Nanocomposite Polypropylene For DC Cables And Capacitors: A New European Project
This paper presents the scientific background of a new European project, GRIDABLE, which was launched at the beginning of 2017 and has to deliver results in manufacturing and characterization of LV-MV capacitors and MV-HV cables for DC application. The innovation is in the development of nanostructured materials based on polypropylene and silica, and the relevant capacitor and cable manufacturing procedures. The initial results regarding the electrical properties of PP-SiO2 materials, which have brought to the proposal of this project, are presented in this paper, focusing on breakdown strength and space charge measurements performed on nanofilled PP films for capacitors.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Electrical Energy Engineering, Research area: Power engineering, Research group: High voltage engineering, University of Bologna, Italy, VTT Technical Research Centre of Finland
Authors: Montanari, G. C., Seri, P., Karttunen, M., Paajanen, M., Lahti, K., Rytöluoto, I.
Number of pages: 4
Pages: 433-436
Publication date: 15 Sep 2017

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Title of host publication: Proceeding of the 8th international symposium on electrical insulating materials (ISEIM)
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Place of publication: Toyahashi City, Japan
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ISBN (Print): 978-1-5090-6460-1
ISBN (Electronic): 978-4-88686-100-9
Keywords: HVDC, space charge, nanocomposite, DC cable, Capacitor, SiO2
DOI: 10.23919/ISEIM.2017.8088777
Research output: Scientific - peer-review » Conference contribution

Resistive current waveform as a tool to identify degraded parts of polymeric surge arresters subjected to internal moisture

Aspects of moisture ingress in polymer housed surge arresters
Polymers have been extensively applied in the industry, especially in energy system e.g. due to their good processability and insulation properties. However, all polymers are permeable in different extent, which requires a good knowledge about the process of permeation through these materials. In this study the moisture dynamics of four different surge arresters were studied in several ways,—at first by analysing the moisture diffusion properties of the housing polymers and finally by testing the full arrester structures against moisture ingress. Housing polymer composites were evaluated using thermogravimetric analysis and differential scanning calorimetry while the polymers’ ability to withstand moisture diffusion was studied by water vapor transmission rate measurements. Moisture ingress behavior of the full surge arresters was examined by daily measurements of internal resistive leakage current along 30 days immersion test. Although correlations were found between the material composition and the diffusivity through the polymer, the moisture dynamic is deemed to be much more complex in the full surge arrester. Moisture permeation through separate housing material samples was typically high compared to internal leakage current formed in real arresters which highlights the main conclusion drawn,—internal structures and long term quality of interfaces are the key issues in preventing moisture induced degradation in metal oxide surge arresters.

General information
Utilization Possibilities of Electrical Energy Storages in Households' Energy Management in Finland

Electrical energy storage is one option for making the environmental impact of households' energy usage smaller. A storage could improve the profitability of household level electricity production and could also decrease the load in the electricity networks. So far, poor profitability has been the greatest barrier to the use of storages. The battery systems prices have been high and the benefits difficult to predict. The benefit of the use of storage and the factors affecting to the benefits are studied in this paper. For this purpose, a simulator has been designed for modelling the energy storage as part of the household's electricity grid. The control of the storage significantly affects to the amount of benefits. The developed control method of the simulator aims to maximize the benefits. The simulations took into account the variables that are not accurately known when the storage is controlled. For these variables, such as e.g. future consumption, various forecasts were formed.
Edellytykset kysyntäjouston toteutumiselle kiinteistössä

General information
State: Published
Ministry of Education publication type: D4 Published development or research report or study
Authors: Harsia, P., Penttinen, S., Järventausta, P., Sorri, J., Aalto, P., Kallioharju, K., Kaivo-oja, J., Kojo, M., Korpela, T., Ruostetsaari, I., Oksa, A. M.
Pages: 1-7
Publication date: 2017
Publication information
Publisher: EL-TRAN Analyysi
ISBN (Electronic): 978-952-03-0393-8
Publication series
Name: EL-TRAN analyysi
Volume: 1/2017
Research output: Professional › Discussion paper

Uuden sukupolven HF-kommunikaatiotekniikat: Tiivistelmäraportti
Tiivistelmä: Hankkeessa kehitettiin (i) fyysisen kerroksen algoritmiratkaisuja uuden sukupolven HF-laitteille, jotka perustuvat kehitettyyn suodatinpankkipohjaiseen monikantoaaltotekniikkaan, sekä (ii) linearisoituja tehovahvistinratkaisuja HF-lähettimiin. Uudet monikantoaaltotekniikat mahdollistavat nykyisiin ratkaisuihin verrattuna aiempaa joustavamman ja tehokkaamman epäjatkuvan spektrinkäytön. Linearisointi mahdollistaa annetujen spektrimaskien saavuttamisen paremmalla hyötysuhteella ja suuremmalla lähetysteholla.

General information
State: Published
Ministry of Education publication type: D4 Published development or research report or study
Organisations: Electronics and Communications Engineering, Research group: Wireless Communications and Positioning, Kyynel Oy
Authors: Renfors, M., Anttila, L., Korhonen, M., Yli-Kaakinen, J., Tuomivaara, H.
Number of pages: 9
Publication date: 2017
Publication information
Publisher: Puolustusministeriö
Original language: Finnish
A comparative study between surge arrester monitoring through capacitive/resistive measurement bridge and digital decomposition

In order to improve the reliability of the energy system, a variety of techniques to access the condition monitoring of important equipment connected to the network have been developed in the past decades. However, it is important to choose the adequate method when evaluating the behavior of these devices. In this way, the current work aims to compare three techniques used to evaluate the condition of metal oxide surge arrester based on the decomposition of leakage current into its capacitive and resistive components. Each method was described in detail and their results compared.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering, University of Campinas, Cardiff University
Authors: Da Silva, D. A., Pissolato Filho, J., Lahti, K., Haddad, A., Albano, M.
Number of pages: 6
Publication date: 22 Sep 2016

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Title of host publication: Proceedings of the 2016 IEEE - PES Transmission and Distribution Latin America Conference & Exhibition
Publisher: IEEE
Article number: 115
ISBN (Electronic): 978-1-5090-2875-7
ASJC Scopus subject areas: Electrical and Electronic Engineering
DOIs:
10.1109/TDC-LA.2016.7805670
Research output: Scientific - peer-review › Conference contribution

Implementing of Activating Learning Strategy for a Course on Electric Drives
Effective teaching of electric drives is highly important for the electrical engineers, because almost half of the global produced electrical energy is consumed by electric motor drives. Electric drives are a key technology for reducing energy consumption of industrial processes, for wind power generation and for electric transportation. The pedagogical premise is to improve the educational methods of an Electrical Drives course by activating students to work on their own. The paper describes the educational strategy and course objectives. Student feedback was collected at the end of the course and the results of the evaluation are summarized.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering
Authors: Rekola, J., Suntio, T.
Number of pages: 8
Pages: 1-8
Publication date: 14 Sep 2016

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Publisher: European Society for Engineering Education SEFI
ISBN (Electronic): 9782873520144
Keywords: Electrical engineering education , variable speed drives , simulation, laboratory
Electronic versions:
sefi_final_paper
Links:
http://urn.fi/URN:NBN:fi.tty-201709201900
Modeling of Hysteresis Losses in Ferromagnetic Laminations under Mechanical Stress

A novel approach for predicting magnetic hysteresis loops and losses in ferromagnetic laminations under mechanical stress is presented. The model is based on combining a Helmholtz free energy-based anhysteretic magnetoelastic constitutive law to a vector Jiles-Atherton hysteresis model. This paper focuses only on unidirectional and parallel magnetic fields and stresses, albeit the model is developed in full 3-D configuration in order to account also for strains perpendicular to the loading direction. The model parameters are fitted to magnetization curve measurements under compressive and tensile stresses. Both the hysteresis loops and losses are modeled accurately for stresses ranging from -50 to 80 MPa.

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Department of Mechanical Engineering and Industrial Systems, Research area: Applied Mechanics, Research group: Teknillinen mekaniikka ja lujuusoppi, Aalto University
Authors: Rasilo, P., Singh, D., Aydin, U., Martin, F., Kouhia, R., Belahcen, A., Arkkio, A.
Number of pages: 4
Publication date: Mar 2016
Peer-reviewed: Yes

Publication information
Journal: IEEE Transactions on Magnetics
Volume: 52
Issue number: 3
Article number: 7300204
ISSN (Print): 0018-9464
Ratings:
Scopus rating (2016): CiteScore 1.47 SJR 0.48 SNIP 0.915
Scopus rating (2015): SJR 0.565 SNIP 1.207 CiteScore 1.77
Scopus rating (2014): SJR 0.715 SNIP 1.491 CiteScore 1.68
Scopus rating (2013): SJR 0.608 SNIP 1.424 CiteScore 1.75
Scopus rating (2012): SJR 0.788 SNIP 1.574 CiteScore 1.89
Scopus rating (2011): SJR 0.829 SNIP 1.445 CiteScore 1.69
Scopus rating (2010): SJR 0.698 SNIP 1.134
Scopus rating (2009): SJR 0.644 SNIP 1.098
Scopus rating (2008): SJR 0.788 SNIP 1.165
Scopus rating (2007): SJR 0.71 SNIP 1.152
Scopus rating (2006): SJR 0.913 SNIP 1.232
Scopus rating (2005): SJR 1.024 SNIP 1.258
Scopus rating (2004): SJR 0.813 SNIP 1.129
Scopus rating (2003): SJR 1.056 SNIP 1.094
Scopus rating (2002): SJR 1.078 SNIP 1.027
Scopus rating (2001): SJR 0.707 SNIP 1.007
Scopus rating (2000): SJR 0.831 SNIP 1.022
Scopus rating (1999): SJR 0.918 SNIP 1.249
Original language: English
Keywords: Helmholtz free energy, magnetic hysteresis, magnetoelasticity, magnetostriction, strain, stress
Electronic versions:
Rasilo2015
DOIs:
10.1109/TMAG.2015.2468599
Links:
http://urn.fi/URN:NBN:fi.tty-201605033909
Research output: Scientific - peer-review » Article

Mimetic Interfaces Project: Functional Electrical Stimulation of Facial Muscles

General information
State: Published
Coil Winding Losses: Decomposition Strategy

Precise modeling of the magnetic field in the coil wire of an electric machine often becomes a major challenge: with the high number of turns and small penetration depth, the number of degrees of freedom exceeds reasonable limits in any standard approximation method. Precise approximation, however, is critical, e.g., to reliable coil loss estimation. Hence, there is a call for specialized approximative methods. This paper presents a method for time-harmonic coil wire field computations in 2-D problems. We replace the coil by a lattice of polygonal plane fillers and span a low-dimensional function space on the polygon boundaries. The reliability of loss estimates requires accurate computations of the responses to the interface excitations of this space. The responses constitute a Dirichlet-to-Neumann map to efficiently couple plane fillers together and to a standard finite-element method (FEM) outside the coil regions. The outcome is significantly faster than the standard FEM alone. The results are still in good agreement.
Coupled Magneto-Mechanical Analysis of Iron Sheets Under Biaxial Stress

A novel single sheet tester design is proposed and a directly coupled magneto-mechanical model is used to numerically analyze the behavior of iron sheets under biaxial magneto-mechanical loading applied by the tester device. Magneto-mechanically coupled constitutive equations of the material derived using an energy based approach are integrated into a finite element model of the single sheet tester device and simulations are performed to solve for the displacement field and the magnetic vector potential in the sample. The obtained numerical results of magnetostriction evolution due to uniaxial stress and stress induced anisotropies due to permeability variation under different magneto-mechanical loadings are presented. The simulation results are compared to the results published in the literature for the purpose of validation.
Model of Magnetic Anisotropy of Non-Oriented Steel Sheets for Finite Element Method

Even non-oriented steel sheets present a magnetic anisotropic behavior. From rotational flux density measurements at 5 Hz, the model of magnetic anisotropy is derived from two surface Basis-cubic splines with the boundary conditions matching with ferromagnetic theory. Furthermore, the investigation of the magnetic anisotropy shows that the H(B) characteristic is not strictly monotonous due to the angle difference between the field and the flux density. Hence, standard non-linear solvers would either diverge or converge towards the closest local minimum. Thus, we propose two different specific solvers: a combined Particle Swarm Optimization with a relaxed Newton-Raphson and a Modified Newton Method.

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Aalto University
Authors: Martin, F., Singh, D., Rasilo, P., Belahcen, A., Arkkio, A.
Publication date: 2016
Peer-reviewed: Yes
Early online date: 1 Jan 2015

Publication information
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Volume: 52
Issue number: 3
Article number: 7002704
ISSN (Print): 0018-9464
Ratings:
Scopus rating (2016): CiteScore 1.47 SJR 0.48 SNIP 0.915
Scopus rating (2015): SJR 0.565 SNIP 1.207 CiteScore 1.77
Scopus rating (2014): SJR 0.715 SNIP 1.491 CiteScore 1.68
Scopus rating (2013): SJR 0.608 SNIP 1.424 CiteScore 1.75
Scopus rating (2012): SJR 0.788 SNIP 1.574 CiteScore 1.89
Scopus rating (2011): SJR 0.829 SNIP 1.445 CiteScore 1.69
Scopus rating (2010): SJR 0.698 SNIP 1.134
Scopus rating (2009): SJR 0.644 SNIP 1.098
Scopus rating (2008): SJR 0.788 SNIP 1.165
Scopus rating (2007): SJR 0.71 SNIP 1.152
Scopus rating (2006): SJR 0.913 SNIP 1.232
Scopus rating (2005): SJR 1.024 SNIP 1.258
Scopus rating (2004): SJR 0.813 SNIP 1.129
Scopus rating (2003): SJR 1.056 SNIP 1.094
Scopus rating (2002): SJR 1.078 SNIP 1.027
Scopus rating (2001): SJR 0.707 SNIP 1.007
Scopus rating (2000): SJR 0.831 SNIP 1.022
Scopus rating (1999): SJR 0.918 SNIP 1.249
Original language: English
Keywords: magnetic anisotropy, modified Newton method, Newton-Raphson, non-oriented steel sheet, particle swarm optimization, surface basis-cubic spline
Electronic versions:
Model of Magnetic Anisotropy of Non-Oriented Steel Sheets for Finite Element Method
DOIs: 10.1109/TMAG.2015.2488100
Research output: Scientific - peer-review › Article

Numerical Analysis of the Power Balance of an Electrical Machine with Rotor Eccentricity

The power balance in the numerical simulation of a cage induction machine with eccentric rotor has been studied. The asymmetrical air gap flux density caused by the non-uniform air gap due to eccentricity produces forces that play an important role in the rotordynamic stability. These forces act both in the radial and the tangential directions. The tangential force together with the whirling motion produces additional power in the shaft. If the power balance of the simulation satisfies, the power due to the whirling can be calculated from the power balance. This could also give a new approach to compute the forces due to eccentricity or verify the existing force computation methods. The error in the
Numerical Analysis of the Power Balance of an Electrical Machine with Rotor Eccentricity

Performance of a Polymer-Based Sensor Package at Extreme Temperature

There is an increasing need for inexpensive packaging structures for demanding industrial electronics applications. This paper studies the usability of a polymer-based sensor package at very high temperatures. Resistance-based temperature sensors were attached with polymer-based electrically conductive adhesives (ECAs) onto flexible polyimide (PI) printed circuit boards (PCB). The materials used in the structure were not specifically designed for high temperature use. However, they were all commercial materials, easily available and typically reliable under normal use conditions of consumer electronics. The samples were aged at 240°C and electrically monitored during the test. Electrically, the sensor samples were observed to fail after 100 h of aging. However, material characterisation revealed that the materials started to degrade much earlier. The adhesive layer in the PI PCB and the ECA materials started to degrade after just 30 h of aging at 240°C, and mechanically the materials were observed to become brittle, making them prone to cracking and delamination. The results showed that such a polymer package is usable at 240°C for relatively short exposure times, but under longer exposure times the mechanical reliability of the package deteriorates and this needs to be taken into account.
Electrically Conductive Adhesives for Demanding Temperature Cycling Environment with Water Immersions

Electrically conductive adhesives are versatile attachment materials offering benefits for many applications in industrial electronics. However, the stability of these materials is typically less than that of metals and ceramics, thus their suitability for demanding environments must be carefully studied. In this paper the performance of anisotropically conductive adhesive (ACA) attachments was studied in a demanding environment combining both high temperature cycling and water immersions. Real-time measurements were conducted during testing. Significant differences between the ACA materials were seen. Promising results were obtained with some of the ACA materials studied, emphasising the importance of material choice. Cracking in the ACA interconnections could be seen in some of the samples studied for failure analysis. However, it remained unclear whether the cracks were the reason for the failures during testing.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Reliability
Authors: Lahokallio, S., Kiilunen, J., Frisk, L.
Publication date: 3 Dec 2015

Host publication information
Title of host publication: Proceedings of the 17th Electronics Packaging Technology Conference
ISBN (Electronic): 978-1-4673-7268-8
DOIs:
10.1109/EPTC.2015.7412362
Research output: Scientific - peer-review › Conference contribution

Thermal Cycling Reliability Analysis of an Anisotropic Conductive Adhesive Attached Large-Area Chip with Area Array Configuration

The reliability of adhesive flip chip attachments was studied. A large-area chip with a great number of contacts was attached onto a flexible polyimide substrate using anisotropic conductive adhesive film (ACF). The test samples were manufactured using various bonding forces and the reliability of the assemblies was examined using a thermal cycling test. Two temperature change rates were used in the cycling test to study the effect of the change rate on the observed failure times and modes. The results show that the ACF flip chip attachment of large-area chips with matrix array interconnections is an applicable technique. Furthermore, a significant increase in the reliability of the assemblies was obtained by increasing the bonding force. However, early failures were observed in all the samples, especially in the outermost adhesive interconnections. Failure analysis performed on the samples exhibiting early failures showed signs of adhesive delamination and silicon chip cracking. No clear differences in the results between the two temperature cycling tests used were observed. However, the faster temperature change rate seemed to cause a higher number of early failures.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Reliability
Authors: Kiilunen, J., Lahokallio, S., Frisk, L.
Number of pages: 6
Publication date: 2 Dec 2015

Host publication information
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Publisher: IEEE
ISBN (Electronic): 978-1-4673-7268-8
DOIs:
10.1109/EPTC.2015.7412380
Research output: Scientific - peer-review › Conference contribution
Temperature Cycling of Low Voltage Motor Drives

Motor drives are used in a wide range of industrial applications, many of which impose high reliability demands on the electronics used in them. Moreover, the environmental conditions in industrial applications may vary a lot and therefore reliability studies for the motor drives are essential. In this study the reliability of a low voltage motor drive was studied with two different temperature cycling profiles. The results of the study showed that temperature cycling triggered some reversible device faults during testing, but catastrophic IGBT failures, common for power electronics, were less seen. More detailed analysis suggests that the reason for the device faults may have been cracks in the solder joints of the pinheader connector between two PCBs of the device, or fretting corrosion on the connector contact materials.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Reliability
Authors: Pippola, J., Kiilunen, J., Frisk, L.
Publication date: Dec 2015

Decomposition of Electric Motor Torque According to Electromagnetic Field Sources

This paper proposes a systematic approach to isolate and quantify electromagnetic forces and torques between any two distinct parts of an electric motor. The approach is based on a decomposition of the magnetic field into components that are generated by different magnetized or current-carrying motor parts. Forces and torques exerted by the field components can be computed using the conventional force and torque formulas. The proposed decomposition is applied to a squirrel-cage induction motor and to a permanent magnet synchronous motor. In these examples, the magnetic fields are decomposed according to current-carrying conductors, magnetized iron, and permanent magnets. Thereafter, the torques exerted by these fields are specified. The results predict which part-pairs of the motor produce the desired and undesired behavior, for example, torque and torque ripple, respectively.

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Research area: Electromagnetics
Authors: Tampio, J., Puumala, V., Kovanen, T., Suuriniemi, S., Kettunen, L.
Number of pages: 8
Pages: 588-595
Publication date: 20 Nov 2015
Peer-reviewed: Yes

Publication information
Journal: IEEE Transactions on Energy Conversion
Volume: 31
Issue number: 2
ISSN (Print): 0885-8969
Ratings:
Scopus rating (2016): CiteScore 5.08 SJR 1.524 SNIP 2.213
Scopus rating (2015): SJR 1.601 SNIP 2.624 CiteScore 5.22
Scopus rating (2014): SJR 1.633 SNIP 2.876 CiteScore 5.03
Scopus rating (2013): SJR 2.077 SNIP 3.285 CiteScore 5.67
Scopus rating (2012): SJR 1.719 SNIP 3.218 CiteScore 5.48
Scopus rating (2011): SJR 1.709 SNIP 3.075 CiteScore 5.35
Scopus rating (2010): SJR 2.152 SNIP 3.056
Scopus rating (2009): SJR 2.157 SNIP 2.916
Scopus rating (2008): SJR 2.43 SNIP 2.919
Scopus rating (2007): SJR 1.459 SNIP 2.793
Scopus rating (2006): SJR 1.284 SNIP 2.529
Scopus rating (2005): SJR 1.405 SNIP 2.194
Towards washable electro-textile UHF RFID tags: reliability study of epoxy-coated copper fabric antennas

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Research group: Wireless Identification and Sensing Systems Research Group, Sensing Systems for Wireless Medicine (MediSense), City University of Hong Kong
Authors: Wang, S., Chong, N. L., Virkki, J., Björninen, T., Sydänheimo, L., Ukkonen, L.
Publication date: 8 Nov 2015
Peer-reviewed: Yes

Publication information
Journal: International Journal of Antennas and Propagation
Article number: 424150
ISSN (Print): 1687-5869
Ratings:
Scopus rating (2016): CiteScore 0.94 SJR 0.276 SNIP 0.576
Scopus rating (2015): SJR 0.35 SNIP 0.753 CiteScore 0.97
Scopus rating (2014): SJR 0.36 SNIP 0.695 CiteScore 0.94
Scopus rating (2013): SJR 0.337 SNIP 0.677 CiteScore 1.04
Scopus rating (2012): SJR 0.256 SNIP 0.546 CiteScore 0.85
Scopus rating (2011): SJR 0.133 SNIP 0.14 CiteScore 0.79
Original language: English
DOIs: 10.1155/2015/424150
Links: http://www.hindawi.com/journals/ijap/2015/424150/ (This article is openly available in the publisher’s website.)
Research output: Scientific - peer-review › Article

Aspects of Electric Vehicles and Demand Response in Electricity Grids
The growing global energy demand combined with limited resources of fossil energy (especially crude oil), climate change and other environmental issues, the energy system has faced significant challenges. There is significant pressure to diversify the energy sources towards more sustainable choices and to increase energy efficiency. Shifting gradually from the use of fossil fuels to use of renewable energy sources is a long way to go, and to make it economically feasible requires a significant amount of will, effort and innovation.

This thesis deals with two parts of the energy system: the electrical energy system and the energy system of road transportation. A "smart" electrical energy system of the future includes the flexibility of electricity demand, i.e. demand response (DR), enabled by different types of incentives and offering many potential advantages. A road transportation system of the future can include significant amount of electric vehicles (full electric vehicles – full EVs and plug-in hybrid electric vehicles – PHEVs) as part of the vehicle fleet. These vehicles could also participate in the operation of an electrical power system. This thesis discusses electric vehicles and demand response in smart grid context.

The most important results and findings of the thesis are the following. In Finland, PHEVs could offer a significant proportion or even most of the benefits of EVs even with a quite modest charging infrastructure, and simultaneously the most severe obstacles of full EVs could be avoided or at least mitigated. In this thesis, a flexible methodology for modeling PHEV charging load using National Travel Survey data has been developed. Statistical PHEV charging load models,
taking into account modeled statistical distributions of the loads, have been used by two different real DNOs in their network information systems to assess the impacts of EVs on distribution network planning in urban networks. It seems that high amounts of EVs fit well into Finnish distribution networks, but in certain cases demand response of electric vehicles would be reasonable. Electric vehicles, some DR actions and other changes in electricity use can increase peak powers in distribution networks. New distribution tariffs have been developed and simulated in a real distribution network with the purpose of encouraging small electricity customers towards peak load restriction. It seems that these kinds of tariffs would be efficient in restricting the increase of peak powers of spot price based DR, although it seems to be hard to decrease the present peak powers very much in the distribution networks. Different general DR and smart charging concepts have been sketched, and a practical local customer-site peak load control management algorithm of an EV charging station group has been developed as a tool to realize demand response of a group of electric vehicles.

**General information**

State: Published
Ministry of Education publication type: G5 Doctoral dissertation (article)
Organisations: Department of Electrical Engineering, Research area: Power engineering
Authors: Rautiainen, A.
Number of pages: 80
Publication date: 6 Nov 2015

**Publication information**

Publisher: Tampere University of Technology
Original language: English

**Publication series**

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Volume: 1327
ISSN (Print): 1459-2045
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rautiainen_1327
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**Bibliographical note**

Awarding institution:Tampere University of Technology
Versio ok 16.12.2015
Research output: Collection of articles › Doctoral Thesis

**Preparation of Supercapacitors on Flexible Substrates with Electrodeposited PEDOT/Graphene Composites**

Composite films consisting of poly(3,4-ethylenedioxythiophene) (PEDOT) and graphene oxide (GO) were electrochemically polymerized by electrooxidation of EDOT in ionic liquid (BMIMBF₄) onto flexible electrode substrates. Two polymerization approaches were compared, and the cyclic voltammetry (CV) method was found to be superior to potentiostatic polymerization for the growth of PEDOT/GO films. After deposition, incorporated GO was reduced to rGO by a rapid electrochemical method of repetitive cathodic potential cycling, without using any reducing reagents. The films were characterized in 3-electrode configuration in BMIMBF₄. Symmetric supercapacitors with aqueous electrolyte were assembled from the composite films and characterized through cyclic voltammetry and galvanostatic discharge tests. It was shown that PEDOT/rGO composites have better capacitive properties than pure PEDOT or the unreduced composite film. The cycling stability of the supercapacitors was also tested, and the results indicate that the specific capacitance still retains well over 90% of the initial value after 2000 consecutive charging/discharging cycles. The supercapacitors were demonstrated as energy storages in a room light energy harvester with a printed organic solar cell and printed electrochromic display. The results are promising for the development of energy-autonomous, low-power, and disposable electronics.

**General information**

State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electronics and Communications Engineering, Department of Automation Science and Engineering, Augmented Human Activities (AHA), Turun Yliopisto/Turun Biomateriaalikeskus
Authors: Lehtimäki, S., Suominen, M., Damlin, P., Tuukkanen, S., Kvamström, C., Lupo, D.
Number of pages: 11
Pages: 22137-22147
Publication date: 14 Oct 2015
Peer-reviewed: Yes
Methodology for Dynamic Stability and Robustness Analysis of Commercial-Power-Module-Based DC-Distributed Systems

The purpose of this thesis is to present dynamic small-signal stability and performance analysis methodology for dc-distributed systems consisting of commercial power modules. Furthermore, the objective is to introduce simple method to state the least conservative margins for robust stability as a single number. In addition, an index characterizing the overall system stability is obtained, based on which different dc-distributed systems can be compared in terms of robustness.

The interconnected systems are prone to impedance-based interactions which might lead to transient-performance degradation or even instability. These systems typically are constructed using commercial converters with unknown internal structure. Therefore, the analysis presented throughout this thesis is based on frequency responses measurable from the input and output terminals. The stability margins are stated utilizing a concept of maximum peak criteria, derived from the behavior of impedance-based sensitivity function that provides a single number to state robust stability. Using this concept, the stability information at every system interface is combined to a meaningful number to state the average robustness of the system. In addition, theoretical formulas are extracted to assess source and load side interactions in order to describe detailed couplings within the system. The presented theoretical analysis methodologies are experimentally validated throughout the thesis.

In this thesis, according to the presented analysis, the least conservative stability margins are provided as a single number guaranteeing robustness. It is also shown that within the interconnected system the robust stability is ensured only if the impedance-based minor-loop gain is determined at the very input or output of each subsystem. Moreover, a complete set of impedance-type internal parameters as well as the formulas according to which the interaction sensitivity can be fully explained and analyzed, is provided. The given formulation can be utilized equally either based on measured frequency responses, time-domain identified internal parameters or extracted analytic transfer functions.

Based on the analysis methodologies presented in this thesis, the stability and performance of interconnected systems consisting of converters with unknown internal structure, can be predicted. Moreover, the provided concept to assess the least conservative stability margins enables to obtain an index to state the overall robust stability of distributed power architecture and thus to compare different systems in terms of stability.
Towards deeper comprehension in higher engineering education: rethinking "in theory yes, but not in practice"

General information
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Organisations: Department of Electrical Engineering, Research area: Electromagnetics, Department of Electrical Engineering, Tampere University of Applied Sciences, Tampere, Finland
Authors: Korpela, A., Tarhasaari, T., Kettunen, L., Mikkonen, R., Kinnari-Korpela, H.
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Decomposition analysis of Cuban energy production and use: Analysis of energy transformation for sustainability
The aim of the article to analyse the changes in Cuban energy system. It uses decomposition analysis to reveal the impacts of the changes in key drivers of energy consumption and CO2 emissions. The Cuban Energy Revolution, which was started in 2006, was the policy response to the local energy crisis; oil imports caused serious balance of payment problems, the old centralised electricity production system was inefficient and hurricanes caused wide damage to the transmission and distribution system resulting large black outs. The Energy Revolution has been quite successful in changing the energy use patterns in Cuban households. Switch from kerosene to electricity in cooking and using energy saving pressure cookers have had an effect on energy efficiency. In addition, the decentralisation of electricity production has increased the reliability of supply and improved the efficiency when new smaller scale power plants have replaced older technology. The energy revolution has, so far not had much impact on energy use in industry, transport and agriculture, which are the areas where the future policies should be directed.

General information
State: Published
Optimization of Quench Protection Heater Performance in High-Field Accelerator Magnets through Computational and Experimental Analysis

Superconducting accelerator magnets with increasingly high magnetic fields are being designed to improve the performance of the Large Hadron Collider (LHC) at CERN. One of the technical challenges is the magnet quench protection, i.e., preventing damage in the case of an unexpected loss of superconductivity and the heat generation related to that. Traditionally this is done by disconnecting the magnet current supply and using so-called protection heaters. The heaters suppress the superconducting state across a large fraction of the winding thus leading to a uniform dissipation of the stored energy. Preliminary studies suggested that the high-field Nb3Sn magnets under development for the LHC luminosity upgrade (HiLumi) could not be reliably protected using the existing heaters. In this thesis work I analyzed in detail the present state-of-the-art protection heater technology, aiming to optimize its performance and evaluate the prospects in high-field magnet protection. The heater efficiency analyses focused on the time delays from heater activation to normal zone initiation in the coils. I developed a numerical simulation tool CoHDA (Code for Heater Delay Analysis) to model the heat transfer from the heater to the cables and estimate the delay based on the superconductor critical surface. All the important parameters relative to the heater, the cable, and the magnet operation conditions were included. The simulation results were validated experimentally using measured data from several R&D Nb3Sn quadrupoles and dipoles. Then, a method based on parametric sweeps was utilized to optimize the heater layouts. The goal was to minimize the delay to quench the entire coil, taking into account the different field regions. New heater designs were proposed for the Nb3Sn R&D prototype LHQ and the HiLumi quadrupole QXF. Finally, I simulated the heaters in high temperature superconductor magnets, which are being considered for the LHC energy upgrade. Consequently, I proposed technology improvements to increase the heater energy in order to meet the requirements also in these very high-field magnets.
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Analysis of uncertainties in protection heater delay time measurements and simulations in Nb3Sn high-field accelerator magnets

The quench protection of superconducting high-field accelerator magnets is presently based on protection heaters, which are activated upon quench detection to accelerate the quench propagation within the winding. Estimations of the heater delay to initiate a normal zone in the coil are essential for the protection design. During the development of Nb3Sn magnets for the LHC luminosity upgrade, protection heater delays have been measured in several experiments, and a new computational tool CoHDA (Code for Heater Delay Analysis) has been developed for heater design. Several computational quench analyses suggest that the efficiency of the present heater technology is on the borderline of protecting the magnets. Quantifying the inevitable uncertainties related to the measured and simulated delays is therefore of pivotal importance. In this paper, we analyze the uncertainties in the heater delay measurements and simulations using data from five impregnated high-field Nb3Sn magnets with different heater geometries.
The results suggest that a minimum variation of 3 ms or 20% should be accounted in the heater design for coil outer surfaces and at least 10 ms or 40% in the inner surfaces due to more uncertain heater contact. We also propose a simulation criterion that gives an upper bound enclosing 90% of the measured delays for heaters on the coil outer surface.

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Authors: Salmi, T., Chlachidze, G., Marchevsky, M., Bajas, H., Felice, H., Stenvall, A.
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Scopus rating (2006): SJR 0.731 SNIP 0.935
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Scopus rating (2003): SJR 0.494 SNIP 1.045
Scopus rating (2002): SJR 0.849 SNIP 1.024
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Cardiac pacemakers in magnetic fields of a shunt reactor at a 400 kV substation

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Organisations: Department of Electronics and Communications Engineering, Research group: Environmental Health, Fingrid Oyj, The Heart Center, Tampere University Hospital
Authors: Korpinen, L., Kuisti, H., Tarao, H., Elovaara, J., Virtanen, V.
Number of pages: 4
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Publication information
Accelerator-quality HTS dipole magnet demonstrator designs for the EuCARD-2 5-T 40-mm clear aperture magnet

Future high-energy accelerators will need very high magnetic fields in the range of 20 T. The Enhanced European Coordination for Accelerator Research and Development (EuCARD-2) Work Package 10 is a collaborative push to take high-temperature superconductor (HTS) materials into an accelerator-quality demonstrator magnet. The demonstrator will produce 5 T stand alone and between 17 and 20 T when inserted into the 100-mm aperture of a Fresca-2 high-field outsert magnet. The HTS magnet will demonstrate the field strength and the field quality that can be achieved. An effective quench detection and protection system will have to be developed to operate with the HTS superconducting materials. This paper presents a ReBCO magnet design using a multistrand Roebel cable that develops a stand-alone field of 5 T in a 40-mm clear aperture and discusses the challenges associated with a good field quality using this type of material. A selection of magnet designs is presented as the result of the first phase of development.

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Managing cascade transformers equipped with on-load tap changers in bidirectional power flow environment

Existing voltage control schemes of cascade on-load tap changers (OLTCs) have been developed considering unidirectional power flow. However, in recent years, integration of distributed generation such as solar and wind power to the grid has created possibility for bidirectional power flow resulting in inefficiency of previous voltage control methods of cascade OLTCs. In this paper, an effective method for managing cascade OLTCs in bidirectional power flow environment is presented. Tracking the active and reactive power changes in both MV and LV networks, the developed method is able to detect the cause of voltage variation i.e. MV or LV network. Accordingly, it enables the system operator to order tap actions at accurate voltage level which decreases unnecessary tap actions and improves the voltage quality at costumer points. The proposed voltage control method is tested in different network scenarios.

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Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES)
Authors: Moghaddam, F., Kulmala, A., Repo, S.
Number of pages: 5
Pages: 1-5
Publication date: 1 Jun 2015
Suitability of bundle approximation in AC loss analysis of NbTi wires: Simulations and experiment

Multifilamentary NbTi wires for ac applications are manufactured by embedding filament bundles into a metal matrix. In this stage of the manufacturing process, it is possible to affect the layout of the cross section and to choose whether to use few large or many small bundles in order to achieve a certain amount of filaments. All in all, up to 100 000 filaments are attainable for wire having the diameter of 1 mm. In this paper, ac loss measurements in external magnetic field on differently stacked NbTi samples are described. The measurements were performed in a LHe-cooled cryostat. The amplitude of the external field was varied between 250 mT and 3 T at frequencies of 0.02 and 0.12 Hz. We discuss possibilities to simulate the losses with finite element method. In particular, we concentrate on the filament bundle approximation and the possibilities to exploit it in the research and development process of new NbTi wires. In this approach, the filament bundles are considered as a homogenous mixture of matrix and superconducting filaments. According to the results, the bundle approximation greatly overestimates the losses. Furthermore, it should not be used for comparing, e.g., two wire structures where one has bundles of different size than the other. However, when considering how to situate the bundles on the cross section to achieve minimal ac loss, the bundle approximation can be a useful tool.

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Authors: Lyly, M., Krooshoop, E., Lübkemann, R., Wessel, S., Stenvall, A., Dhalle, M., Mikkonen, R.
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Systematic method for the development of future active distribution network automation architectures

In response to the EU Mandate M/490, two crucial tools were developed for supporting the standardization of the Smart Grid: the Smart Architecture Model (SGAM) framework and the Use Case Methodology. This paper shows and exemplifies the use of these tools to incrementally develop the automation architecture for future active distribution power systems, by
leveraging on existing automation architectures from literature and existing standards. This method for architecture development has been formalized and used in EU Project IDE4L, but it is generally applicable.

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Authors: Riccobono, A., Angioni, A., Ponci, F., Monti, A., Della Giustina, D., Dede, A., Repo, S.

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**Test results of the LARP HQ02b magnet at 1.9 K**

The HQ magnet is a 120-mm aperture, 1-m-long Nb3Sn quadrupole developed by the LARP collaboration in the framework of the High-Luminosity LHC project. A first series of coils was assembled and tested in five assemblies of the HQ01 series. The HQ01e model achieved a maximum gradient of 170 T/m at 4.5 K at LBNL in 2010-2011 and reached 184 T/m at 1.9 K at CERN in 2012. A new series of coils incorporating major design changes was fabricated for the HQ02 series. The first model, HQ02a, was tested at Fermilab where it reached 98% of the short sample limit at 4.5 K with a gradient of 182 T/m in 2013. However, the full training of the coils at 1.9 K could not be performed due to a current limit of 15 kA. Following this test, the azimuthal coil pre-load was increased by about 30 MPa and an additional current lead was installed at the electrical center of the magnet for quench protection studies. The test name of this magnet changed to HQ02b. In 2014, HQ02b was then shipped to CERN as the first opportunity for full training at 1.9 K. In this paper, we present a comprehensive summary of the HQ02 test results including: magnet training at 1.9 K with increased preload; quench origin and propagation; and ramp rate dependence. A series of powering tests was also performed to assess changes in magnet performance with a gradual increase of the MIITs. We also present the results of quench protection studies using different setting for detection, heater coverage, energy extraction and the coupling-loss induced quench (CLIQ) system.

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The EuCARD-2 future magnets European collaboration for accelerator-quality HTS magnets

EuCARD-2 is a project supported by FP7-European Commission that includes, inter alia, a work-package (WP10) called "Future Magnets." This project is part of the long term development that CERN is launching to explore magnet technology at 16 T to 20 T dipole operating field, within the scope of a study on Future Circular Colliders. The EuCARD2 collaboration is closely liaising with similar programs for high field accelerator magnets in the USA and Japan. The main focus of EuCARD2 WP10 is the development of a 10 kA-class superconducting, high current density cable suitable for accelerator magnets. The cable will be used to wind a stand-alone magnet 500 mm long and with an aperture of 40 mm. This magnet should yield 5 T, when stand-alone, and will enable to reach a 15 to 18 T dipole field by placing it in a large bore background dipole of 12-15 T. REBCO based Roebel cables is the baseline. Various magnet configurations with HTS tapes are under investigation and also use of Bi-2212 round wire based cables is considered. The paper presents the structure of the collaboration and describes the main choices made in the first year of the program, which has a breadth of five to six years of which four are covered by the FP7 frame.
Utilizing triangular mesh with MMEV to study hysteresis losses of round superconductors obeying critical state model

Nature's minimum energy principle formulated in minimum magnetic energy variation (MMEV) and coupled with the Bean's critical state model (CSM) has resulted in feasible tools to model hysteresis losses in superconductors. These tools have been applied for single wires as well as for multi-turn coils in two-dimensional modelling domains. However, so far the discretization of the modelling domain has always relied on regular rectangular meshes. Therefore, the mesh representation of round filaments suffers from large discretization error if the mesh is not refined considerably more than triangular meshing would need. In this paper, we study the utilisation of triangular mesh in such a hysteresis loss modelling tool. We present the required extension to the already available knowledge that is needed to implement such a modelling tool. With our home-brewed tool, we study the convergence of the simulated transport current losses in the cross-section of a round wire represented with triangular and rectangular meshes of different types and of different densities. According to the results, triangular meshing is considerably more efficient than rectangular meshing for simulating transport current losses in the investigated situation.
DC Dielectric Breakdown Behavior of Thermally Sprayed Ceramic Coatings

Previous studies of dielectric properties of thermally sprayed insulating ceramic coatings are focused on linearly ramped dielectric breakdown strength as well as DC resistivity, relative permittivity and dielectric loss characterizations. However, reports of the effects of ramp rate or of any kind of long term stressing on the breakdown strength cannot be found in literature. The aim of this paper was to study the DC breakdown behavior of one type of HVOF sprayed alumina coating under different stresses. It can be concluded that the ramp rate of DC breakdown measurement has no remarkably influence on the breakdown strength. The breakdown behavior was also studied using step-by-step tests with two constant step voltages and step durations. The DC resistivity of the alumina coating showed strong dependence on the applied electric field. The resistivity behaved ohmically below the field strength of ~0.5 V/µm and above ~8…12 V/µm, however, the resistivity decreased approximately three decades in the non-ohmic region (0.5 V/µm). At electric field strengths above ~25 V/µm, the degradation started in the material leading to breakdown. However, when the step duration was longer (60 min), the degradation process started already slightly below the applied field of 25 V/µm.

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Authors: Niittymäki, M., Suhonen, T., Metsäjoki, J., Lahti, K.
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Electromagnetic Design of Ultrafast Electromechanical Switches

To open electromechanical switches within the range of tens of microseconds, we exploit repulsive electromagnetic forces between current-carrying conductor loops. For this we study the power conversion efficiency from electromagnetic to kinetic form. These studies suggest connecting moving coils in series rather than employing inductive coupling. These techniques are put into practice in two prototype switches: the first one is based on induction and the other on series connected coils. Measurements with a high-speed camera verify that both switches achieve accelerations in the magnitude of 140000 g and breaking distances of 1 mm within 50 μs. The switch with series connected coils obtains 44% greater force than the one based on induction.
Variation of Quench Propagation Velocities in YBCO Cables

We show by modelling that the quench propagation velocity is not constant in HTS coils but it changes during the quench. Due to the large temperature margin between the operation and the current sharing temperatures, the normal zone does not propagate with the temperature front. This means that the temperature will rise in a considerably larger volume when compared to the quenched volume. Thus, the evolution of the temperature distribution below current sharing temperature T (c s) after the quench onset affects the normal zone propagation velocity in HTS more than in LTS coils. This can be seen as an acceleration of the quench propagation velocities while the quench evolves when margin to T (c s) is high. In this paper, we scrutinize quench propagation in a stack of YBCO cables with an in-house finite element method software which solves the heat diffusion equation. We compute the longitudinal and transverse normal zone propagation velocities at various distances from the hot spot to demonstrate the distance-variation of these velocities. According to the results in our particular simulation case, the longitudinal normal zone propagation velocity is 30 % higher far away from the quench origin compared to its immediate vicinity when T (op)=4.2 K and T (c s) =15 K.

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Scopus rating (2011): SJR 0.443 SNIP 0.436 CiteScore 0.71
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Scopus rating (2002): SJR 0.601 SNIP 0.431
Scopus rating (2001): SJR 0.582 SNIP 0.456
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Feasibility of electric buses in public transport

This study examines the economic feasibility of electric buses in a mid-sized city, where public transport is currently organized with buses only. The difference in lifetime cost of electric buses and diesel buses was calculated with the chosen parameters that were selected after careful background analysis. A viable business case can be created when the battery and the charging infrastructure are selected shrewdly. The electricity is much cheaper fuel than diesel but with the current battery technologies and battery prices the significant cost from operating an e-bus comes from the wear of the battery. Two types of Li-ion batteries were compared, LFP (Lithium Iron Phosphate) and LTO (Lithium Titanate). Also different conductive opportunity charging strategies were examined: 1. Charging at the depot. 2. Charging at the end stop(s). 3. Charging at the line stops.

The round trip line length assessed was 20 km. Calculations show that the LTO buses and a fast charger at the end stop complemented with low power overnight chargers at the depot is the best investment combination based on the given assumptions. The 200 kW charging power is sufficient to ensure the charging in the normal end stop breaks. Due to a longer cycle life the wear cost per km was lower for LTO than for LFP. LTO is also better adapted for fast charging. The battery size has to be sufficient compared to the required driving range during peak consumption, to the charging current and to the performance requirements of the e-bus. Oversizing the battery has some positive effects (improved cycle life, less heating and better flexibility) but the negative effects were estimated to be more significant (higher investment cost, increased weight and space requirement).

Product level accelerated reliability testing of motor drives with input power interruptions

Motor drives utilizing power semiconductors play an important role in modern day electric motor control. Although the reliability of power semiconductors is widely studied, the product level reliability of motor drives has been studied markedly less even though their more complex control and measuring electronics often make them more vulnerable to environmental stresses. In order to advance product level accelerated reliability testing, customized test methods with multiple simultaneous or sequential stresses can be used. However, the knowledge of combined effects of different stresses is still largely unknown. In this research the reliability of a commercial motor drive was studied. Environmental conditions used included an 85 °C constant temperature test and an 85 °C test with 85% relative humidity. Additionally, input power interruptions were included to study the effect of sudden shortages of electricity. The results of the study showed that the mean time to failure for the devices tested with the input power interruptions was notably shorter than that for the test series without them. An especially clear effect of the input power interruptions was seen on the power MOSFETs of the motor drives. Moreover, the humidity was found to play an important role in the reliability of the motor drives.
Hot spot temperature in an HTS Coil: Simulations with MIITs and finite element method

MIITs, a zero-dimensional concept to study hot spot temperature, has been previously used to estimate hot spot temperatures and quench heater delays in NbTi and Nb$_3$Sn magnets. However, quench behavior is completely different in high-temperature superconducting (HTS) magnets due to the slow normal zone propagation velocity and the high temperature margin. Because the MIITs concept does not take into account thermal diffusion in the magnet, opposite to the finite-element method (FEM) analysis, the difference of these concepts is studied in this paper. Here, we have taken the approach to compute the hot spot temperatures for a future HTS magnet, designed to be built from REBCO Roebel cable, with MIITs and FEM simulations. The magnet protection is accomplished with a dump resistor, and the effect of quench detection threshold voltage on the hot spot temperature has been studied. Furthermore, the inductance of the magnet increases with the magnet length. Thus, there exists a maximum inductance of the magnet, which should not be exceeded to be able to protect the magnet only with a dump resistor. The hot spot temperatures with different values of inductance are also studied in this paper. Our simulations show that the hot spot temperatures computed with MIITs are from 60 to 150 K higher than those of FEM analysis. Thus, the MIITs concept seems unreliable when considering hot spot temperatures in HTS magnets protected with only dump resistors. However, the MIITs concept might be a usable tool when comparing different magnet designs. If 400 K is the upper limit for the hot spot temperature and the protection scheme includes only a dump resistor, the length of the investigated magnet can be increased to only such value that the magnet inductance is at most 50 mH.
On improvement of transient stage of composite nonlinear feedback control using arbitrary order set point filters

This paper studies the generalization of composite nonlinear feedback (CNF) control using arbitrary order set point filters, which focus on the initial stage of the transient response. The set point filters can be used to provide more performance by shortening the rise and settling times of the control system. Furthermore, the filters operate outside the feedback loop, and hence, they do not sacrifice loop robustness. The new method is illustrated by a benchmark problem found in an open literature. The simulation results show that the proposed method improves the set point response more than 10% in terms of settling time.

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Systematic approach to secure automation – coordinated voltage control use-case

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Name: SAS Julkaisusarja
Publisher: Finnish Society of Automation
Volume: 44

Bibliographical note
ORG=ase,0.8
ORG=dee,0.2

Towards automation security research and training environment
An automation system is a networked software product in hardware intensive environment and requires more than normal IT security skills. Building an automation security research and training environment for automation requires knowledge on the internal workings of an automation system as well as creative approach on how to keep the system secure where needed, and broken when required for development and teaching purposes. The main challenges are to combine the amount of automation specific hardware and to create good practices which keep the need for maintenance, versatility and pedagogical aspects in balance. This paper presents a project called TUTCyberLabs, the learned lessons and the design decisions. The main focus is on Department of Automation Science and Engineering environment ASECyberLab.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Authors: Seppälä, J., Salmenperä, M., Koivisto, H., Harju, J., Repo, S., Holmström, J., Ahonen, P.
Publication date: 18 Mar 2015

Host publication information
Title of host publication: Proceedings of Automaatio XXI, The Industrial Revolution of Internet – From Intelligent Devices to Networked Intelligence
Place of publication: Helsinki, Finland
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Publication series
Name: SAS Julkaisusarja
Publisher: Finnish Society of Automation
Volume: 44

Bibliographical note
ORG=ase,0.8
ORG=tie,0.1
ORG=dee,0.1

Research output: Scientific - peer-review › Conference contribution
Air Gap Fields in Electrical Machines: Harmonics and Modelling of Movement

The aim of this thesis is to develop mathematical tools for the efficient electromagnetic analysis of electromechanical devices. In the analysis of rotating electrical machines, the air gap fields play an important role. It is particularly useful to write the magnetic flux density in the air gap as a Fourier series expansion with respect to mechanical angle and/or time. Different terms in the series expansions are then called space and time harmonics and almost all relevant phenomena can be understood from the behaviour of the harmonics. The main topic of this thesis is the application of spectral Dirichlet-to-Neumann mappings to model rotating electrical machines in terms of air gap harmonics. A spectral Dirichlet-to-Neumann mapping for a rotor or stator subproblem in a time or frequency domain boundary value problem (BVP) completely characterizes the electromagnetic behaviour of the subproblem from the viewpoint of the remaining problem and can be used to replace the subproblem with an implicit Neumann boundary condition. This allows the development of new efficient numerical and analytical methods for analysis of electrical machines. We discuss several analytical and numerical methods, where reformulation of one or both subproblems with Dirichlet-to-Neumann maps is used to speed up the solution or to obtain more accurate solutions. Moreover, properties of the spectral Dirichlet-to-Neumann maps yield information, which can be used to predict and understand the air gap field harmonics. The second topic of the thesis is the application of Riemannian geometry to construct BVPs for electromechanical devices in coordinate systems fixed to the moving bodies. Then, change of distances of the material points corresponds to change in the coordinate expression of the metric tensor in the air gap. In FE implementations, this allows modeling of movement without changes to the finite element mesh. We discuss the application of the approach to linear and rotating movement.

General information
State: Published
Ministry of Education publication type: G5 Doctoral dissertation (article)
Organisations: Department of Electrical Engineering
Authors: Räisänen, V.
Number of pages: 78
Publication date: 13 Feb 2015

Publication information
Publisher: Tampere University of Technology
Original language: English

Publication series
Name: Tampere University of Technology. Publication
Publisher: Tampere University of Technology
Volume: 1281
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Bibliographical note
Awarding institution: Tampereen teknillinen yliopisto - Tampere University of Technology<br/>Submitter: Submitted by Ville RÄisänen (ville.raisanen@tut.fi) on 2015-01-16T11:51:53Z
No. of bitstreams: 1
main.pdf: 1260988 bytes, checksum: e71585df8f6c692bb8a67b02c5cc2254 (MD5)<br/>Submitter: Approved for entry into archive by Kaisa Kulkki (kaisa.kulkki@tut.fi) on 2015-01-20T12:04:46Z (GMT)
No. of bitstreams: 1
main.pdf: 1260988 bytes, checksum: e71585df8f6c692bb8a67b02c5cc2254 (MD5)<br/>Submitter: Made available in DSpace on 2015-01-20T12:04:46Z (GMT)
No. of bitstreams: 1
main.pdf: 1260988 bytes, checksum: e71585df8f6c692bb8a67b02c5cc2254 (MD5)
Source: researchoutputwizard
Source-ID: 123456789/22703
Research output: Collection of articles › Doctoral Thesis

Design, fabrication, and testing of a low AC-loss conduction-cooled cryostat for magnetization loss measurement apparatus

Conduction cooling has become a viable alternative for cooling superconducting devices. However, the thermal pathways of a conduction-cooled cryostat can be problematic for applications where time-varying magnetic fields are present. Such alternating magnetic fields are present, e.g., in a magnetization ac-loss measurement system. The losses in the thermal pathways are unwanted as they increase the heat load into the cryostat and interfere with the measurement. To solve this challenge, a conduction-cooled cryostat with special attention in limiting eddy-current losses in the cryostat structures was constructed. The design process is illustrated in detail starting from the specifications and proceeding through the
fabrication of individual components. The loss dissipated in the cryostat is experimentally examined, and the finished conduction-cooled magnetization loss measurement system is demonstrated by characterizing a multifilamentary MgB$_2$ conductor.

**Recognition and modelling of irradiance transitions caused by moving clouds**

Fast irradiance transitions caused by the edges of shadows of moving clouds have various effects on the operation of photovoltaic (PV) systems. They can lead to situations where the grid inverter is not able to follow the global maximum power point causing extra losses. Fast fluctuations of the power fed to the electric grid can also cause energy balance and power quality problems. Further, partial shading of PV generators causes mismatch losses.

In this paper, a method to recognize irradiance transitions caused by moving clouds from the measured extensive irradiance data is presented. A total of around 40,000 irradiance transitions were recognized from a measured data of 13 months around midsummer in 2011-2013 and their shading strength, duration, time of occurrence etc. have been analysed. It has been found that the duration of irradiance transitions varies a lot from a few seconds up to several minutes. The average duration of irradiance rises is clearly longer than that of falls. Shading strengths of transitions varies quite evenly from very thin shadings up to 90% shading strength and the highest transition rates take place around noon. Furthermore, a mathematical model of the irradiance transitions has been developed and validated with the extensive set of experimental data. (C) 2014 Elsevier Ltd. All rights reserved.
Modeling deformations in magnetic systems - a finite element implementation

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Research area: Electromagnetics
Authors: Kovanen, T., Tarhasaari, T., Kettunen, L.
Publication date: Jan 2015
Peer-reviewed: Yes

Publication information
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ISSN (Print): 0018-9464
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Scopus rating (2016): CiteScore 1.47 SJR 0.48 SNIP 0.915
Scopus rating (2015): SJR 0.565 SNIP 1.207 CiteScore 1.77
Scopus rating (2014): SJR 0.715 SNIP 1.491 CiteScore 1.68
Scopus rating (2013): SJR 0.608 SNIP 1.424 CiteScore 1.75
Scopus rating (2012): SJR 0.788 SNIP 1.574 CiteScore 1.89
Scopus rating (2011): SJR 0.829 SNIP 1.445 CiteScore 1.69
Scopus rating (2010): SJR 0.698 SNIP 1.134
Scopus rating (2009): SJR 0.644 SNIP 1.098
Scopus rating (2008): SJR 0.788 SNIP 1.165
Scopus rating (2007): SJR 0.71 SNIP 1.152
Scopus rating (2006): SJR 0.913 SNIP 1.232
Scopus rating (2005): SJR 1.024 SNIP 1.258
Scopus rating (2004): SJR 0.813 SNIP 1.129
Scopus rating (2003): SJR 1.056 SNIP 1.094
Scopus rating (2002): SJR 1.078 SNIP 1.027
Scopus rating (2001): SJR 0.707 SNIP 1.007
Scopus rating (2000): SJR 0.831 SNIP 1.022
Scopus rating (1999): SJR 0.918 SNIP 1.249
Original language: English
DOIs:
10.1109/TMAG.2015.2453140
Research output: Scientific - peer-review › Article

**Combined Electricity and Mobile Network Situation Awareness System for Disturbance Management**

**General information**
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering, Department of Electronics and Communications Engineering, Research group: Laboratory of Radio Network Planning
Authors: Krohns-Välimäki, H., Haapanen, J., Verho, P., Säe, J., Lempiäinen, J.
Publication date: 2015

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Title of host publication: 2015 IEEE Innovative Smart Grid Technologies - Asia (ISGT Asia)
Publisher: Institute of Electrical and Electronics Engineers IEEE
ISBN (Electronic): 978-1-5090-1237-4
DOIs:
10.1109/ISGT-Asia.2015.7387099

**Bibliographical note**
ORG=dee,0.7
ORG=elt,0.3
Research output: Scientific - peer-review › Conference contribution

**DC ramp rate effect on the breakdown response of SiO2-BOPP nanocomposites**
The effect of voltage ramp rate on the short-term dielectric breakdown strength of polymer nanocomposites is not well-documented. In this paper, the effect of DC field ramp rate on the large-area breakdown performance of melt-extruded biaxially oriented polypropylene (BOPP) films incorporating 4.5 wt-% of nano-silica is studied. By utilizing a self-healing multi-breakdown measurement method with a variable DC voltage ramp rate, a statistically large amount of breakdown data was obtained from a large total sample film area as a function of DC field ramp rate (0.1–50 Vs−1µm−1). With a decreasing ramp rate, Weibull statistical analysis of the breakdown data suggests a systematically decreasing trend in the breakdown strength (Weibull α) and an increase in the Weibull shape parameter of time (>1) for the nanocomposite. The observed behavior is speculated to be attributable to highly altered internal charge dynamics of the silica-BOPP nanocomposite. The results exemplify the importance of careful breakdown strength assessment when dielectric films of more complex internal structure are studied.

**General information**
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES), VTT Technical Research Centre of Finland
Effect of Inductor Saturation on the Harmonic Currents of Grid-Connected Three-Phase VSI in PV Application

The optimal design of a VSI-based photovoltaic (PV) inverter has been studied extensively during the last years. The focus in these studies has been in the selection of the reactive components of the LCL-filter, leaving the inductor design out from the discussion. However, the inductor design plays an important role when the design target is to minimize the size and the cost of the filter. Unfortunately, the minimization of the filter size might yield saturating inductors. In this paper, the effect of inductor saturation on the harmonic currents of grid-connected three-phase PV inverter is studied by simulations and measurements on a prototype inverter. The results indicate that application of saturating inductors increases the fifth and seventh harmonics in the output current of the inverter when it is operating at open-loop. However, these harmonics are effectively attenuated when the inverter is operated at closed-loop.

Electric field dependency of dielectric behavior of thermally sprayed ceramic coatings

High temperature applications e.g. fuel cells require ceramic-based insulation solutions instead of polymers. The aim of this paper was to characterize the dielectric properties of thermally sprayed ceramic coatings; especially the electric field dependency of AC and DC behavior of thermally sprayed ceramic coatings. One of the spinel samples and one of the alumina samples have quite similar lamellar microstructure which may partly explain their similar type of behavior in DC resistivity as well as in AC loss indexes at low frequencies. These two samples had smaller lamellar size than the other alumina and spinel samples which also had quite similar behavior of AC losses at low frequencies, respectively. In addition to the lamellar size and structure, also micro cracks in the coating microstructure are proposed to have an effect on the dielectric behavior and its electric field dependency.
Flexible fast-convolution implementation of single-carrier waveform processing for 5G

This paper proposes and analyzes the use of effective and flexible fast-convolution (FC) implementation for single-carrier (SC) waveforms with very small roll-offs to reach high spectrum efficiency and significantly lower peak-to-average power ratio (PAPR) than corresponding multicarrier schemes. The generated waveforms are spectrally well-contained, with very small power leakage to adjacent frequencies, and are thus good candidates for opportunistic and heterogeneous spectrum use scenarios. The SC-waveforms are found to exhibit similar PAPR characteristics as the OFDM based SC-FDMA scheme. On the receiver side, fast-convolution filter bank (FC-FB) approach supports effective frequency-domain equalization with low complexity. It can be used for simultaneous processing of multiple SC channels with individually tunable bandwidths, center frequencies and timing offsets. This solution enables different terminals to operate with different roll-offs and hence with different PAPR. The approach supports well asynchronous multi-user operation, which is considered as an important element in 5G networks.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electronics and Communications Engineering, Research group: Wireless Communications and Positioning, Wireless Communications and Positioning (WICO)
Authors: Yli-Kaakinen, J., Renfors, M.
Pages: 1269 - 1274
Publication date: 2015

Host publication information
Title of host publication: 2015 IEEE International Conference on Communication Workshop, ICCW 2015 – Workshop on 5G & Beyond – Enabling Technologies and Applications
Publisher: IEEE
ISBN (Print): 978-1-4673-6305-1
DOIs:
10.1109/ICCW.2015.7247352
Research output: Scientific - peer-review › Conference contribution

Generalized multivariable small-signal model of three-phase grid-connected inverter in DQ-domain

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES)
Authors: Messo, T., Aapro, A., Suntio, T.
Publication date: 2015

Host publication information
Title of host publication: IEEE 16th Workshop on Control and Modeling for Power Electronics (COMPEL)
Publisher: IEEE
ISBN (Print): 978-1-4673-6847-6
DOIs:
10.1109/COMPEL.2015.7236460
Research output: Scientific - peer-review › Conference contribution

High-Temperature Storage Testing of ACF Attached Sensor Structures

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Research area: Reliability, Department of Materials Science, Research group: Plastics and Elastomer Technology, Engineering materials science and solutions (EMASS)
Authors: Lahokallio, S., Hoikkanen, M., Vuorinen, J., Frisk, L.
Pages: 8641-8660
Publication date: 2015
Kanavamittaus moderneja laajakaistaisia HF-järjestelmiä varten: Tilvistemäraportti

General information
State: Published
Ministry of Education publication type: D4 Published development or research report or study
Organisations: Department of Electronics and Communications Engineering, Research group: Wireless Communications and Positioning, Kyynel Oy, Oulun Yliopisto/CWC
Authors: Saarnisaari, H., Hovinen, V., Tuomivaara, H., Yli-Kaakinen, J., Renfors, M.
Number of pages: 10
Publication date: 2015

Publication information
Publisher: Puolustusministeriö
Original language: Finnish

Publication series
Name: MATINE raporttisarja
Publisher: Puolustusministeriö
ISSN (Electronic): 1797-3457
Links:
Research output: Professional → Commissioned report

Miten sähkö on kehittynyt?

General information
State: Published
Ministry of Education publication type: Not Eligible
Organisations: Department of Electrical Engineering, Research area: Electromagnetics
Authors: Stenvall, A.
Number of pages: 1
Pages: 132-132
Publication date: 2015

Host publication information
Title of host publication: Ovatko kaikki esineet olleet jokin märkiä?
Place of publication: Bookwell, Porvoo
Publisher: HS Kirjat
Modeling of Minimum Energy Required to Quench an HTS Magnet with a Strip Heater

Due to the wide spectrum of current sharing temperatures in an HTS magnet, estimating the energy required to quench the magnet is a complicated task. On the other hand, quenching an LTS magnet for quench characterization purposes with a heater is straightforward due to the small temperature margin, and correspondingly low minimum quench energy (MQE). To estimate the required energy for LTS magnet, the analytic concept of MQE can be utilized. In this paper we propose that only numerical simulations can give adequate estimates to the MQE of an HTS magnet for measurement purposes. Further, due to the high enthalpy margin, the utilization of spot heaters with short energy pulses becomes questionable. We present in detail the effect of heater’s pulse length to the MQE when a strip heater is utilized for quenching. In addition, the effect of the heater area on MQE is studied. We consider the model of a REBCO coil to be constructed and tested in a European project EuCARD-2. According to the results: 1) MQE increases almost linearly for pulse lengths between 100 ms and 500 ms. 2) When the heater area is enlarged, the required energy per area saturates to a certain value related to the coil’s enthalpy margin. 3) MQE obtained with a traditional analytic approach based on a minimum propagating zone (MPZ) underestimates considerably the numerically obtained MQE.

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Research area: Electromagnetics
Authors: Härö, E., Stenvall, A., van Nugteren, J., Kirby, G.
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: IEEE Transactions on Applied Superconductivity
ISSN (Print): 1051-8223
Ratings:
Scopus rating (2016): CiteScore 1.42 SJR 0.395 SNIP 1.031
Scopus rating (2015): SJR 0.35 SNIP 0.935 CiteScore 1.27
Scopus rating (2014): SJR 0.47 SNIP 1.113 CiteScore 0.83
Scopus rating (2013): SJR 0.431 SNIP 1.171 CiteScore 1.32
Scopus rating (2012): SJR 0.575 SNIP 1.27 CiteScore 1.11
Scopus rating (2011): SJR 0.364 SNIP 1.063 CiteScore 1.16
Scopus rating (2010): SJR 0.468 SNIP 1.073
Scopus rating (2009): SJR 0.452 SNIP 1.033
Scopus rating (2008): SJR 0.878 SNIP 0.987
Scopus rating (2007): SJR 0.611 SNIP 1.104
Scopus rating (2006): SJR 0.731 SNIP 0.935
Scopus rating (2005): SJR 0.645 SNIP 0.996
Scopus rating (2004): SJR 0.867 SNIP 0.9
Scopus rating (2003): SJR 0.494 SNIP 1.045
Scopus rating (2002): SJR 0.849 SNIP 1.024
Scopus rating (2001): SJR 0.523 SNIP 1.336
Scopus rating (2000): SJR 0.799 SNIP 0.95
Scopus rating (1999): SJR 1.073 SNIP 2.106
Original language: English
Keywords: Finite element analysis, Heating, High-temperature superconductors, Magnetic domains, Saturation magnetization, Superconducting magnets, Temperature measurement, high temperature superconductors, minimum quench energy, quench simulation, stability analysis, super conducting magnets
DOI: 10.1109/TASC.2015.2493125
Source: RIS
Source-ID: urn:70EBBBBD786991509F6813202BBCEA070
Research output: Scientific - peer-review › Article

Modeling quench protection heater delays in an HTS coil
OPC UA security for protecting substation and control center data communication in the distribution domain of the smart grid

The distribution domain of the smart grid incorporates advantages of the newest substation automation standards in order to enhance distribution network automation. State-of-the-art distribution automation solutions use the public Internet for exchanging data between substation and control center. This presents challenges for cybersecurity, particularly for critical data determining distribution network operation. Therefore, Internet communication between substation and control center should be carried out via a secure communication protocol. OPC Unified Architecture (UA) is an interoperable communication standard supports Internet protocols from one hand and obtains benefits from mature built-in security mechanisms from other hand. This paper describes a solution for secure data transmission between modern substation and control center over the Internet. In this approach, circuit breaker position data is chosen as the data example that is defined in respect to the IEC 61850 data model and securely transmitted to OPC UA client application at remote control center by employing the OPC UA security architecture functions.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Principles of designing for situation awareness

High level of situation awareness is a key factor in many domains to ensure correct decision making and actions. Situation awareness has been studied extensively in the aviation and military domains but the research also applies to other domains e.g. power grid operations and managing disturbances of electricity supply. Based on the research design principles have been created in order to help system designers to create better user interfaces for systems used in operational activities. These principles have been applied when designing the situation awareness system concept for managing disturbances of electricity supply.
Simulointi nopeuttaa käyttöiän määrittää

General information
State: Published
Ministry of Education publication type: D1 Article in a trade journal
Organisations: Department of Materials Science, Research group: Tribology and Machine Elements, Department of Mechanical Engineering and Industrial Systems, Research group: Kokeellinen virtaustekniikka, Research area: Applied Mechanics, Department of Intelligent Hydraulics and Automation, Research group: Fluid power automation in mobile machines, Department of Electrical Engineering, Research area: Reliability
Number of pages: 4
Pages: 24-27
Publication date: 2015
Peer-reviewed: Unknown

Publication information
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Volume: 2
ISSN (Print): 1797-2000
Original language: Finnish

Bibliographical note
ORG=mol,0.25
ORG=mei,0.25
ORG=iha,0.25
ORG=dee,0.25
Research output: Professional › Article

Subdomain Reduction by Dirichlet-to-Neumann Mappings in Time-Domain Electrical Machine Modeling

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering
Authors: Räisänen, V., Suuriniemi, S., Kurz, S., Kettunen, L.
Number of pages: 9
Pages: 340-348
Publication date: 2015
Peer-reviewed: Yes

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Journal: IEEE Transactions on Energy Conversion
Volume: 30
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ISSN (Print): 0885-8969
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Scopus rating (2015): SJR 1.601 SNIP 2.624 CiteScore 5.22
Scopus rating (2014): SJR 1.633 SNIP 2.876 CiteScore 5.03
Scopus rating (2013): SJR 2.077 SNIP 3.285 CiteScore 5.67
Scopus rating (2012): SJR 1.719 SNIP 3.218 CiteScore 5.48
Scopus rating (2011): SJR 1.709 SNIP 3.075 CiteScore 5.35
Temperature Effect on Breakdown Performance of Insulating Polymer Thin Films

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering
Authors: Ritamäki, M., Rytöluoto, I., Lahti, K.
Number of pages: 4
Pages: 75-79
Publication date: 2015

Host publication information
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ISBN (Print): 978-82-321-0274-7

Publication series
Name: Proceedings of the Nordic Insulation Symposium
No.: 24
ISSN (Electronic): 2525-3969
Research output: Scientific - peer-review › Conference contribution

The role of film processing in the large-area dielectric breakdown performance of nano-silica-BOPP films
This paper summarizes the effects of various compositional, structural and film processing factors on the breakdown behavior of laboratory- and pilot-scale melt-compounded bi-axially oriented polypropylene (BOPP) nanocomposite films with silica fillers. A self-healing multi-breakdown measurement approach has been extensively utilized for large-area breakdown characterization of a large number of material variants from different processing trials. The results suggest that although the optimum level of silica presumably resides at the low fill-fraction range (~1 wt-%), the silica content itself is not the only determining factor, as compounds with equal silica content were found to exhibit large differences in the breakdown properties depending on the compounding and film processing steps. Dispersion quality and filler agglomeration (in both the nm- and µm-scale) appear to be of great importance. Indications of possible interaction between nano-silica and co-stabilizer Irgafos 168 are also presented. Overall, the laboratory- and pilot-scale film processing trials suggest that up-scaling of the polymer nanocomposite production is sensible with traditional melt-blending technology, although further development and optimization of nanocomposite formulations and processing is necessary.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering, VTT Technical Research Centre of Finland
Characterization of MgB2 Superconductors in Conduction-Cooled Systems

Superconductivity as a phenomenon was discovered over 100 years ago and the first commercially viable materials have been in use for over 50 years. Today, the truly commercial applications in medical imaging and scientific research are limited to operating temperatures near 4.2 K. However, the discovery of high temperature superconductivity in 1986, and the discovery of superconductivity in magnesium diboride, MgB2, in 2001, have the potential for changing this. The high temperature superconductors have proven to be useful in many applications including electric machinery and power transfer. However, their wide spread application is in part limited by their steep price. This is not the case with MgB2. The cheap and easy-to-manufacture material has been shown to be competitive at applications with low to medium strength magnetic fields at an elevated operation temperature of 20 K. The most important commercial application, the magnetic resonance imaging falls within this range. These elevated operation temperatures are cost-effectively reachable with conduction-cooling and mechanical cryorefrigerators, i.e. crycoolers. Designing and engineering of such dry system requires different approaches than their liquid cooled predecessors. To support these activities, accurate and relevant measurement data on the superconductor properties under the proper operating conditions, is required. In this thesis, I present the approaches, challenges and solutions for obtaining valid measurement data in a conduction-cooled measurement system, focusing on the measurements of the properties used in characterizing the superconductor performance. I show how measurements in conduction-cooled system differs from ones cooled with liquid or gaseous cryogens. I discuss the importance of a proper sample holder and present considerations on how to make one. While the physical components of the measurement system are important, acquiring valid results requires proper measurement procedures. I analyze the voltage-current characteristic measurement and show how the results are easily effected by improper procedures. I consider, how the quench initiation and propagation experiments are performed, and how the quench dynamics MgB2 and high temperature superconductors differ from low temperature ones. To demonstrate the applicability of conduction-cooling, I present the design, construction and benchmarking a measurement system for determining the magnetization AC-losses in a superconductor.
Issues in Discontinuous Space-Vector Modulation and Grid-Current Control of Three-Wire Three-Level Static Synchronous Compensator

In modern power systems, the quality of electric power should be maintained within statutory limits and tolerances to enable normal and uninterrupted operation of the load equipment in their electrical environment. However, the severity of power quality problems, as well as the frequency of their occurrence, has been in continuous increase because of growing energy consumption, proliferation of non-linear loads, and the sensitivity of modern loads to electromagnetic disturbances in the networks. Therefore, more efficient and faster-acting power quality conditioners are needed. Currently the broadest operating range and the fastest dynamics are provided by solid-state power quality conditioners based on pulse-width modulated power converters. Considering high power and medium to high voltage applications, the multilevel converter topologies have gained special interest because they can generate low-harmonic voltage and current waveforms by using lower switching frequencies and with no need for complex transformer circuits. This thesis studies the digital control of a STATCOM (static synchronous compensator) based on the three-wire three-level neutral-point-clamped rectifier. The focus is on the control system functions that primarily determine the dynamic behavior and the performance of the compensator. The main addressed research issues are the pulse-width modulation strategy and the grid current control, using a suitable combination of fundamental theory, computer-aided modelling and simulations, and laboratory experiments. A discontinuous space-vector modulation algorithm is implemented for a three-level STATCOM. Space-vector theory is used to analyse the effect of switching sequence arrangement on the switching ripple current. It is revealed that the sequences should be arranged according to a specific method to maintain sinusoidal grid currents when an LCL grid interface filter is used. Furthermore, the output voltage distortion caused by the blanking times and the semiconductor voltage losses is studied and a compensation algorithm is developed. After that, two grid current control strategies are analysed by means of dynamic modelling and simulations. The main problems observed are poor capability to reject low-order grid voltage harmonics and the sensitivity to parametric uncertainties. The presented theoretical considerations are validated with laboratory tests of a 10 kVA three-wire three-level STATCOM prototype.

Differentiation of multiple maximum power points of partially shaded photovoltaic power generators

Partial shading conditions have a major effect on the electrical characteristics of photovoltaic (PV) power generators. In this paper, the effects of partial shading on maximum power points (MPPs) of a PV power generator have been systematically studied by using Simulink simulation model of a PV power generator composed of 18 series-connected PV modules. It is shown that the local MPPs can be classified into MPPs at low and high voltages based on the MPP
operating point of the PV generator. The results also show that based on the MPP current and voltage it is possible to
directly know if the MPP at high voltages is a local or a global MPP. The differentiation between local and global MPPs at
high voltages is based on the voltage difference between the actual MPP voltage at high voltages and the theoretical MPP
voltage under corresponding uniform conditions. This differentiation method was also tested to work correctly by utilizing
experimental measurements of the Tampere University of Technology Solar PV Power Station Research Plant. By using
this method, it can be identified if the system is operating at a local or a global MPP. This method can further be utilized to
develop global MPP tracking algorithms. (C) 2014 Elsevier Ltd. All rights reserved.

General information
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Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES)
Authors: Mäki, A., Valkealahti, S.
Number of pages: 11
Pages: 89-99
Publication date: Nov 2014
Peer-reviewed: Yes

Publication information
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Scopus rating (2015): SJR 1.845 SNIP 2.118 CiteScore 4.51
Scopus rating (2014): SJR 1.983 SNIP 2.687 CiteScore 4.51
Scopus rating (2013): SJR 2.066 SNIP 2.767 CiteScore 4.63
Scopus rating (2012): SJR 1.852 SNIP 2.745 CiteScore 3.97
Scopus rating (2011): SJR 1.688 SNIP 2.404 CiteScore 3.9
Scopus rating (2010): SJR 1.494 SNIP 2.215
Scopus rating (2009): SJR 1.305 SNIP 1.945
Scopus rating (2008): SJR 1.449 SNIP 1.867
Scopus rating (2007): SJR 1.214 SNIP 1.65
Scopus rating (2006): SJR 1.137 SNIP 1.486
Scopus rating (2005): SJR 1.215 SNIP 1.26
Scopus rating (2004): SJR 0.76 SNIP 1.154
Scopus rating (2003): SJR 0.965 SNIP 0.948
Scopus rating (2002): SJR 0.473 SNIP 0.539
Scopus rating (2001): SJR 0.554 SNIP 0.449
Scopus rating (2000): SJR 0.466 SNIP 0.697
Scopus rating (1999): SJR 0.264 SNIP 0.627
Original language: English
Keywords: Global maximum power point, Maximum power point, Maximum power point tracking, Partial shading,
Photovoltaic power generator, CURRENT-VOLTAGE CHARACTERISTICS, PARTIAL SHADING CONDITIONS, SOLAR-
CELLS, THERMAL-MODEL, PV MODULE, ARRAYS, SIMULATION, TRACKING, SYSTEMS, MISMATCH
DOIs:
10.1016/j.renene.2014.05.018

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Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2014-06-17<br/>Publisher name: Pergamon
Source: researchoutputwizard
Source-ID: 1000
Research output: Scientific - peer-review › Article

Modeling and Analysis of the Operation of PV Power Generators Under Varying Atmospheric Conditions
Photovoltaic (PV) technology permits us to harness and transform solar radiation into electricity. However, PV power
generators are still a minor share in the global power generation capacity. One of the main reasons for it is that PV
systems are greatly dependent on the atmospheric conditions affecting their operation. Furthermore, series connection
of PV cells is prone to power losses when the electrical characteristics of the cells are dissimilar or the cells operate under
non-uniform operating conditions. Especially during changing atmospheric conditions, the operation and control of PV
generators is complicated and there is a demand for improvement since today's inverters do not reach their best
performance. In this thesis, a state of the art inclusive thermal and electric simulation model of PV generators is proposed
and validated with data measured at the Tampere University of Technology (TUT) solar PV power station research plant. The dynamic thermal and electric behaviors of the PV modules are first modelled separately theoretically based on previous authors’ work. Subsequently, these models are further improved by analyzing module temperature measurements and the electric behavior of the PV modules operating under varying meteorological conditions. All the relevant climatic and site specific parameters, heat transfer mechanisms and parasitic resistive effects are considered without major simplifications to obtain the highest possible accuracy. Finally, the separate thermal and electric models are integrated and the result is a comprehensive simulation model that predicts the thermal and electric performance of PV generators operating under varying atmospheric conditions. This simulation model is intended, among other things, to assist in the inverter design and development of maximum power point (MPP) tracking algorithms, especially to improve their efficiency and operation under non-ideal and fast changing environmental conditions. Partial shading affects the electrical characteristics of PV generators, causing them to operate away from their MPP and thus complicating the task to reach the maximum power production. This task is normally carried out by the power electronic converters interfacing the PV generators. Furthermore, partial shading conditions generally cause mismatch losses too. In this thesis, a method to generate a spatial irradiance map from a set of irradiance measurements is proposed and utilized to analyze the effect of moving clouds on the mismatch losses on several PV generator configurations and layouts. The mismatch losses are studied for several sizes of generators in which both series and parallel connection of PV modules are considered. The results indicate that the mismatch power losses caused by non-uniform operating conditions due to moving clouds can be reduced by locating PV modules of the generator as close to each other as possible. Furthermore, parallel connection of PV modules should be favored with respect to series connection.

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Organisations: Department of Electrical Engineering
Authors: Torres Lobera, D.
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Awarding institution: Tampere University of Technology
Source: researchoutputwizard
Source-ID: 1640
Research output: Monograph › Doctoral Thesis

Development and Evaluation of Accelerated Environmental Test Methods for Products with High Reliability Requirements
Reliability testing of electronics is performed to ensure that products function as planned in specific conditions for a specified amount of time. This is usually both time-consuming and expensive and therefore test time acceleration is often required. The acceleration may be realized by using more severe stress levels or higher use cycle frequencies, but at the same time the risk increases of inducing failure mechanisms not relevant to the use conditions. As a consequence, the accelerated reliability testing of products with markedly long lifetimes and high reliability is frequently challenging. In this thesis different methods for test time acceleration for products with high reliability requirements and long service lives were studied. Both standard tests and modifications of these were used. The effect of the accelerated tests used on the failure modes and mechanisms observed was examined and the limitations of the test methods discussed. The research in this work was conducted at both interconnection level and at device level. The interconnection level testing focused on anisotropically conductive adhesive (ACA) flex-on-board (FOB) attachments. In addition to the effect of the curing process on the mechanical strength of ACA FOB attachments, their applicability and long-term performance in industrial applications was studied. According to the real-time resistance measurement the assembly tested was observed to be extremely resilient in thermal cycling and hygrothermal aging. However, a significant decrease in the mechanical strength of the FOB attachment was also seen. Hydrolysis and embrittleness of the flex material was also observed to limit the
applicability of harsher hygrothermal aging conditions. Clear ACA joint failures were only observed with moisture condensation testing, but this may not be a suitable test method for applications that are not susceptible to such a stressor. The device level testing comprised reliability analysis of two frequency converter models. The older generation device and its field failure data were used as the starting point in the development of a test method that could be used to minimize testing time and to induce comparable failure modes to those occurring in the use conditions of the devices. The tests showed that only with the simultaneous use of stresses could a significant reduction in the testing time be achieved. However, the application of the same test method to the newer generation device proved challenging because of differences in materials, components and layouts. Although similar failure modes were observed in both devices, the combined effect of the stresses used on the failure mechanisms requires further study. In addition, knowledge of the service conditions, the environmental stresses and their severity is critical. The main disadvantage of simultaneous stress testing was observed to be the interpretation of the test results, especially due to the complexity of the devices tested. Moreover, the results obtained may be highly application specific. However, regardless of the difficulties in the lifetime estimation, the use of combined stresses was observed to be a practical method to study the weaknesses in a product.

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Organisations: Department of Electrical Engineering
Authors: Kiilunen, J.
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Bibliographical note
Awarding institution:Tampere University of Technology
Source: researchoutputwizard
Source-ID: 719
Research output: Collection of articles › Doctoral Thesis

Factors Affecting Stable Operation of Grid-Connected Three-Phase Photovoltaic Inverters
The amount of grid-connected photovoltaic energy generation has grown enormously since the beginning of the 21st century. Photovoltaic power plants are interfaced with the utility grid by using three or single-phase inverters which convert the direct current generated by the photovoltaic modules into three or single-phase alternating current. The photovoltaic inverters have been observed to degrade power quality in the grid and to suffer from reliability problems related to their control software. Therefore, the design of these inverters has become a significant research topic in academia and in the power electronic industry. Control design of a photovoltaic inverter is often based on the small-signal models characterizing its dynamic behavior. In this thesis, the existing small-signal models are upgraded to include the effect of an upstream DC-DC converter and its control mode. In addition, the models are upgraded to include the effect of a phase-locked-loop which is often used as a synchronization method and the effect of the grid-voltage feedforward which is often used to improve the transient performance. The control mode of the upstream DC-DC converter and its control mode. In addition, the models are upgraded to include the effect of a phase-locked-loop which is often used as a synchronization method and the effect of the grid-voltage feedforward which is often used to improve the transient performance. The control mode of the upstream DC-DC converter is shown to have a significant effect on the minimum DC-link capacitance which is required for stable operation due to a RHP-pole in the inverter control dynamics. However, operating the DC-DC converter under input-voltage control is shown to remove the RHP-pole and, consequently, the constraint imposed on the size of the minimum DC-link capacitance. The phase-locked-loop (PLL) is shown to make the q-component of the inverter’s output impedance resemble a negative resistor. Based on the small-signal models, the negative resistance is shown to appear at the frequencies below the crossover frequency of the PLL. Therefore, a wide-bandwidth PLL causes easily instability due to the negative-resistance behavior when the grid inductance is large. The grid-voltage feedforward is shown to increase the magnitude of both the d and q-components of the inverter’s output impedance. The PV inverter with grid-voltage feedforward is shown to be more resistant against impedance-based interactions than an inverter without the feedforward.
Searching for Frontiers in Contemporary Eddy Current Model Based Hysteresis Loss Modelling of Superconductors

Alternating current (AC) or magnetic field leads to heat generation in otherwise lossless superconducting materials. Such heat generation is called AC loss. AC loss of special type that occurs in the superconducting material itself, and not in the normal-conducting parts of the superconducting wire is called hysteresis loss. Hysteresis loss is a restricting factor for the feasibility of many superconducting applications, and hence, having reliable and efficient models for predicting hysteresis losses in devices is crucial for the design process. In this thesis, we first introduce the readers to the mathematical structures that are essential for simulating AC losses. The level of abstraction deviates from what is typical in this field, but it allows us to present the models and formulations we use in a structured manner and naturally program simulation tools, which are independent of the dimension of the modelling domain. We also discuss the background of the research by presenting important aspects of our research philosophy and the framework inside which the research in this field is conducted. Then, we briefly present two formulations implemented in our AC loss simulation tool, the so called H-formulation and the so called T-Phi-Psi-formulation, and compare their properties through simulations. The latter of the formulations exploits the topology of the modelling domain to reduce the number of required equations, and it is superior to the former in terms of running times of the simulations. Furthermore, we discuss the properties of two widely used models, the critical state model and the eddy current model, through particular case studies of superconductors under direct current bias and an alternating magnetic field. Neither one of the models is fully able to reflect the intrinsic properties of high-temperature superconductors. Finally, the possibilities of our simulation tool are investigated: we study the potential of the tool in question to yield predictions of multifilamentary twisted superconductors with partially coupled filaments in external magnetic field in two dimensions. We present a simple algorithm for this, and the obtained simulation results show good agreement with results of three-dimensional simulations.
Design of boost-power-stage converter for PV generator interfacing
This paper investigates the benefits which can be obtained if the maximum output current of a photovoltaic (PV) generator is taken into account in the design of a boost-power-stage converter. The investigations clearly show that the benefits are smaller inductor core size and more uniform temperature distribution among the power electronic components compared to the conventional design method. It will also be shown how to make the design with small input capacitor and how to take the power decoupling into account in the design process.

Physical insight into the factors affecting the load-transient response of a buck converter
This paper investigates the physical issues affecting the load transient response both from the power-stage-component-selection and control-design point of views. A conventional buck converter under three different control schemes - direct-duty-ratio control, peak-current control and peak-current-control with load-current-frontend control - is used as an example. The outcomes of the investigation are validated by simulations and experimental tests.
This paper presents an integrated thermal and electric simulation model for the operation of photovoltaic (PV) modules and strings. The dynamic thermal model is based on the total energy balance in the module in which all essential heat transfer mechanisms between the module and the environment are modeled theoretically. The electric model is based on the well-known one-diode model and a method is introduced to derive the unknown parameters from the manufacturer's information datasheet. The complete model has been implemented in Matlab Simulink software for a PV module and a PV string of six series-connected modules and validated using environmental and electric measurements of the TUT solar PV power station research plant during 20 days of the summer and autumn in 2013. The input parameters used by the integrated simulation model are the received solar radiation on the tilted plane of the PV modules, the global and diffuse solar radiations received on the horizontal plane, the wind speed and direction and the ambient temperature. The accuracy of the predicted module temperatures and the complete power voltage (P-V) curves has been evaluated by means of the root mean square error (RMSET) and the normalized root mean square error (NRMSEP), respectively. The results show a good agreement between the predicted and measured module temperatures and P V curves. The average RMSET and NRMSEP values during the measurement period were 1.34 degrees C and 1.98%, respectively. (C) 2014 Elsevier Ltd. All rights reserved.
Active Voltage Control in Distribution Networks Including Distributed Energy Resources

The structure and control methods of existing distribution networks are planned assuming unidirectional power flows. The amount of generation connected to distribution networks is, however, constantly increasing which changes the operational and planning principles of distribution networks radically. Distributed generation (DG) affects power flows and fault currents in the distribution network and its effect on network operation can be positive or negative depending on the size, type, location and time variation of the generator. In weak distribution networks, voltage rise is usually the factor that limits the network’s hosting capacity for DG. At present, voltage rise is usually mitigated either by increasing the conductor size or by connecting the generator to a dedicated feeder. These passive approaches maintain the current network operational principles but can lead to high DG connection costs. The voltage rise can be mitigated also using active voltage control methods that change the operational principles of the network radically but can, in many cases, lead to significantly smaller total costs of the distribution network than the passive approach. The active voltage control methods can utilize active resources such as DG in their control and also the control principles of existing voltage control equipment such as the main transformer tap changer can be altered. Although active voltage control can often decrease the distribution network total costs and its effect on voltage quality can also be positive, the number of real distribution network implementations is still very low and the distribution network operators (DNOs) do not consider active voltage control as a real option in distribution network planning. Some work is, hence, still needed to enable widespread utilization of active voltage control. This thesis aims at overcoming some of the barriers that are, at present, preventing active voltage control from becoming business as usual for the DNOs. In this thesis, active voltage control methods that can be easily implemented to real distribution networks are developed. The developed methods are, at first, tested using time domain simulations. Operation of one coordinated voltage control (CVC) method is tested also using real time simulations and finally a real distribution network demonstration is conducted. The conducted simulations and demonstrations verify that the developed voltage control methods can be implemented relatively easily and that they are able to keep all network voltages between acceptable limits as long as an adequate amount of controllable resources is available. The developed methods control the substation voltage based on voltages in the whole distribution network and also reactive and real powers of distributed energy resources (DERs) are utilized in some of the developed CVC methods. All types of DERs capable of reactive or real power control can be utilized in the control. The distribution network planning tools and procedures currently are not capable of taking active voltage control into account. DG interconnection planning is based only on two extreme loading conditions (maximum generation/minimum load and minimum generation/maximum load) and network effects and costs of alternative voltage control methods cannot be compared. In this thesis, the distribution network planning procedure is developed to enable comparison of different voltage control strategies. The statistical distribution network planning method is introduced and its usage is demonstrated in example cases. In statistical distribution network planning, load flow is calculated for every hour of the year using statistical-based hourly load and production curves. When the outputs of hourly load flows (e.g. annual losses, transmission charges and curtailed generation) are combined with investment costs the total costs of alternative voltage control strategies can be compared and the most cost-effective approach can be selected. The example calculations show that the most suitable voltage control strategy varies depending on the network and DG characteristics. The studies of this thesis aim at making the introduction of active voltage control as easy as possible to the DNOs. The developed CVC methods are such that they can be implemented as a part of the existing distribution management systems and they can utilize the already existing data transfer infrastructure of SCADA. The developed planning procedure can be implemented as a part of the existing network information systems. Hence, the currently used network planning and operational tools do not need to be replaced but only enhanced.
A Novel Anti-islanding Protection Method Based on the Combination of a Q-f Droop and RPV
Assessment of Some Methods for Short-Term Load Forecasting

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State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering
Authors: Koponen, P., Mutanen, A., Niska, H.
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Research output: Scientific - peer-review › Conference contribution

Comparison of the Low Voltage Distribution Network Voltage Control Schemes

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Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Tuominen, J., Repo, S., Kulmala, A.
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Links: http://www.ieee-isgt-eu.org/

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Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2014-12-30
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Source-ID: 1652
Research output: Scientific - peer-review › Conference contribution

Control Strategies of Network Connected Electricity Storage Elements - Case Simulations

General information
State: Published
Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Electrical Engineering


Authors: Supponen, A., Repo, S.
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Pages: 1-10
Publication date: 2014

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Research output: Scientific › Conference contribution

Coordinated Voltage Control Algorithms Tested in Real Time Digital Simulator

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Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Tuominen, J., Repo, S., Kulmala, A.
Number of pages: 7
Pages: 1-7
Publication date: 2014

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Links:

Bibliographical note
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Research output: Scientific - peer-review › Conference contribution

Coordinated Voltage Control in Distribution Networks Including Several Distributed Energy Resources

General information
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Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Kulmala, A.,Repo, S.,Järventausta, P.
Number of pages: 11
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Journal: IEEE Transactions on Smart Grids
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Scopus rating (2014): SJR 3.105 SNIP 3.799 CiteScore 7.77
Scopus rating (2013): SJR 3.175 SNIP 4.831 CiteScore 9.88
Demand Response in Finland - Potential Obstacles in Practical Implementation

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Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Electrical Engineering
Authors: Honkapuro, S., Tuunanen, J., Valtonen, P., Partanen, J., Järventausta, P., Harsia, P.
Number of pages: 8
Pages: 1-8
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Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2014-11-30<br/>Publisher name: Institute of Electrical and Electronics Engineers IEEE
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Research output: Scientific › Conference contribution

Design of a Control Scheme for Distribution Static Synchronous Compensators with Power-Quality Improvement Capability

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Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Roncero-Sanchez, P., Acha, E.
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Scopus rating (2016): CiteScore 2.5 SJR 0.691 SNIP 1.053
Scopus rating (2015): SJR 0.804 SNIP 1.416 CiteScore 2.87
Scopus rating (2014): SJR 0.87 SNIP 1.601 CiteScore 2.66
Scopus rating (2013): SJR 0.632 SNIP 1.345 CiteScore 2.29
Scopus rating (2012): SJR 0.874 SNIP 1.54 CiteScore 2.46
Scopus rating (2011): SJR 0.659 SNIP 1.439 CiteScore 2.24
Developing Situation Awareness in Major Disturbances of Electricity Supply

General information
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Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Krohns-Välimäki, H., Aalto, H., Pykkänen, K., Strand, J., Verho, P., Sarsama, J.
Number of pages: 6
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Research output: Scientific - peer-review › Conference contribution

Dynamic Characterization of Power Electronic Interfaces

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Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Suntio, T., Viinamäki, J., Jokipii, J., Messo, T., Kuperman, A.
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Scopus rating (2014): SJR 0.879 SNIP 2.375
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Effect of conventional grid-voltage feedforward on the output impedance of a three-phase photovoltaic inverter

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Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Messo, T., Jokipii, J., Suntio, T.
Number of pages: 8
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Publisher: Institute of Electrical and Electronics Engineers IEEE
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DOIs: 10.1109/IPEC.2014.6869632

Effect of input and output terminal sources on dynamic behavior of switched-mode converters

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Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Suntio, T., Viinamäki, J., Jokipii, J., Messo, T., Sitbon, M., Kuperman, A.
Number of pages: 7
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Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
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Effect of network configuration and load profile on efficiency of LVDC distribution network

General information
State: Published
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Effects of demand response on load profiling of small-scale customers

General information
State: Published
Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Electrical Engineering
Authors: Grip, K., Mutanen, A., Järventausta, P.
Number of pages: 8
Pages: 1-8
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Bibliographical note
Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2014-11-30
Source: researchoutputwizard
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Research output: Scientific › Conference contribution

Efficiency of Converters and Amorphous Core AC-Filters in an LVDC Distribution

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State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Rekola, J., Tuusa, H.
Number of pages: 8
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Publication date: 2014

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Electricity Distribution Pricing Methodology In Finnish Regulation Framework - A Case Study of Matching Principle

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Organisations: Department of Electrical Engineering
Authors: Lummi, K., Mäkinen, A., Mutanen, A., Järventausta, P.
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Bibliographical note
Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2014-11-30
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Research output: Scientific › Conference contribution

Frequency Domain Methods for Transmission Network Planning to Assess Subsynchronous Torsional Interaction due to High Voltage Direct Current Transmission System

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Ministry of Education publication type: G5 Doctoral dissertation (article)
Organisations: Department of Electrical Engineering
Authors: Rauhala, T.
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Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2014-11-30
Source: researchoutputwizard
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Research output: Collection of articles › Doctoral Thesis

Holistic View of Active Distribution Network and Evolution of Distribution Automation

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State: Published
Impact Evaluation of PV Generation on LV Networks

General information
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Authors: Supponen, A., Repo, S.
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Publication date: 2014

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Research output: Scientific - peer-review › Conference contribution

Influence of humidity and temperature on the dielectric properties of thermally sprayed ceramic MgAl2O4 coatings

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Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Niittymäki, M., Lahti, K., Suhonen, T., Kanerva, U., Metsäjoki, J.
Number of pages: 4
Pages: 94-97
Publication date: 2014

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Publisher: Institute of Electrical and Electronics Engineers IEEE
ISBN (Print): 978-1-4799-7523-5

Bibliographical note
Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2014-12-07
Source: researchoutputwizard
Source-ID: 778
Research output: Scientific - peer-review › Conference contribution
Influence of Low Amounts of Nanostructured Silica and Calcium Carbonate Fillers on the Large-Area Dielectric Breakdown Performance of Bi-axially Oriented Polypropylene

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Rytöluoto, I., Lahti, K., Karttunen, M., Koponen, M., Virtanen, S., Pettersson, M.
Number of pages: 4
Pages: 655-658
Publication date: 2014

Host publication information
Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
ISBN (Print): 978-1-4799-7523-5
DOIs:
10.1109/CEIDP.2014.6995848

Influence of Major Disturbances in Electricity Supply on the Operating Environment of Distribution System Operators: a Case Study

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Stranden, J., Krohns-Välimäki, H., Verho, P., Sarsama, J., Hälvä, V.
Number of pages: 10
Pages: 363-372
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: International Review of Electrical Engineering: IREE
Volume: 9
Issue number: 2
ISSN (Print): 1827-6660
Ratings:
Scopus rating (2016): SJR 0.556 SNIP 0.556 CiteScore 0.97
Scopus rating (2015): SJR 0.384 SNIP 0.387 CiteScore 0.59
Scopus rating (2014): SJR 0.469 SNIP 0.503 CiteScore 0.68
Scopus rating (2013): SJR 0.373 SNIP 0.711 CiteScore 0.93
Scopus rating (2012): SJR 0.32 SNIP 0.529 CiteScore 1.49
Scopus rating (2011): SJR 0.306 SNIP 0.975 CiteScore 2.07
Scopus rating (2010): SJR 0.261 SNIP 0.269
Load Control System of an EV Charging Station Group

General information
State: Published
Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Electrical Engineering
Authors: Rautiainen, A., Järventausta, P.
Number of pages: 11
Pages: 1-11
Publication date: 2014

Host publication information
Title of host publication: NORDAC 2014, The 11th Nordic Electricity Distribution and Management Conference, 8-9 September 2014, Stockholm, Sweden

Publication series
Name: Elforsk rapport 14:32

Bibliographical note
Contribution: organisation=dee,FACT1=1Portfolio EDEND: 2014-11-30
Source: researchoutputwizard
Source-ID: 1365
Research output: Scientific Conference contribution

Losses of Converters with Iron and Amorphous Core AC-Filter Inductors in an LVDC Distribution

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES)
Authors: Rekola, J., Jokipii, J., Suntio, T.
Number of pages: 7
Pages: 1-7
Publication date: 2014

Host publication information
Title of host publication: 40th Annual Conference of the IEEE Industrial Electronics Society, October 29 - November 1, 2014, Dallas, TX, USA
Publisher: Institute of Electrical and Electronics Engineers IEEE
ISBN (Print): 9781479940325
DOIs: 10.1109/IECON.2014.7048714

Bibliographical note
Siirretään Portfolio15Contribution: organisation=dee,FACT1=1Portfolio EDEND: 2014-12-30
Source: researchoutputwizard
Source-ID: 1371
Research output: Scientific peer-review Conference contribution

Modeling Rotation in Electrical Machines

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering
Net environmental impacts of low-share wood pellet co-combustion in an existing coal-fired CHP (combined heat and power) production in Helsinki, Finland

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Automation Science and Engineering
Authors: Judl, J., Koskela, S., Korpela, T., Karvosenoja, N., Häyrinen, A., Rantsi, J.
Number of pages: 8
Pages: 844-851
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Energy
Volume: 77
ISSN (Print): 0360-5442
Ratings:
Scopus rating (2016): SJR 1.999 SNIP 1.798 CiteScore 5.17
Observers and splitting structures in relativistic electrodynamics

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering
Authors: Auchmann, B., Kurz, S.
Number of pages: 72
Pages: 1-72
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of Physics A: Mathematical and Theoretical
Volume: 47
Issue number: 43
ISSN (Print): 1751-8113
Ratings:
Scopus rating (2016): CiteScore 1.45 SJR 0.879 SNIP 0.868
Scopus rating (2015): SJR 0.921 SNIP 0.963 CiteScore 1.34
Scopus rating (2014): SJR 0.92 SNIP 0.918 CiteScore 1.36
Scopus rating (2013): SJR 0.926 SNIP 1.002 CiteScore 1.42
Scopus rating (2012): SJR 1.016 SNIP 1.05 CiteScore 1.49
Scopus rating (2011): SJR 0.934 SNIP 0.946 CiteScore 1.41
Scopus rating (2010): SJR 1.056 SNIP 1.037
Scopus rating (2009): SJR 1.075 SNIP 1.001
Scopus rating (2008): SJR 1.136 SNIP 1.071
Scopus rating (2007): SJR 1.151 SNIP 1.152
Scopus rating (2006): SJR 0.97 SNIP 1.038
Scopus rating (2005): SJR 0.996 SNIP 0.981
Scopus rating (2004): SJR 0.98 SNIP 0.939
Optimizing the accuracy of electrical models of PV systems operating under non-ideal conditions

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Torres-Lobera, D., Valkealahti, S.
Number of pages: 8
Pages: 1-8
Publication date: 2014

Host publication information
Title of host publication: EPE 14-ECCE Europe, the 16th European Conference on Power Electronics and Applications, 26-28 August 2014, Lappeenranta, Finland
Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
DOIs:
10.1109/EPE.2014.6910873

Possibilities to protect pole-mounted distribution transformers by means of externally gapped MO arresters

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Research area: Power engineering, Smart Energy Systems (SES)
Authors: Lahti, K., da Silva, D.
Number of pages: 4
Pages: 1-4
Publication date: 2014

Host publication information
Title of host publication: 2014 International Conference on High Voltage Engineering and Application, ICHVE 2014, September 8-11, 2014, Poznan, Poland
Publisher: IEEE
ISBN (Print): 978-1-4799-6613-4

Publication series
Name: International Conference on High Voltage Engineering and Application
DOIs:
Power hardware in-the-loop laboratory test environment for small scale wind turbine prototype

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Mäkinen, A., Messo, T., Tuusa, H.
Number of pages: 10
Pages: 1-10
Publication date: 2014

Host publication information
Title of host publication: EPE 14-ECCE Europe, the 16th European Conference on Power Electronics and Applications, 26-28 August 2014, Lappeenranta, Finland
Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
DOI: 10.1109/EPE.2014.6910804

Protection Heater Delay Time Optimization for High-Field Nb3Sn Accelerator Magnets

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering
Authors: Salmi, T., Ambrosio, G., Caspi, S., Chlachidze, G., Felice, H., Marchevsky, M., Prestemon, S., ten Kate, H.
Number of pages: 5
Pages: 1-5
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: IEEE Transactions on Applied Superconductivity
Volume: 24
Issue number: 3
ISSN (Print): 1051-8223
Ratings:
Scopus rating (2016): CiteScore 1.42 SJR 0.395 SNIP 1.031
Scopus rating (2015): SJR 0.35 SNIP 0.935 CiteScore 1.27
Scopus rating (2014): SJR 0.47 SNIP 1.113 CiteScore 0.83
Scopus rating (2013): SJR 0.431 SNIP 1.171 CiteScore 1.32
Scopus rating (2012): SJR 0.575 SNIP 1.27 CiteScore 1.11
Scopus rating (2011): SJR 0.364 SNIP 1.063 CiteScore 1.16
Scopus rating (2010): SJR 0.468 SNIP 1.073
Scopus rating (2009): SJR 0.452 SNIP 1.033
Scopus rating (2008): SJR 0.878 SNIP 0.987
Scopus rating (2007): SJR 0.611 SNIP 1.104
Recognition of irradiance transitions caused by moving clouds harmful to the operation of PV systems

**General information**
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering
Authors: Lappalainen, K., Valkealahti, S.
Number of pages: 4
Pages: 2650-2653
Publication date: 2014

**Host publication information**
Place of publication: Munich, Germany
Publisher: WIP
Editors: Bokhoven, T., Jäger-Waldau, A., Helm, P.
ISBN (Print): 3-936338-34-5
DOIs: 10.4229/EUPVSEC20142014-5BV.1.23
Links: http://www.eupvsec-proceedings.com/

**Bibliographical note**
Contribution: organisation=dee,FACT1=1
Portfolio EDEND: 2014-12-15
Source: researchoutputwizard
Source-ID: 889
Research output: Scientific - peer-review › Conference contribution

Reliability analysis of an ACA attached flex-on-board assembly for industrial application

**General information**
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering
Authors: Kiilunen, J., Frisk, L.
Number of pages: 9
Pages: 62-70
Publication date: 2014
Peer-reviewed: Yes

**Publication information**
Journal: Soldering and Surface Mount Technology
Ripple field losses in direct current biased superconductors: Simulations and comparison with measurements

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering
Authors: Lahtinen, V., Pardo, E., Souc, J., Solovyov, M., Stenvall, A.
Number of pages: 15
Pages: 1-15
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of Applied Physics
Volume: 115
Issue number: 11
ISSN (Print): 0021-8979
Ratings:
Scopus rating (2016): CiteScore 1.72 SJR 0.632 SNIP 0.815
Scopus rating (2015): SJR 0.618 SNIP 0.84 CiteScore 1.57
Scopus rating (2014): SJR 1.005 SNIP 1.18 CiteScore 2.04
Scopus rating (2013): SJR 1.165 SNIP 1.317 CiteScore 2.24
Scopus rating (2012): SJR 1.305 SNIP 1.294 CiteScore 2.13
Scopus rating (2011): SJR 1.373 SNIP 1.318 CiteScore 2.24
Scopus rating (2010): SJR 1.47 SNIP 1.195
Scopus rating (2009): SJR 1.518 SNIP 1.238
Secure integration of the Home Energy Management System to the battery management system in the customer domain of the smart grid

**General information**
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Department of Automation Science and Engineering, Smart Energy Systems (SES)
Authors: Jafary, P.; Repo, S.; Koivisto, H.
Number of pages: 5
Pages: 1-5
Publication date: 2014

**Host publication information**
Title of host publication: IEEE Power & Energy Society General Meeting, 27-31 July, 2014, National Harbor, MD, United States
Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
DOIs: 10.1109/PESGM.2014.6938986

**Bibliographical note**
Contribution: organisation=dee,FACT1=0.7
Contribution: organisation=ase,FACT2=0.3
Portfolio EDEND: 2014-11-30
Source: researchoutputwizard
Source-ID: 567
Research output: Scientific - peer-review & Conference contribution

Shear Strength of Eutectic Sn-Bi Lead-Free Solders After Corrosion Testing and Thermal Aging

**General information**
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering
Authors: Mostofizadeh, M.; Pippola, J.; Frisk, L.
Number of pages: 12
Pages: 1335-1346
Publication date: 2014
Peer-reviewed: Yes
Simple method for measuring output impedance of a three-phase inverter in dq-domain

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Jokipii, J., Messo, T., Suntio, T.
Number of pages: 5
Pages: 1466-1470
Publication date: 2014

Host publication information
Title of host publication: International Power Electronics Conference, ECCE ASIA, IPEC-Hiroshima, May 18-21, 2014, Hiroshima, Japan
Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
ISBN (Print): 978-1-4799-2705-0
DOIs: 10.1109/IPEC.2014.6869778

Bibliographical note
Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2014-11-30<br/>Publisher name: Springer New York
Source: researchoutputwizard
Source-ID: 1107
Research output: Scientific - peer-review › Article
Sizing energy storage to be used in parallel with grid connected PV inverters to balance the output power fluctuations due to varying insolation.
Time and frequency-domain evidence on power quality issues caused by grid-connected three-phase photovoltaic inverters

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Messo, T., Jokipii, J., Aapro, A., Suntio, T.
Number of pages: 9
Pages: 1-9
Publication date: 2014

Host publication information
Title of host publication: EPE 14-ECCE Europe, the 16th European Conference on Power Electronics and Applications, 26-28 August 2014, Lappeenranta, Finland
Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
DOIs:
Validation of an Inclusive Dynamic-Thermal and Electric Simulation Model for PV Systems with Measurements from a Commercial Grid-Connected PV Inverter

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering
Authors: Torres-Lobera, D., Valkealahti, S.
Number of pages: 5
Pages: 2794-2798
Publication date: 2014

Host publication information
Place of publication: Munich, Germany
Publisher: WIP
Editors: Bokhoven, T., Jäger-Waldau, A., Helm, P.
ISBN (Print): 3-936338-34-5
DOIs: 10.4229/EUPVSEC20142014-5BV.2.2
Links: http://www.eupvsec-proceedings.com/

MO Surge Arresters Stresses and Test Procedures: CIGRE Technical Broshure, WG A3.17

General information
State: Published
Ministry of Education publication type: D4 Published development or research report or study
Organisations: Department of Electrical Engineering, Research area: Power engineering
Number of pages: 146
Publication date: Aug 2013

Publication information
Publisher: International Council on Large Electric Systems CIGRE
Volume: 544
Original language: English
Research output: Professional › Commissioned report

A comparision of measures to reduce the intensity of magnetic field outside high voltage power substations

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electronics and Communications Engineering
Authors: Okun, O., Shevchenko, S., Korpinen, L.
Number of pages: 5
An Advanced STATCOM Model for Optimal Power Flows Using Newton's Method

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Kazemtabrizi, B., Acha, E.
Number of pages: 12
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: IEEE Transactions on Power Systems
ISSN (Print): 0885-8950
Ratings:
Scopus rating (2016): SJR 3.757 SNIP 3.624 CiteScore 8.17
Scopus rating (2015): SJR 3.602 SNIP 3.486 CiteScore 6.6
Scopus rating (2014): SJR 2.831 SNIP 3.577 CiteScore 5.31
Scopus rating (2013): SJR 2.939 SNIP 4.35 CiteScore 6.33
Scopus rating (2012): SJR 2.177 SNIP 3.516 CiteScore 5.84
Scopus rating (2011): SJR 1.725 SNIP 3.254 CiteScore 5.34
Scopus rating (2010): SJR 1.949 SNIP 2.826
Scopus rating (2009): SJR 1.94 SNIP 2.723
Scopus rating (2008): SJR 1.537 SNIP 2.448
Scopus rating (2007): SJR 1.242 SNIP 2.521
Scopus rating (2006): SJR 1.233 SNIP 2.316
Scopus rating (2005): SJR 1.582 SNIP 2.547
Scopus rating (2004): SJR 1.036 SNIP 2.843
Scopus rating (2003): SJR 2.669 SNIP 2.652
Scopus rating (2002): SJR 2.271 SNIP 2.337
Scopus rating (2001): SJR 1.708 SNIP 1.837
Scopus rating (2000): SJR 1.169 SNIP 3.37
Scopus rating (1999): SJR 0.418 SNIP 1.408
Original language: English
DOI:
10.1109/TPWRS.2013.2287914

Bibliographical note
Contribution: organisation=dee,FACT1=1<br/>Portfolio EDEND: 2013-11-29<br/>Publisher name: Institute of Electrical and Electronics Engineers IEEE
Source: researchoutputwizard
Source-ID: 2537
Research output: Scientific - peer-review › Article
A Theoretical Investigation of the Influence of Underground Power Cable Parameters on Magnetic Field Levels

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electronics and Communications Engineering
Authors: Rostovskiy, I., Okun, O., Shevchenko, S., Korpinen, L.
Number of pages: 4
Pages: 1105-1108
Publication date: 2013

Host publication information
Title of host publication: PIERS Proceedings, August 12-15, Stockholm, 2013
Links:
http://piers.org/piersproceedings/download.php?file=cGlIcnMyMDEzU3Rv2tob2xtfDJQX0tfMTEwNS5wZGZ8MTMwMzE5MDc1NDA0

Bibliographical note
Contribution: organisation=elt,FACT1=1<br/>Portfolio EDEND: 2013-09-29
Source: researchoutputwizard
Source-ID: 3291
Research output: Scientific - peer-review › Conference contribution

Examples of spark discharge under a 400 kV power line

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electronics and Communications Engineering
Authors: Korpinen, L., Pääkkönen, R., Tarao, H., Kuisti, H.
Number of pages: 4
Pages: 113-116
Publication date: 2013

Host publication information
Title of host publication: 18th International Symposium on High Voltage Engineering, ISH 2013, in Hanyang University in Seoul, Republic of Korea from August 25 to 30, 2013
Article number: PA-12

Publication series
Name: International Symposium on High Voltage Engineering

Bibliographical note
Contribution: organisation=elt,FACT1=1<br/>Portfolio EDEND: 2013-09-29
Source: researchoutputwizard
Source-ID: 2621
Research output: Scientific - peer-review › Conference contribution

Examples of UV Measurements under 400 kV Powerlines in Finland

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electronics and Communications Engineering
Authors: Pääkkönen, R., Korpinen, L., Gobba, F.
Number of pages: 4
Pages: 1640 - 1643
Publication date: 2013

Host publication information

Publication series
Input voltage control of a three-phase Z-source inverter in photovoltaic applications

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Jokipii, J., Messo, T., Suntio, T.
Number of pages: 8
Pages: 1-8
Publication date: 2013

Host publication information
Title of host publication: Conference Proceedings of the 2013 4th IEEE International Symposium on Power Electronics for Distributed Generation Systems, (PEDG), July 8-11, 2013, Rogers, Arkansas, USA
Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
DOIs: 10.1109/PEDG.2013.6785600

Modeling the Grid Synchronization Induced Negative-Resistor-Like Behavior in the Output Impedance of a Three-Phase Photovoltaic Inverter

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electrical Engineering, Smart Energy Systems (SES)
Authors: Messo, T., Jokipii, J., Mäkinen, A., Suntio, T.
Number of pages: 7
Pages: 1-7
Publication date: 2013

Host publication information
Place of publication: Piscataway, NJ
Publisher: Institute of Electrical and Electronics Engineers IEEE
DOIs: 10.1109/PEDG.2013.6785602
Possible Methods for Limiting Magnetic Fields outside a High Voltage Power Substation by Changing the Phase Sequence of Busbar Wires

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Electronics and Communications Engineering
Authors: Okun, O., Shevchenko, S., Korpinen, L.
Number of pages: 4
Pages: 1109 - 1112
Publication date: 2013

Host publication information
Links:
http://piers.org/piersproceedings/download.php?file=cGlzcnMyMDEzU3RvY2tob2xtfDJQX0tfMTEwOS5wZGZ8MTMwMzE5MDc1MjIz
http://www.piers.org/piersproceedings/

Bibliographical note
Contribution: organisation=elt,FACT1=1<br/>Portfolio EDEND: 2013-09-29
Source: researchoutputwizard
Source-ID: 3054
Research output: Scientific - peer-review › Conference contribution