Grid Voltage Harmonization for Dispersed Generation Systems in the Event of a Grid Failure

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Abstract
The real grid code requirements are getting more and more stringent when it comes to the grid connection for distributed generating systems, primarily photovoltaic (PV) and wind installations. For transmission system operators (TSOs), the low-voltage-ride-by regulations are of particular concern. In order to meet these necessities, solution depending on the setup of dynamic voltage regulators (DVRs) and STATCOMs, so as on complex is in charge of features meant by distributed generation plants' existing power converters; have helped to improve these systems' answer in faulty and distorted scenarios. With such structure, it is essential to depend on precise and rapid grid voltage harmonization algorithms that can function in distorted in addition to imbalanced environments in order to get appropriate results. Three advanced synchronization structures are examined in this paper: the decoupled double synchronized reference framework phase-locked loop (PLL), the three-phase improved PLL, and the dual second order wider integrator PLL, which are all intended to function in such circumstances. PLLs were selected because of their connection to dq 0 controllers, despite the development of additional systems depending on frequency-locked loops. The various algorithms will be discussed and discretized in the sections that follow, and their effectiveness will be assessed in an experimental setting under controlled conditions to gauge its accuracy and practicality. This research involved decoupling the three-phase improved PLL ($3phEPLL$), the dual second order generalized integrator PLL ($DSOGI\ PLL$), and the double synchronous references frame PLL ($DDSRF\ PLL$).
Keywords: Grid voltage, Primarily pthotovolatic, TSO, PLL,

Introduction

The photovoltaic phenomenon was discovered when French physicist Edmund Becquerel discovered in 1839 that convinced material create minute amounts of electrical power in reaction to light. For his explanations of the characteristics of light and the resultant photoelectric effect, which are the cornerstones of the solar energy system, Albert Einstein was awarded the Nobel Prize in physics in 1905. In 1954, Bell Laboratories produced its initial solar module. Although it was advertised as a solar battery, its primary usage remained as a curiosity due to its high cost. The space industry started using the technology to power spacecraft in a serious way in the 1960s. The space projects helped to enhance technology, establish its dependability, and bring down costs. Photovoltaic technology became well-known as a power resource for non-space relevance throughout the 1970s energy predicament.

The basic component of photovoltaic expertise is the solar cell. Materials used to make semiconductors, like silicon, are used in solar cells. The ability to readily alter a semiconductor's conductivity by adding impurities to its crystal lattice is one of their most advantageous characteristics. For illustration, silicon, that has 4 electrons with valences, It receives treatment to increase its ability to conduct in order to create a solar cell that uses photovoltaics. The outermost layer of the cell's silicon material receives weakly attached electrons containing valence from the impurities, phosphorus atoms containing five electrons for valence, or n-donors, which results in an overabundance of negatively charged carriers.

However, boron atoms carrying three valence electrons $(p - donor)$ have a larger tendency to pull in electrons than silicon atoms do. Because the p-type and n-type silicon are in close proximity, a p-n junction forms and protons diffuse across the zone of high electron density $(the\ n - type\ side)$ towards the location of low electron concentrations $(the\ p - type\ side)$. As the charged particles propagate across the p-n junction, they recombination producing holes on the p-type side.

Nevertheless, the dispersal of particles is not infinite since an electric field is created by the instantaneous difference of accuse on both sides of the junction. A diode formed by this electric field encourages existing to flow exclusively in one direction.

Ohmic metal-semiconductor connections are made on the n-type while p-type surfaces of the solar cell, and the conducting electrodes are ready to be associated to an external load. The energy of light photons colliding using the cell is transferred to the carriers of charges. The electric field above the junction disconnect the positive charge carriers created by photons $(holes)$ by their negative counterparts, electrons. When the circuit is blocked on a load from the outside, an electrical current is thus withdrawn.

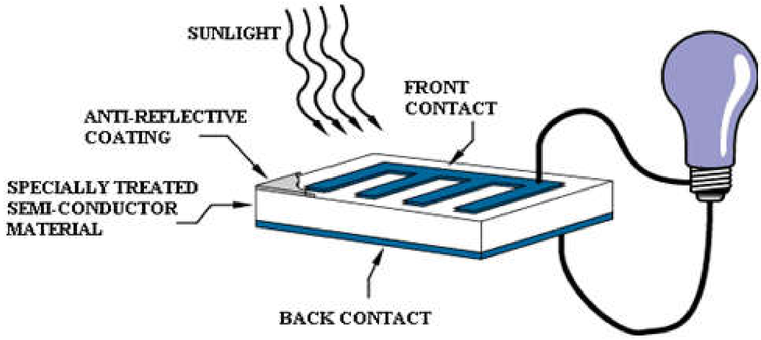

Fig.1. Solar cell.

Solar cell:

Edmund Becquerel initially described the photovoltaic consequence in 1839 when he saw so as to light acting on a platinum electrode covered in silver and submerged in electrolyte generated an electric current. Forty years later, scientists studying selenium's freshly found photoconductivity built the initial solid state photovoltaic systems. *William Adams and Richard Day* discovered in 1876 that when two heated platinum contacts made contact with a sample of selenium, a photocurrent could be generated. In contrast to its photoconductive activity, the selenium's photovoltaic action generated a current on its own when light was present.

A group of solar cells arranged in an isolated frame or supporting structure and electrically connected to each other is called a "photovoltaic module". Modules, such as a typical 12-volt system, are intended to provide power at a specified voltage. The quantity of light that enters the module has a direct impact on the current produced. It is possible to form an array by connecting several modules. Solar panels and arrays produce electricity with direct current. They might be interconnected in series or parallel to provide any required voltage and current combinations

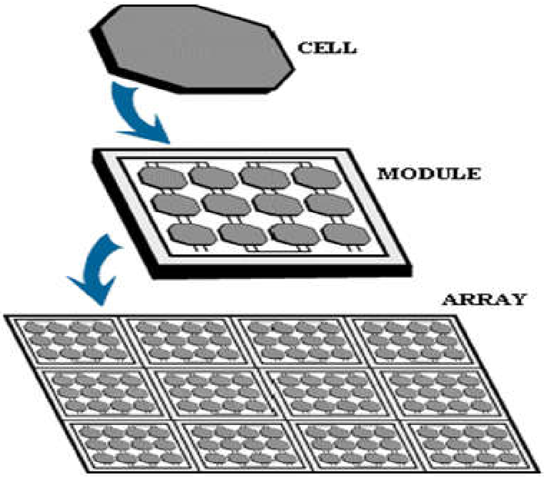

Fig.2. array, module, and cell structure

Depending on the device's design and the selected semi-conductor material(s), a single cell's electrical output may be insufficient for the majority of uses. Several cells need to be electrically associated so as to produce the right amount of electrical power. Present are two main ways to link cells: series connection, where each cell's top contact is connected to the subsequent cell's rear contact in the sequence; and parallel connection, where all top and bottom associates are associated to each other. This leaves the group of cells with just two electrically connected sites in both scenarios

Structure plan

The stand-alone and grid-connected system configurations by two primary types. As its name suggests, a stand-alone photovoltaic system functions without the assistance of any other power source and typically provides electricity to one or more designated loads. It might have a battery bank or other type of storage to facilitate the provision of electrical energy at night or throughout periods with low sunlight. Because they run without the need for external power sources, stand-alone systems are also normally referred to as independent systems. In contrast, the grid-connected photovoltaic system operates concurrently with the conventional electricity distribution system. It might be utilized for supplying electricity through the grid circulation system or to energize loads whose may receive electricity through the grid.

To meet part of the load needs, it is in addition feasible to add solitary or additional alternative power supply (such as a wind turbine or diesel generator) to the system. The term "hybrid" systems are then applied to these systems.

While hybrid systems are applicable to both standalone and grid-connected application, they are more frequently utilized in the previous due to their ability to reduce storage requirements without increasing the likelihood of a load failure, provided that complimentary power supplies have been selected. The schematic illustration of the 3 primary classification types is shown in the figures below.

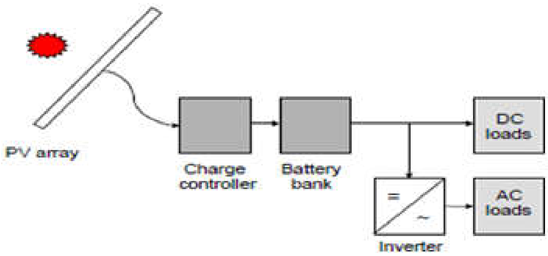

Fig.3. representation illustration of a standalone solar energy structure

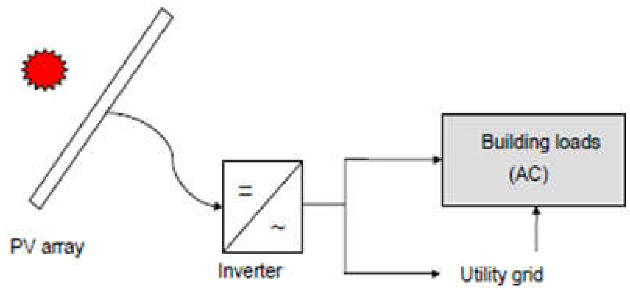

Fig.4. Diagram representation for a photovoltaic system connected to the grid.

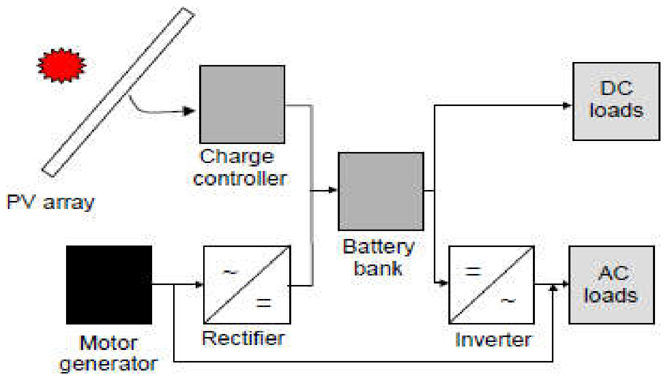

Fig.5. Diagrammatic representation of a hybrid structure that combines a motor generator (such as wind or diesel) and a solar array.

GRID SYSTEM

The word "grid" refers to a network and might not be understood to indicate a specific width or physical arrangement. The term "grid" can be worn to designate a subnetwork, such as the transmission or distribution grid for a local utility, or it can refer to the electrical network of a whole continent.

A basic distribution grid that connects houses to a central generator could supply electricity in a distant area. In affluent nations, the conventional paradigm for distributing power is more intricate. Typically, generating plants are placed away from densely inhabited regions and close to a water source. Typically, they are rather large in order to benefit from economies of scale. When the generated electric power joins to the transmission network, it is increased in voltage. Power is transported over vast distances by the transmission network, Often traversing both state as well as international borders, it continues until it gets to its wholesalers client, usually the company running the regional shipping network. When the power reaches the substation, it will be reduced from an output level power to a distributing level voltage. As it exits the substation, it gets into the transmission wiring. Finally, upon reaching the service location, power is again brought down to reduce the supply voltage to the required service voltage(s).

PI controller

Figure displays the PI speed controller's general block illustration

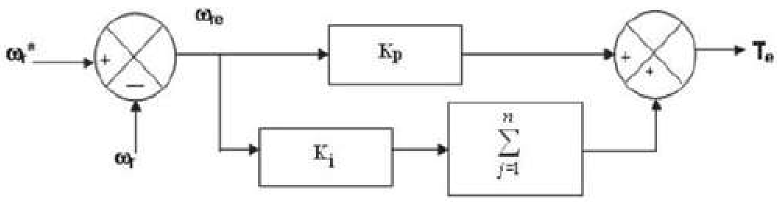

Fig.6. PI Speed controller

The output
The torque command (speed controller) at the n-th instant is stated as follows.

$Te\ (n) = Te(n-1) + Kp\_\omega re(n) + Ki\omega re(n)$ (10)
while Kp and Ki are the proportionate and integrated gain constants, subsequently, and Te (n) represents the torque production of the control at the n-th instant

Results & Analysis
Schematic diagram

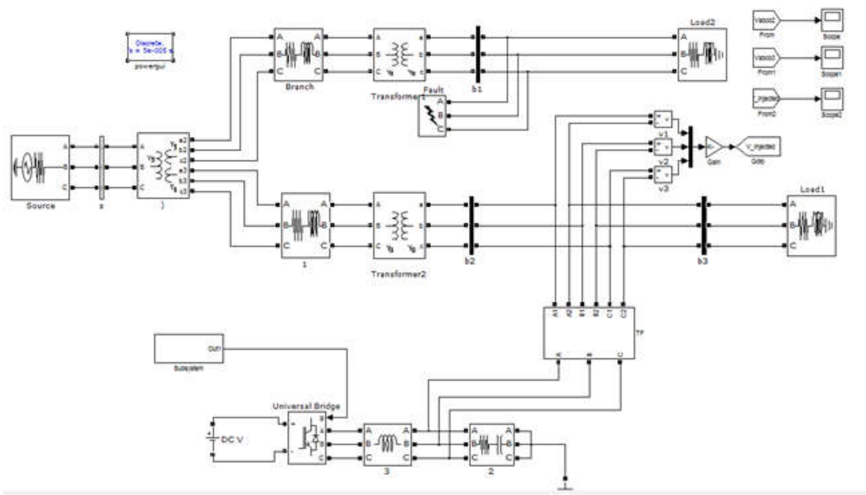

Fig.7. Schematic structure

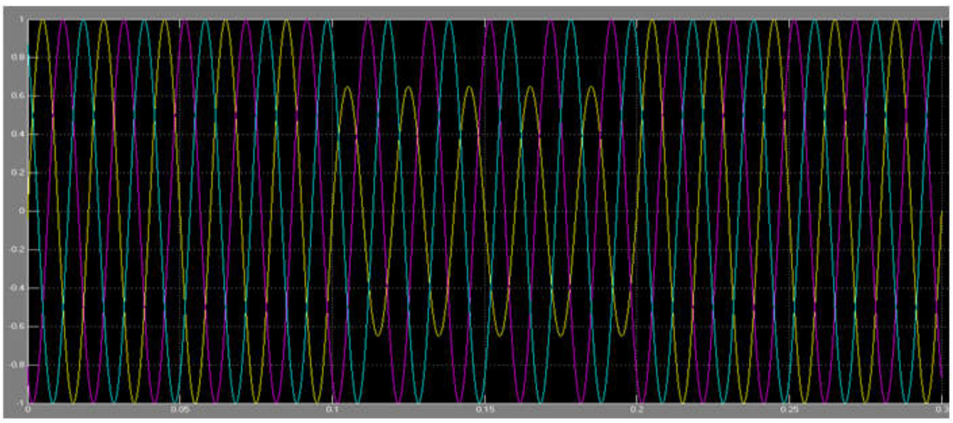

Fig.8. bus 2 voltage

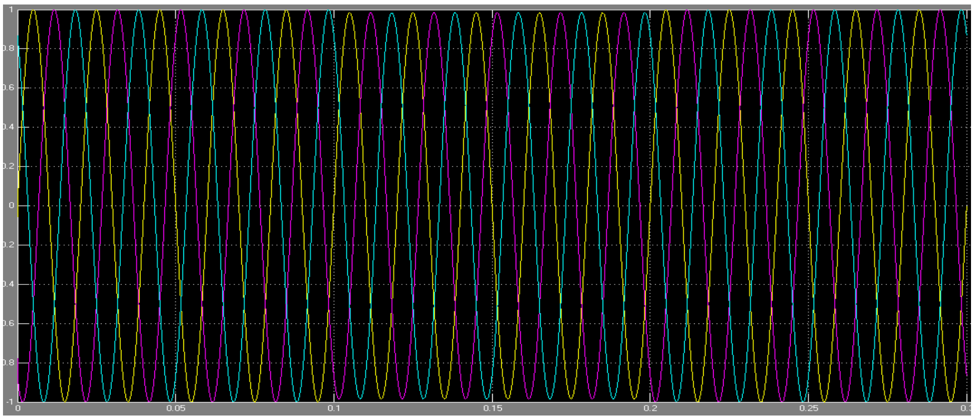

Fig.9. bus 3 voltage

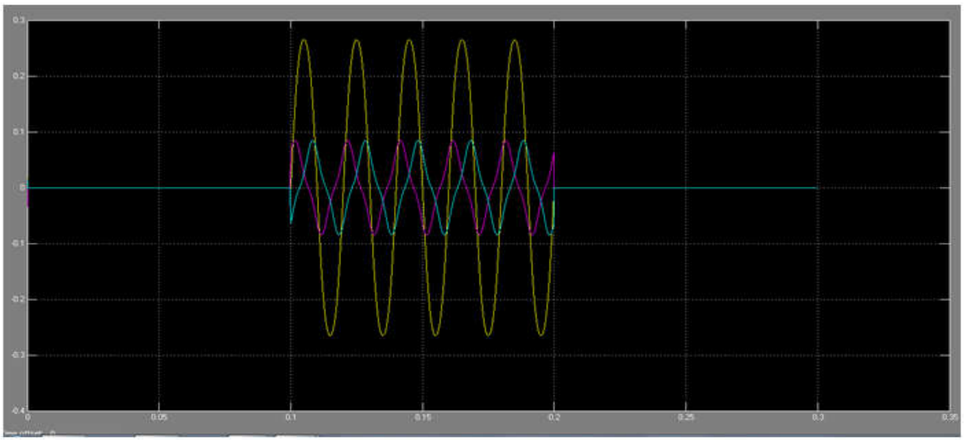

Fig.10. injected voltage

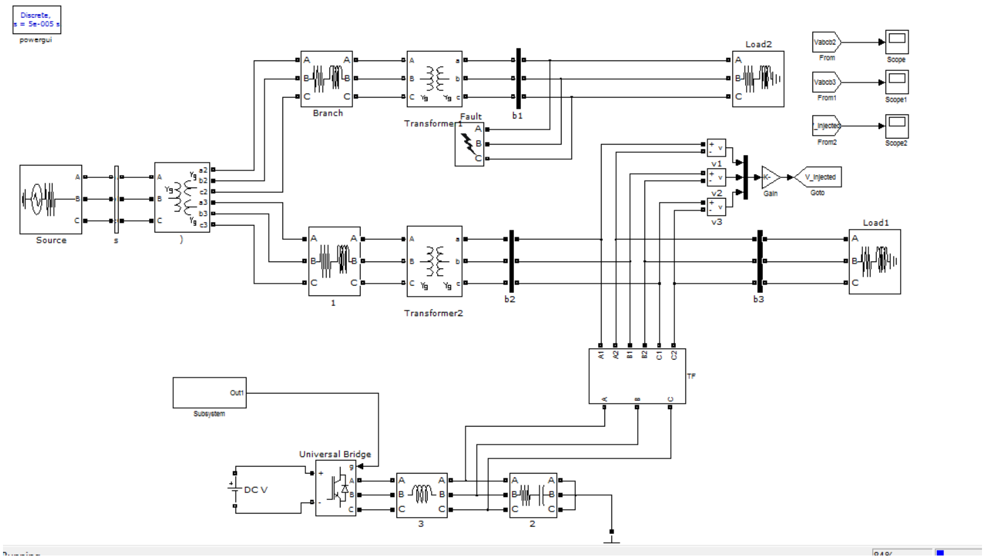

Fig.11. MATLB/SIMULINK illustration of projected structure single phase sag three phase sag

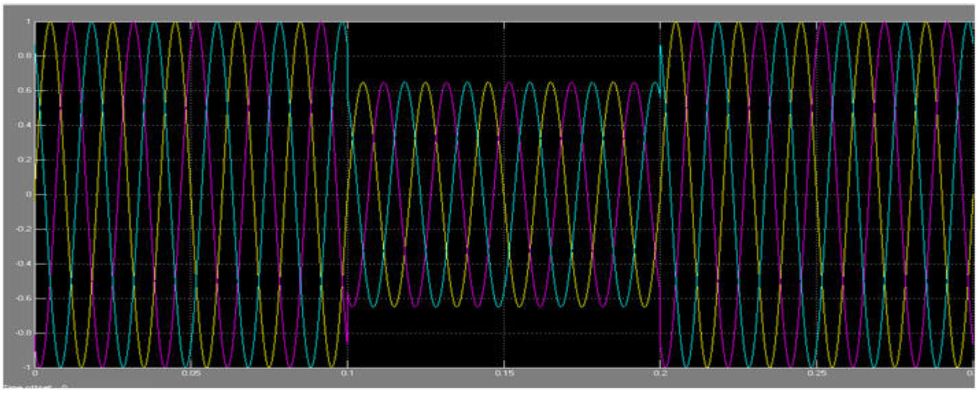

Fig.12. bus 2 voltage

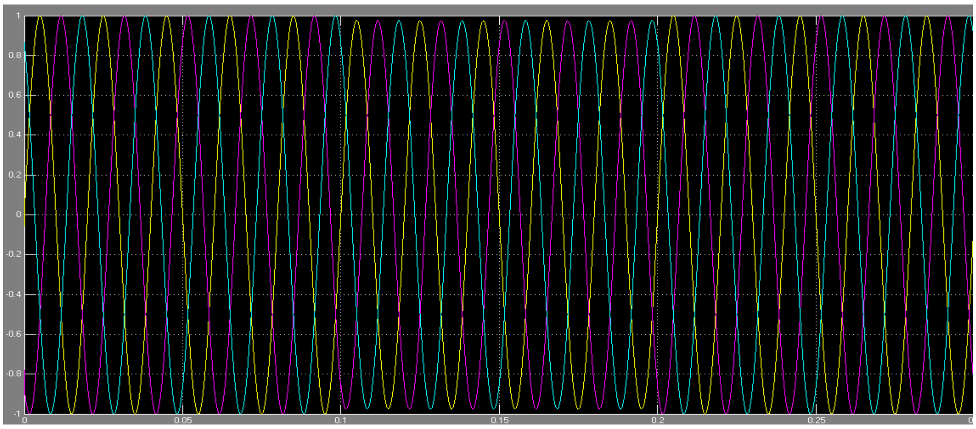

Fig.13. bus 3 voltage

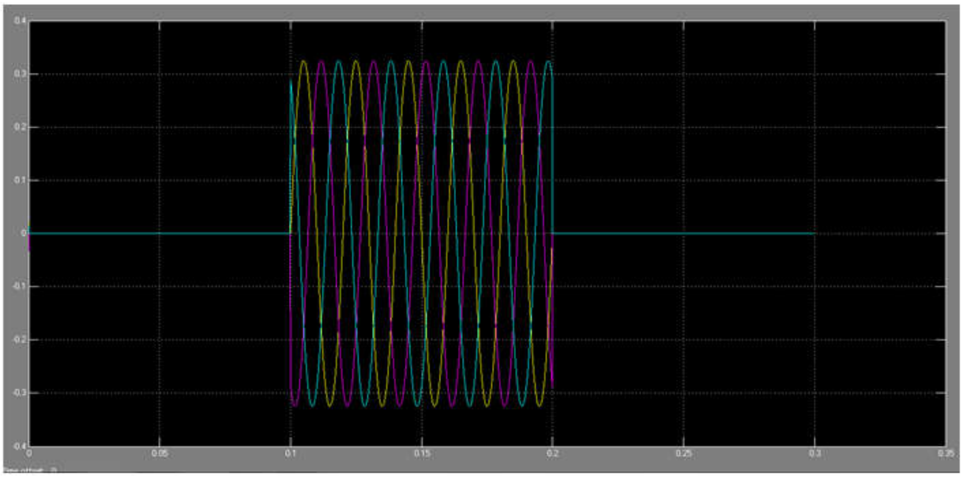

Fig.14. injected voltage

CONCLUSION

The behavior of three sophisticated grid harmonization systems was examined in this research. Their discrete algorithms are described and their structures are revealed. Additionally, these algorithms' performances were evaluated in an experimental setup using a commercial DSP that digitally implemented them, demonstrating their satisfactory responsiveness in both balanced and distorted grid situations. While the 3phEPLL operates with three variables by using the "abc" reference frame, the DDSRF PLL and the DSOGI PLL enable the estimation of the ISCs of a three-phase system operating in the αβ reference frame. It has been demonstrated that this characteristic makes the DSOGI PLL and the DDSRF PLL more straightforward in terms of structure, which enables a reduction in computational load relative to the 3phEPLL without compromising presentation

References

1. Zervos and C. Kjaer, Pure Power: Wind Energy Scenarios for 2030. Brussels, Belgium: European Wind Energy Association (EWEA), Apr. 2008. [Online]. Available: http://www.ewea.org/index.php?id=11
2. e-on, "Grid code—High and extra high voltage," Bayreuth, Germany. Apr. 2006. [Online]. Available: http://www.pvupscale.org/IMG/pdf/ D4_2_DE_annex_A-3_EON_HV_grid connection_requirements_ ENENARHS2006de.pdf
3. PO-12.3 Requisitos de Respuesta Frente a Huecos de Tension de las Instalaciones Eolicas, ComisiónNacional de Energía, Madrid, Spain, Oct. 2006.
4. IEEE Standard for Interconnecting Distributed Resources With Electric Power Systems, IEEE Std. 1547-2003, 2003.
5. The Grid Code: Revision 31, National Grid Electricity Transmission, Warwick, U.K., Oct. 2008, no. 3. [Online]. Available: http://www2. nationalgrid.com/uk/industry-information/electricity-codes/grid-code/ the-grid-code/
6. Elkraft System og Eltra, "Vindmuller tilsluttet net med sprindinger under 100 kv," Fredericia, Denmark,TF3.2.6, 2004. [Online]. Available: http:// www.energinet.dk/SiteCollectionDocuments/Engelske%20dokumenter/ El/Grid%20Code%203.2.5%20Wind%20Turbines%20connected% 20above%20100%20kV.pdf
7. M. Tsili and S. Papathanassiou, "A review of grid code technical requirements for wind farms," IET Renew. Power Gen., vol. 3, no. 3, pp. 308–332, Sep. 2009.
8. F. Iov, A. Hansen, P. Sorensen, and N. Cutululis, "Mapping of Grid Faults and Grid Codes," Risø Nat. Lab., Roskilde, Denmark, Tech. Rep. Risoe- R-1617, 2007.
9. A. Luna, P. Rodriguez, R. Teodorescu, and F. Blaabjerg, "Low voltage ride through strategies for SCIG wind turbines in distributed power generation systems," in Proc. IEEE PESC, Jun. 15–19, 2008, no. 1, pp. 2333–2339.
10. D. Xiang, L. Ran, P. J. Tavner, and S. Yang, "Control of a doubly fed induction generator in a wind turbine during grid fault ride-through," IEEE Trans. Energy Convers., vol. 21, no. 3, pp. 652–662, Sep. 2006.
11. J. Morren and S. W. H. de Haan, "Ridethrough of wind turbines with doubly-fed induction generator during a voltage dip," IEEE Trans. Energy Convers., vol. 20, no. 2, pp. 435–441, Jun. 2005.
12. M. Molinas, J. A. Suul, and T. Undeland, "Low voltage ride through of wind farms with cage generators: STATCOM versus SVC," IEEE Trans. Power Electron., vol. 23, no. 3, pp. 1104–1117, May 2008.
13. K. Li, J. Liu, Z. Wang, and B. Wei, "Strategies and operating point optimization of STATCOM control for voltage unbalance mitigation in three-phase three-wire systems," IEEE Trans. Power Del., vol. 22, no. 1, pp. 413–422, Jan. 2007.
14. J. A. Barrena, L. Marroyo, M. A. R. Vidal, and J. R. T. Apraiz, "Individual voltage balancing strategy for PWM cascaded H-bridge converterbased STATCOM," IEEE Trans. Ind. Electron., vol. 55, no. 1, pp. 21– 29, Jan. 2008.