantly because of the utilization of acceptance generators for vitality sparing. The essential standard of Induction generators is that they expend receptive power to set up the excitation or attractive field so as to produce genuine power. This receptive power utilization prompts expanded transmission and conveyance misfortunes.

GENERATION OF CURRENT HARMONICS

Current music is produced because of delicate beginning of enlistment generators during motoring mode. This twists the voltage hanging in the balance and influences every one of the purchasers associated with the line.

INJECTION OF FLUCTUATING POWER

Power in wind naturally is differed and is checked by yearly, month to month, day by day and hourly varieties. These outcomes in age and supply of a

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power that is fluctuating and prompting operational issues.

WIND POWER EXTRACTION WITH BATTERIES

The proposed wind vitality extraction from wind generator and battery vitality stockpiling with disseminated system is arranged on its working guideline and depends on the control procedure for exchanging the inverter. The DPQC based current control voltage source inverter infuses the current into the network so that the sources current are sans consonant and there is stage distinction concerning source voltage has some ideal esteem. The current is infused which will counterbalance the responsive part and symphonious piece of the heap and acceptance generator current, improves both power factor and the power quality, The proposed framework is actualized for power quality improvement at purpose of regular coupling (PCC) , as appeared in Fig. 1. The matrix associated framework in Fig. 1, indicates wind vitality age framework and battery vitality stockpiling framework with DPQC.

DC LINK FOR BATTERY STORAGE AND WIND ENERGY GENERATOR

The battery vitality stockpiling system (BESS) is utilized as a vitality stockpiling component with the end goal of voltage guideline. The BESS keep up dc capacitor voltage steady and is appropriate for DPQC since it quickly infuses or retained receptive power to balance out the lattice system. It additionally controls the quick rate of circulation and transmission system. At the point when a power variety happens in the system, the BESS can be utilized to control the power variety by charging and releasing task. The battery is associated in shunt to the dc capacitor of DPQC.

The battery stockpiling and WEG's are associated over the dc connect. The dc connection comprises of capacitor which decouples the wind producing system and air conditioning source (lattice) system. The battery stockpiling will get accused of the assistance of wind generator. The utilization of dc interface capacitors is progressively effective, more affordable and is spoken to as pursues.

C Vdc = Idc (rec) – Idc (inv) – Ib ----------------------- (4) Where C is dc interface capacitor, Vdc is rectifier yield voltage, Idc (rec) is dc-side amended current, Idc (inv) is inverter side dc current and Ib is the battery current. The battery stockpiling is associated with arrangement associated dc interface voltage source Eb and opposition Rb. At that point its voltage fluctuates with the charging status of the battery. The terminal voltage Vdc is given by

$$Vdc=Eb-Ib*Rb \text{ ------------------------- (5)}$$

Where I_b is the battery current.

DPQC-CURRENT CONTROLLED DEVICE

The DPQC is a blend of static compensator and static arrangement remuneration. It goes about as a shunt redressing and a stage moving gadget at the same time. The DPQC comprises of a shunt and an arrangement transformer, which are associated by means of two voltage source converters with a typical dc-capacitor. The dc-circuit permits the dynamic power trade among shunt and arrangement transformer to control the stage move of the arrangement voltage. This setup as appeared in figure.2 gives the full controllability to voltage and power quality. The arrangement converter should be ensured with a thyristor connect. Because of the high endeavors for the voltage source converters and the insurance, a DPQC is getting very costly, which restricts the pragmatic applications where the voltage and power quality control is required at the same time.
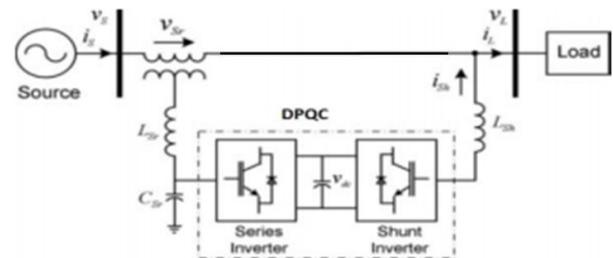
Fig.2. Principle configuration of a DPQC

As indicated by the controlled procedure the DPQC compensator yield is differed in order to keep up the power quality guidelines in the network system. Current control methodology is incorporated into the control conspire with the goal that it characterizes the utilitarian activity of the DPQC compensator in the power system. DPQC utilizing protected door bipolar transistor is proposed to give receptive power support, to the nonlinear burden to the acceptance generator in the lattice system. The operational outline of the blend of a static compensator and static arrangement pay.

CONTROL SCHEME OF SYSTEM

The control conspire with battery stockpiling and miniaturized scale wind producing system uses the dc connect to extricate the vitality from the wind. The wind generator is associated through a stage up interfacing transformer and to the rectifier connect to acquire the dc voltage .Also a lead corrosive cell battery is utilized for keeping up the dc transport voltage steady. Along these lines the inverter is actualized effectively in the appropriated system. The control plan approach depends on infusing the current in to the network utilizing hysteresis band current controller. Utilizing such

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procedures controller keeps the control system factors between the limits of hysteresis are and hence gives right exchanging sign for the inverter task. Fig.3. demonstrates the control plot for producing the changing sign to the inverter.

The control calculation needs the estimation of a few factors, for example, three-stage source current iSabc for every stage, dc transport voltage Vdc, and inverter current Iiabc with the assistance of estimation sensors.

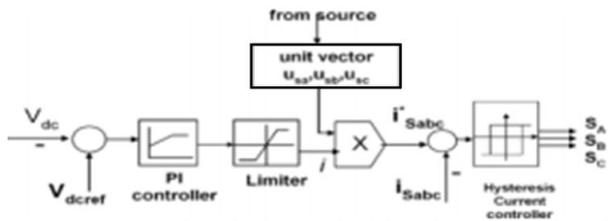**Fig.3.Control circuit for switching inverter circuit**

The present control unit gets a contribution of reference current i*Sabc and genuine current iSabc is estimated from every stage individually, which are subtracted in order to actuate the activity of the inverter in current control mode.

HYSTERESIS BASED CURRENT CONTROLLER

Current control based hysteresis controller is utilized in this specific plan. The reference current is produced as in and the real current is identified by current sensors that are subtracted for acquiring current mistakes for a hysteresis based controller. ON/OFF heartbeat signals for IGBT switches of inverter are gotten from hysteresis current controller. At the point when the deliberate current is higher than the produced reference current, it is important to get negative inverter yield voltage with the goal that relating switches are commutated. Consequently yield voltages are diminished with the goal that the yield current achieves the reference current. Additionally, if the deliberate current is not exactly the reference current, positive inverter yield voltage are acquired by commutating specific switch Thus yield current increments to the reference current. Thus, the yield current will be inside a band around the reference one. The exchanging capacity SA for stage 'an' is communicated as pursues.

$i_{sa} > (i_{sa}{}^* + HB)$ then $S_A{}^+ = 0$ and $S_A{}^- = 1$ $i_{sa} < (i_{sa}{}^* - HB)$ then $S_A{}^+ = 1$ and $S_A{}^- = 0$

Where HB is a hysteresis current-band, also the exchanging capacity SB, SC can be determined for stages "b" and "c," separately. The present control method of inverter infuses the current into the lattice so that the source flows are symphonious free and their stage edges are in stage as for source voltage. The responsive and symphonious piece of burden side is offset by the infused current at shunt part.

Along these lines, by and large it diminishes symphonious substance and improves the source current quality at the PCC. When battery vitality system is completely energized with the assistance of small scale wind generator, the power moves happens.
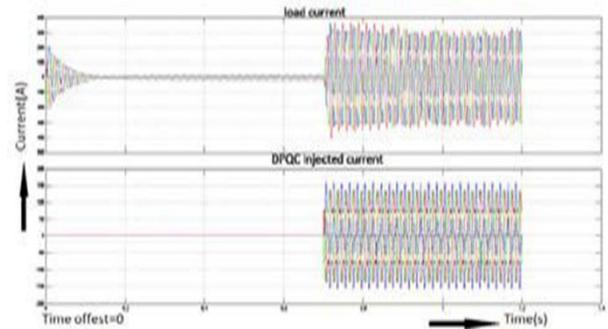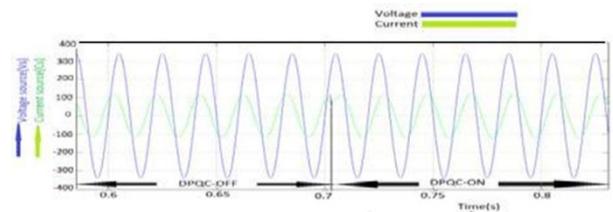

Fig.4.DPQC Output

Fig.5. Supply Voltage and Current at PCC

TABLE -1 SYSTEM PARAMETERS.

s no	Parameters	Ratings
1.	Grid Voltage	3-phase,415V,50HZ
2.	Induction Motor/Gener ator	3.35KVA,4.5V,50HZ,P=4,speed=14 40rpm, Rs=0.01Ω, Rr=0.015Ω,Ls=0.05H,Lr=0.06H
3.	Line series inductance	0.05mH
4.	Inverter Parameters	DC Link voltage=800V,DC link capacitance=100μF, Switching frequency=2KHz
5.	IGBT Rating	Collector voltage=1200v,forwardcurrent=50A, gate voltage=20V,power disipation=310W
6.	Load parameters	Nonlinear load 25KW

The source voltage is detected and synchronized in producing the ideal reference current direction for the inverter task. Hysteresis band based current control strategy is straightforward and its execution isn't costly. The controller has quick reaction since it has unimportant dormancy and deferral. In figure 4 the controller yield is seen. The source current with and without DPQC task is appeared in Fig.5.

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The FFT investigation with and without controller is found in figure 6.
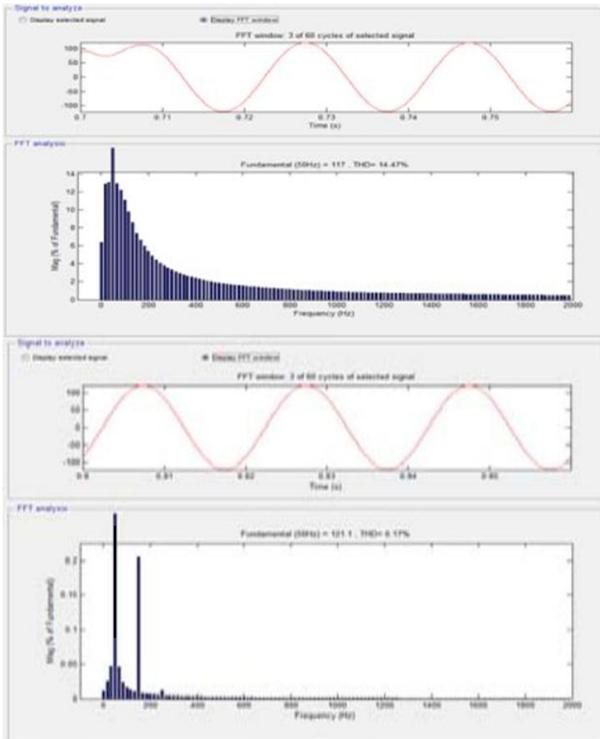
Fig.6.The FFT analysis with and without controller

As of late, the wind power is most significant and promising wellspring of sustainable power source. The wind vitality transformation system are the quickest developing sustainable power source in light of the fact that because of the social, condition and financial advantages. The power quality is an issue which empowers the gear to work appropriately. Great power quality improves the system execution and improves the steadiness of system. In any case, poor power quality delivers the misfortunes in system. The factor which is considered in the power quality is dynamic power, receptive power, voltage variety and sounds. Be that as it may, by utilizing the STATCOM, we can relieve the power quality issues. The STATCOM is associated with purpose of basic coupling with a battery vitality stockpiling system (BESS). In this audit paper we investigation the factor which are examination the power quality issues in the wind vitality transformation system and by utilizing the actualities gadgets we can improve the power quality of wind vitality change system.

As of late, there has been an expanded accentuation on, and worry for, the quality of power conveyed to processing plants, business foundations and living arrangements. Presently a-days, our mechanical world has turned out to be totally needy upon the continues accessibility of electrical power. In a large portion of the nations the electrical power is made accessible through across the country frameworks interconnecting a few creating stations to the heaps. The lattice must supply the essential power requests

of private, lighting, mechanical, budgetary, business, medicinal associations and basic supply to the administrative. Rebuilding of the utilities has entangled the power quality issues. In the rebuilt power advertise, government gives some authorization to the power segment organizations to put resources into the age, transmission and circulation of the power. And furthermore allows to the clients for determination of their power specialist co-op. Because of that now the power situation has turned out to appear as something else.

Previously, the clients characterize the quality of power dependent on the accessibility of power to them. However at this point in ongoing situation, the part of power quality has absolutely changed.[1]To have feasible development and social advancement, it is important to meet the vitality need by using the sustainable power source assets like wind biomass, hydro co-age and so forth. To defensive the appropriated power system by keeping up economic improvement, it is important to tap the sustainable power sources .Now days the power quality is a basic client centered measure and is extraordinarily influenced by the task of a conveyance and transmission organize. There has been a broad development and snappy advancement in the use of wind vitality as of late. In ordinary working system we need a control circuit for the dynamic power creation. For diminishing the unsettling influence we utilize a battery stockpiling system. This remunerates the unsettling influence produced by wind turbine. A DPQC has been proposed for improving the power quality. The DPQC in fact deals with the power level related with the business wind turbines. This system creates an appropriate voltage level having power quality improvements. The wind vitality system is utilized to charge the battery as and when the wind power is accessible.

The fundamental segments of the DPQC are two voltage source inverters (vsi's) sharing a typical dc stockpiling capacitor, and connected to the power system through coupling transformer. Faster exhaustion of petroleum products and ecological harm has come about into expanded utilization of sustainable power sources as a reasonable choice. Out of different sustainable power sources wind vitality is one of the potential vitality source. Framework implanted wind vitality age everywhere scale is expanding step by step and will end up noteworthy piece of power system.

Wind is a period subordinate exceedingly factor, capricious, fluctuating, hard to control vitality source. Incorporation of expansive scale wind ranches involving squirrel confine, doubly encouraged acceptance and synchronous generator with matrix forces different difficulties related with power quality, unwavering quality and responsive power the board. Utilities and transmission system administrators have created

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matrix codes for wind ranches. Considering expanded reconciliation of vast scale wind cultivates in not so distant future with various turbine advancements and topologies it ends up basic to think about power quality, receptive power, unwavering quality and solidness issues related with combination of substantial scale wind ranches to give financially savvy arrangements. To adapt up to network codes wind turbine innovation requires controlling of dynamic just as responsive power both in transient just as relentless state with improved issue ride through capacities. Universal guidelines for evaluation and measurement of power quality of framework connected wind ranches are accessible and IEC 61400-21 is a regularly utilized standard for power quality appraisal.

Power quality issues related with combination of substantial scale wind ranches are of two sorts:

1.   Wind turbine activity which influences power quality of framework.

2.   Grid side power quality issues which influences activity of Wind turbine.

Matrix side power quality issues are for the most part related with brief term and long length RMS voltage varieties amid enduring state and transient framework conditions. Different parameters of matrix side voltage quality are short and long length RMS voltage greatness varieties, recurrence varieties, voltage unbalance and voltage consonant contortion. Wind turbine related power quality issues are connected with glimmer, receptive power, current symphonious contortion, steadiness of wind turbine amid lattice shortcomings and so forth.

Power quality issues, for example, voltage hang, swell, under voltage, over voltage, voltage unbalance, symphonious mutilation, voltage gleam, short and long span intrusions along with receptive power issues, low voltage ride through ability, issue ride through capacity, voltage, power and rotor unsteadiness amid shortcoming, wind choppiness issues are significant worry before specialists, utilities, system administrators, and wind ranch designers.

Evaluation of in general effect of coordination of extensive scale wind ranches to network needs thought of all elements which influences power quality of wind ranches. Different elements which influence power quality of wind ranches are 1) Wind turbine innovation, for example, kind of Electric generator, direct/controlled association with network, gear box or gearless transmission 2) Grid conditions at purpose of normal coupling (PCC, for example, cut off and X/R proportion, interconnection voltage level and guideline, sort of interconnecting transformer, ear thing system 3)Wind homestead structure and control, for example, number and ostensible power of wind turbines, wind ranch inner power system (X/R)

proportion, included voltage/power control 4) Wind ranch nearby attributes, for example, choppiness force, activity of turbine amid frail stream, range of wind 3D part, spatial changeability of wind. It isn't just adequate to evaluate the power quality variety because of activity of huge scale wind ranches inserted in network however improvement of its ability and specialized attributes so as to maintain a strategic distance from debasement in power quality. Matrix codes predominantly center around 1) Identification of middle of the road arranging levels in getting system 2) Allocation of as far as possible to the age offices thinking about impact of contiguous system 3) Evaluation of average points of confinement for consonant current infusion and glint. Voltage quality is administered by system impedance. Joining of extensive scale wind cultivates in frail power system forces impediments.

Wind vitality in India has an amazingly splendid future and there is no uncertainty that, in the sustainable power source part, wind power would assume a transcendent job in including clean and non-contaminating vitality to the potential nation' so wind age frameworks and. In consistently expansive number of wind ranches are being added and interfaced to framework. When contrasted with created nations, Indian power system is feeble with poor foundation for power departure. The level of wind-based age by utilization of extensive scale wind ranches with synchronous and acceptance generator will increment at quicker rate, which will result into power quality corruption and responsive power the board issues.

## DEFINITION OF ELECTRIC POWER QUALITY

As of late, there has been an expanded accentuation and worry for the quality of power conveyed to processing plants, business foundations, and living arrangements. This is because of the expanding utilization of consonant making non direct loads, for example, movable speed drives, exchanged mode power supplies, circular segment heaters, electronic fluorescent light balances etc.[1]. Power quality approximately characterized, as the investigation of powering and establishing electronic systems in order to keep up the respectability of the power provided to the system. IEEE Standard 1159 characterizes power quality as [2]: The idea of powering and establishing delicate gear in a way that is appropriate for the activity of that hardware. In the IEEE 100 Authoritative Dictionary of IEEE Standard Terms, Power quality is characterized as ([1], p. 855): The idea of powering and establishing electronic hardware in a way that is reasonable to the activity of that gear and perfect with the reason wiring system and other associated gear. Great power quality, be that as it may, isn't anything but difficult to characterize on the grounds that what is

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great power quality to a cooler engine may not be adequate for today"s PCs and other touchy burdens.

METHODS

DPQC-Current Controlled Device -

The DPQC is a mix of static compensator and static plan pay. It goes about as a shunt reviewing and a phase moving device in the meantime. The DPQC includes a shunt and a game plan transformer, which are associated through two voltage source converters with a common dc-capacitor. The dc-circuit allows the dynamic power exchange among shunt and game plan transformer to control the stage move of the game plan voltage. This setup as showed up in figure.7 gives the full controllability to voltage and power quality. The plan converter ought to be guaranteed with an engine interface. In light of the high undertakings for the voltage source converters and the affirmation, a DPQC is getting in all respects exorbitant, which obliges the realistic applications where the voltage and power quality control is required at the same time**.**
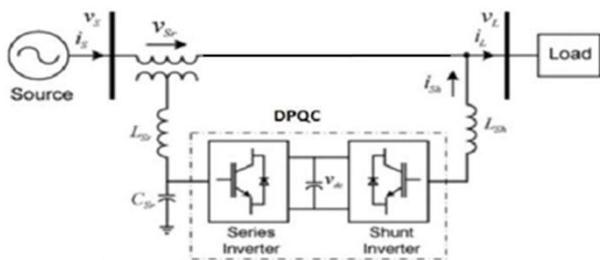
Fig.7: Principle configuration of a DPQC

As shown by the controlled strategy the DPQC compensator yield is changed so as to keep up the power quality rules in the network system. Current control procedure is consolidated into the control plot with the objective that it describes the utilitarian movement of the DPQC compensator in the power system. DPQC utilizing secured portal bipolar transistor is proposed to give responsive power support, to the nonlinear weight to the selection generator in the structure system. The operational layout of the blend of a static compensator and static course of action pay.

Control Scheme of System

Control Scheme of System is the battery current. DPQC-current controlled gadget The DPQC is a blend of static compensator and static arrangement pay. It goes about as a shunt redressing and a stage moving gadget at the same time. The DPQC comprises of a shunt and an arrangement transformer, which are associated by means of two voltage source converters with a typical dc-capacitor. The dc-circuit permits the dynamic power trade among shunt and arrangement transformer to control the stage move of the arrangement voltage. This

setup gives the full controllability to voltage and power quality. The arrangement converter should be ensured with a thruster connect.

CONCLUSION

Proposed ponder on wind vitality change plan utilizing battery vitality stockpiling for nonlinear burden incorporates interface of inverter incurrent controlled mode for trade of genuine and receptive power. The hysteresis current controller is utilized to create the exchanging signal for inverter in such a way that it will drop the symphonious current in the system. This plan improves power factor and furthermore make consonant free source current in the appropriated system at the purpose of regular association. The wind power trade is directed over the dc transport having vitality stockpiling and is made accessible under the enduring state condition. This additionally makes genuine power stream at quick interest of the heap. Fast infusion or ingestion of receptive/genuine power stream in the power system can be made conceivable through battery vitality stockpiling and static compensator. Battery vitality stockpiling gives quick reaction and upgrades the exhibition under the variance of wind turbine yield and improves the voltage soundness of the system. The utility can see each power plant at the same time and precisely by utilizing on the web savvy meter. This plan along these lines gives the system to work both in power quality mode just as in remain solitary.

In this paper examination the factor which are in charge of power quality issue. For development in power quality of wind power, there are numerous controllers are utilized. These controllers are static var compensator, fluffy rationale, static synchronous compensator, static synchronous arrangement compensator, UPFC and IPFC. These controllers dispose of the symphonious and improve the solidness of system. These controllers control the receptive and dynamic power of system and increment the exchange ability of line in light of the fact that in the wind power, the yield of wind power is rely on the wind which isn't consistent at untouched. Because of this first and second era realities gadgets, we can stable the wind power yield.

REFERENCES

1.   Angelo Baggini (2008). "Hand Book of Power Quality", John Wiley and Sons Ltd, pp. 187-236.

2.   B.Singh, K. Al-Haddad and A. Chandra (1999). "A Review of Active Filters for Power Quality Improvement, IEEE Trans.

on Industrial Electronics", 46(5), pp. 960-971.

3. Billinton and Y. Gao (2008). "Energy conversion system models for adequacy assessment of generating systems incorporating wind energy", IEEE Transaction on Energy Conversion, volume. 23, no. 1, pp. 163169, December 2008

4. C. Han, A. Q. Huang, M. Baran, S. Bhattacharya, and W. Litzenberger (2008). "STATCOM impact study on the integration of a large wind farm into a weak loop power system" IEEE Transactions on Energy Conversion, vol. 23, no. 1, pp. 226232, March 2008.

5. Compensation", Proceedings of the IEEE International Conference on Power Electronics and Drive Systems (PEDS). November 17-20, 2003. Singapore: IEEE. 2003, pp. 799-804.

6. Edward. F. Fuchs, Mohammad. A. S. Masoum (2008). "Power Quality in Power Systems and Electrical Machines", ISBN-970-0-12-369536, Elsevier Inc., pp. 1-35, pp. 359-375.

7. F.Z. Peng, Lai Jih-Sheng, J. W. McKeever and J. Van Coevering (1996). "A Multilevel Voltage-Source Inverter with Separate DC Sources for Static Var Generation", IEEE Transactions on Industry Applications, vol. 32, no. 5, pp. 1130–1138.

8. H.Akagi, Y. Kanazawa and A. Nabae (1984). "Instantaneous Reactive Power compensators Comprising of Switching Devices without Energy Storage Components", IEEE Trans. on Industry Applications, 20(3), pp. 625-630.

9. Karuppanan and M. Kamala Kantha (2010). "PLL with PI, PID and Fuzzy Logic Controllers based Shunt Active Power Line Conditioners", IEEE PEDES-International Conference on Power Electronics Drives and Energy Systems.

10. Norman, A. Ahsanul, M. Senan and H. Hashim (2004). "Review of Control Strategies for Power Quality Conditioners", Proceedings of the IEEE National Conference on Power and Energy Conference (PE Con). Nov. 29-30, 2004.Kuala Lumpur, Malaysia: IEEE. 2004, pp. 109-115.

11. Power Systems – a Combined System of Shunt Passive and Series Active Filters", IEEE Trans. On Industry Applications. 1990. 26(6): pp. 983-990.

12. S. Bhattacharya and D. Divan (1995). "Synchronous Frame based Controller implementation for a Hybrid Series Active Filter System", Proceedings of the IEEE Industry Applications Conference. Oct. 8-12, 1995. Florida, USA: IEEE. 1995, pp. 2531-2540.

13. S.Fukuda and T. Endoh (1995). "Control Method for a Combined Active Filter System Employing a Current Source Converter and a High Pass Filter", IEEE Trans. on Industry Applications, 31(3), pp. 590 597.

14. S.K. Jain, P. Agarwal and H.O. Guptha (2002). "Fuzzy Controlled Shunt Active Filter for Power Quality Improvement", IEEE Proc. Electr. Power Appl. 149, pp. 317-328.

15. V.B. Bhavaraju and P. Enjeti: "A Fast Active Power Filter to Correct Line Voltage Sags.

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