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An Extensive Review of Nonisolated DC-DC Boost-Based Converters 1
Fernando Tofoli; Arthur Neves de Paula; Wesley Josias de Paula

High voltage step-up is necessary in several applications, especially considering that dc-ac converters must be supplied by high dc voltages. The conventional boost converter is the most popular topology for this purpose, although the conversion efficiency is limited at high duty cycle values. In order to overcome such limitation and improve the conversion ratio, many boost-type converter topologies have been proposed so far. Within this context, this work intends to review some of the most important works regarding boost-based dc-dc converters. Many structures are covered and classified basically as converters with and without wide conversion ratio. Some of the main advantages and drawbacks regarding the existing approaches are also discussed. Finally, a proper comparison is established among the most significant converters regarding the voltage stress across the semiconductor elements, number of components, and static gain.

Speed Control and Braking System Automation of Wagon Parking System 9
Max Mauro Santos; Alexandre Lugli; Wallas Lanchin

This paper presents the development of an automatic control of retardant system and parking of wagons, where after unloading in the car dumper, passing through retarders and switches and crossings. The retarder system is a device installed on the rails, at the end of the ramp and is responsible for braking the wagons. Automatic control of braking and objectively determine the optimal speed to ensure that the engagement is smooth to the other wagons. Without this control, or if it fails, there may be a short stop before reaching the destination, or cause strong impact on engagement because of high speed, leading to possible breakdowns in couplers and wagons.

Optimal Tuning Parameters Of The Dynamic Matrix Predictive Controller With Ant Colony Optimization 15
Gustavo Almeida; Marco Cuadros; Rogério Pereira; José Leandro Salles

The Dynamic Matrix Control (DMC) Algorithm is a control method widely applied to industrial processes. The goal of this work is to apply the Ant Colony Optimization (ACO) to optimize the tuning parameters of the Dynamic Matrix Controller for SISO (single-input single-output) and MIMO (multi-input multi-output) linear dynamical systems with constraints. A comparison is made between the computational method proposed here with the Genetic Algorithm, showing advantages and disadvantages of these two methods of tuning.
Testing a Predictive Control with Stochastic Model in a Balls Mill Grinding Circuit

Huber Nieto-Chaupis

In this report, the formulation of a stochastic model and its subsequent incorporation into a predictive control of a balls mill grinding circuit, is tested. The proposed approach considers computational simulations of the perceived dynamics attained to the circuit by using stochastic elements as consequence of the possible random variable interaction which appears during the time evolution of system. Thus, this study presents the mathematical modeling of the involved variables throughout the circuit but based on probabilities. Once the model is set-up, it enters in a based-model predictive control which is built by taking into account the hypothesis by which the system variables are under interaction each other. We limit ourselves to the analysis where the circulant load produces interactions to both input and output variables. Although the quantitative measurement of this interaction might be speculative, it is not discarded that it might be actually the main source of strong deviations of the set-point thereby producing the apparition of overloading and alarms. The results have shown positive prospects of the proposed methodology as seen in the control system simulations in where the particle size keeps its stability within an error of around 5.0%, even in those cases where the system is attacked by unexpected fluctuations.

Design and analysis of robustness of DLQR controllers applied to grid-connected inverters

Claudio Luiz do Amaral Santini; Luiz Antonio Maccari Jr.; Vinicius Montagner

This work deals with the design of a robust discrete-time quadratic controller applied to inverters connected to grid with uncertain inductance. First, the plant is modeled taking into account uncertain parameters and parasitic resistances, leading to a discrete-time polytopic model with two vertices. The control gains are computed by means of linear matrix inequality conditions. A design example including resonant controllers to ensure the tracking of sinusoidal reference for the grid injected current and attenuation of harmonics is detailed. As results, analysis of eigenvalues, frequency responses and time responses of the closed-loop system are shown, illustrating good performance for both extreme values of grid inductance.

Analysis of Intermediary Yoke for 12-Pulse Transformer Connections

João Pelicer Junior; Falcondes J. M. de Seixas; Angelo Lourenço

Knowing that power harmonics have a substantial influence in the energy supply quality, a variety of topologies are used to reduce those effects. The twelve-pulse converter analyzed in this work is one of these topologies. Will be analyzed the amount of flux in a core which has an intermediary yoke, the analysis shown will be a comparison of practical results with theoretical modeling, showing that the area of the intermediate yoke can be optimized compared to the use of two separate three-phase cores.

Design and experimental implementation of a robust DLQR for three-phase grid-connected converters

Luiz Antonio Maccari Jr.; Claudio Luiz do Amaral Santini; Ricardo Oliveira; Vinicius Montagner

This paper deals with the design of robust discrete linear quadratic regulators applied to three-phase inverters connected to the grid by means of LCL filters. The system is modeled in the state space in abc coordinates and changed to alpha-beta coordinates, allowing a simple control design and implementation. Resonant controllers are used to ensure the tracking of sinusoidal references for grid current. The control gains are computed by means of a convex optimization problem and ensure that the closed-loop system is robustly stable when operating under conditions of uncertain grid inductance. The controller is experimentally validated with a 5.4 kW prototype, showing good results for three-phase grid current control.
Fault Location in Distribution Systems using the Voltage Sag-Duration Table  
Sreeramulu Naidu; Gilvan Andrade Jr; Edson Guedes da Costa

Abstract
A fault location technique based on the voltage sag-duration table has been described. The technique is simple to apply and has the potential to be implemented on-line. It needs the data from power quality meters installed at a few measuring stations. The technique has been demonstrated by simulating faults in realistic distribution networks.

Regenerative Brake System for Small Scale Electric Bus  
Tarcísio José Pedrobon Ferreira; Guilherme Melo; Carlos Canesin; Moacyr de Brito

This paper proposes the development of a regenerative breaking system on a small scale prototype applied to an electric bus, driven by a DC motor. The employed topology is based on two bidirectional DC-DC converters cascaded connected, which the function is to control the energy flux between the accumulators. The recovered energy through the traction motor, operating as a generator, will be stored either in a super-capacitor or in Li-Ion battery packs depending on their charge conditions. The control logic was developed using MATLAB SIMULINK, and the laboratory prototype will be controlled through DSpace platform.

Power Converter Topologies for a High Performance Transformer Rectifier Unit in Aircraft Applications  
José Luiz Vieira; Jesús Oliver; Pedro Alou; José Cobos

This paper presents some power converter architectures and circuit topologies, which can be used to achieve the requirements of the high performance transformer rectifier unit in aircraft applications, mainly as: high power factor with low THD, high efficiency and high power density.

An Improved Droop Control Strategy for Load Current Sharing in Output Parallel-Connected DC-DC Converters  
Victor Oberto; Márcio Depexe; Thiago Naidon; Alexandre Campos

This work presents a novel current sharing control technique based on an improved droop control scheme for a modular power supply composed of n output parallel-connected DC-DC converters. Each converter is connected to the load through individual line resistance and modeled as a dependent voltage source. In order to provide proper load sharing, a voltage reference adjustment for the main control loop is done through the load current controller output. A distributed power supply composed by three buck converters with their outputs connected in parallel designed for a 70 W Light Emitting Diode (LED) street lighting fixture is tested through simulations to prove the feasibility of the idea.

OCC Applied to a 180W HPF Single-Stage LED Driver Based on Zeta Converter in CCM  
Guilherme Pedrollo; Fernando dos Reis

This paper presents a high power factor single-stage driver powering a high-power-LED. This driver has its base on a Zeta isolated converter controlled by a One-Cycled Control (OCC) technique. First, the motivation of this research is presented, which lies in the Zeta converter features, because it ensures electrical safety, presents single stage power processing and high power factor. This paper also presents the state of the art of the power factor correctors among control techniques dedicated to them. Second, the proposed system, which consists of a Zeta isolated converter in the continuous conduction mode (CCM) is presented. Then, the OCC technique and its variations were discussed. Next, the design procedure is shown. Then, the results using simulation for the classical OCC and the exponential ramp OCC variation are presented and comparatively discussed. Finally, the experimental results confirms that a Zeta converter can be used as an one-stage PFC to drive power LEDs, using the chosen control method.
Harmonic current compensation and control for wind power generation with doubly fed induction generator

Adson Moreira; Târcio Barros; Vanessa Teixeira; Ernesto Ruppert Filho

This paper describes a wind power system which controls the active and reactive power as well as works with the function of filter the harmonics components of the grid current. From the grid side converter, the harmonic compensation is achieved by an algorithm proposed compensation of harmonics. This technique ensures the improvement of power quality. The machine side converter controls the active and reactive power that is delivered to the grid by controlling the stator field oriented. Simulation results confirm the effectiveness of the proposed research.

Model-Based Predictive Direct Speed Control Applied to a Permanent Magnets Synchronous Motor With Trapezoidal Back-EMF

Gabriel Negri; Arthur Bartsch; Mariana Cavalca; Jose Oliveira; Ademir Nied; Antonio Silveira

This paper presents an investigative work about the State Space Model-based Predictive Control application in a three-phase Permanent Magnet Synchronous Motor with trapezoidal back-electromotive force, for speed control. Such motor is utilized in white goods appliances, medical applications among other, especially due to its high efficiency and long life cycle. The predictive control methods present a differential in the driving performance for industrial application, mainly by enabling the imposition of constraints. In this work, a linear prediction model identified with a Least Mean Squares algorithm is used with the State-Space predictive control method. The constraints use is also analysed for the proposed predictive algorithm. Such predictive control method is interesting for industrial applications for being easy to tune, allowing ponderation between tracking performance and spent energy, and having the possibility of imposition of constraints. There are satisfactory simulated and experimental results that show advantages in using the mentioned control method to drive the Permanent Magnets Synchronous Motor.

Bacterial Foraging Optimization Algorithm used to adjust the parameters of Power System Stabilizers and Thyristor Controlled Series Capacitor-Power Oscillation Damping controller

Maxwell de Menezes; Percival B. de Araujo; Elenilson de Vargas Fortes

The objective of this work was to use the Bacterial Foraging Optimization algorithm to determine the parameters of Power System Stabilizers and a Thyristor Controlled Series Capacitor-Power Oscillation Damping controller. The proposal is to synchronize adjustments of these controllers in order to introduce the desired low frequency oscillation damping in an electric power system. A test system distributed in two areas with 4 generators, 10 bars and 15 transmission lines and with local and inter-area oscillation modes is simulated to test the design. The results demonstrate the ability of the algorithm to achieve the objectives defined in this project.

A Simple and Efficient Off-Optical Axis Electro-Optic Voltage Sensor

Marlon Garcia; Jose Galeti; Ricardo Tokio Higuti; Cláudio Kitano

Sinusoidal high-voltage measurements at 50/60 Hz are very important since, at present, power delivery systems use this kind of low frequency waveforms. It is well known that conventional instrument transformers, based on electromagnetic principles, present problems with respect to their responses in the presence of harmonic distortion. On the other hand, optical instrument transformers have excellent frequency response, which significantly contributes to a more accurate measurement of these harmonic components. The high voltages of power delivery systems require monitoring by techniques that provide electrical isolation. For these reasons, optical techniques are a good choice for this application. The basic principle of remote measurement of high voltages using the Pockels effect is inspired by the principle of conventional electro-optic modulator used in optical communication systems, whose carrier works up to MHz frequencies. A typical arrangement of a bulk-type optical voltage sensor consists of an electro-optic crystal placed between two crossed polarizers. The system must usually be biased with a fixed retardation $\frac{\pi}{2}$ rad to the 50% transmission curve point, which can
be achieved using a quarter wave-plate, avoiding the need for a high voltage bias. However, the further elimination of the quarter wave-plate from the voltage sensor would be very effective for simplifying the sensing system, improving the temperature stability and achieving the insensitivity to light wavelength. This effect can be easily achieved by a slight misalignment of the light beam propagating on the X-Z plane, through a small angle from the Z axis of the crystal. The design methodology, the theoretical projection of the electro-optic voltage sensor performance and finally, laboratory low voltage testing are reported in this paper.

A Distributed Communication for Industrial Control based on Ethernet. 102

Alexandre Lugli; Max Mauro Santos

The TCP/IP suite protocol is one of the most widespread protocols groups for communication at long, average and short distances involving computer systems. Then, for trying the industrial networks standardization, for some years, it was also implemented in the industrial environment. The manuscript aims to propose a new way to accomplish the fieldbus modules control, using a flexible distributed architecture applied to the industrial Ethernet networks. The work proposal is to develop an algorithm for messages scheduling, applied to a distributed architecture, with the removal of the master controller, where only the fieldbus modules and switches operate on the network, and then having a communication messages distributed control. The proposed algorithm uses an off-line or pre-run-time type technique of messages scheduling. Therefore, the manuscript develops a new communication concept, applied industrial Ethernet networks, with communication network control and each field element distributed throughout the manufacturing process. For this, it is necessary to model the new communication concept, perform the messages scheduling (which is essential for defining the message communication order in the network trafficked, due to not using a centralized master controller) and perform verification testing and idea proposal validation.

Methodology proposal for multi-objective optimization using NSGAII in industrial applications 108

Anderson Castro

The optimization problems of industrial process attracted many researches since the early 90’s of the last century. The production volume increase, lifespan shorten of the products and technological advances pushed the industries to seek for low cost and quick implementation solutions. One of the process that became the core for increasing this volumes and speed was the surface mount technology. Composed by printing, automated chip mounting and reflow this process took place of old process technology. The automated mounting became one of the object of interests for process optimization because the automation itself is a hard NP problem and the heuristic used to find the best solution can change. This paper formulated a new point of view for modular chip mounters based on the already known feeder assignment problem and head motion problem applying the global optimization using the non sorting dominance genetic algorithm the NSGAII. The modeling of the fitness functions were presented and the multi criteria optimization tool was described using the machine functions and constraints. The same method could be applied to describe other type of machines to support future research works changing fitness functions according to the chip mounter type and operation.

A SEPIC-Energy-Regenerative-Snubber with Linear Current Regulator for Power LEDs 116

Claudinor Nascimento; Eloi Agostini Jr.; Carlos Illa Font; Ismael Burgardt

This paper presents an AC electronic lighting system using a non-isolated SEPIC PFC rectifier to drive and control power LEDs currents. One energy regenerative snubber for reducing the converter switching losses and improve the system efficiency is proposed. To reduce ripple current in the LEDs array a linear current regulator is placed in the SEPIC's output terminals. In order to reduce the efficiency impairment, the conditions for achieving minimum energy loss in the current regulator are also detailed. The main equations of the proposed energy regenerative snubber as well as the experimental results of a prototype that feeds 35 LEDs / 42 W are presented. In this paper, the system operates with 127 Volts of input voltage and the point of minimum energy loss in the linear regulator is adjusted in open loop to validate the converter operation.
Smart meters as a tool for energy efficiency
Haroldo Amaral; André Nunes de Souza; Danilo Sinkiti Gastaldello; Filipe Fernandes; Zita Vale

Gradually smart grids and smart meters are closer to the home consumers. Several countries has developed studies focused in the impacts arising from the introduction of these technologies and one of the main advantages are related to energy efficiency, observed through the awareness of the population on behalf of a more efficient consumption. These benefits are felt directly by consumers through the savings on electricity bills and also by the concessionaires through the minimization of losses in transmission and distribution, system stability, smaller loading during peak hours, among others. In this article two projects that demonstrate the potential energy savings through smart meters and smart grids are presented. The first performed in Korea, focusing on the installation of smart meters and the impact of use of user interfaces. The second performed in Portugal, focusing on the control of loads in a residence with distributed generation.

Modified Approach Using Variable Charges to Solve Inherent Limitations of Potential Fields Method
Milena Pinto; Thiago Mendonça; Leonardo Rocha Olivi; Exuperry Costa; André Luis Marcato

There are several methods to control robots trajectories. The potential fields technique is one of the simplest algorithms that require less computational resources. This work presents a modified version of the potential fields method using variable charge and adapted attractive fields that allows the robot to achieve the goal in dynamical and complex environment, which the original approach is not able to solve. The algorithm has been validated using the MobileSim simulator together with Matlab. The results prove the algorithm efficiency in schemes with multiple local minima, goal close to obstacles and less oscillation in narrow passages. This control method can be used in industrial applications such as automatic forklift operation, robotic manipulators and wheeled robots.

Simulation platform for robust control design using classical and evolutionary optimization algorithms
Gustavo Dill

In this paper, a simulation platform to design robust controllers for electrical power system is presented. Low order controllers with output feedback, including performance and robustness requirements are considered. The design is carried out using mono and multiobjective functions that are solved by classical and evolutionary optimization algorithms. The simulation platform is applied to a small test system, in order to clarify its characteristics and comparisons are made with the optimization methods and objective functions.

Comparative Study of High Power Factor Boost Rectifiers in Continuous Conduction Mode
Fernando Tofoli; Denis de Castro Pereira; Wesley Josias de Paula; Marcio Renato da Silva

This work presents a comparative study of single-phase boost-based ac-dc converters applied to power factor correction. Three structures are chosen for this purpose and analyzed in detail e.g. the classical boost converter, the bridgeless boost converter and the boost converter based on the three-state switching cell (3SSC) operating in continuous conduction mode (CCM). The aforementioned topologies are briefly revised so that they can be properly designed and validated considering results obtained from simulation tests, where aspects such as the input current, regulated output voltage, harmonic content, and dynamic response are investigated.

Magnetic Gear: A Review
Carlos Guilherme Neves; Ály Ferreira Flores filho; Diogo Figueiredo; Anderson Nunes

In this paper the CMG working principle is explained with help of Finite Elements Method (FEM) and Fast Fourier Transform (FFT). This means, the flux densities waves in both gaps are obtained by FEM and its harmonics spectrum it is obtained by FFT to explain the modulation phenomena which plays the fundamental
hole in its behavior. The cogging torques on inner and outer gaps is obtained by step by step FEM technique using movement band.

Mitigating Supply Chain Disruption for Manufacturing Firms A Framework using agent-based model 154
Mauricio Blos

In an era of worldwide economic downturn, managing supply chain disruptions is the best option in the success of any firm. In this context, this paper presents a supply chain risk mitigation framework for manufacturing firms. It was used agent-based model to create a framework to deal with the supply chain disruption. To validate the proposed model, it was used Petri net to assess the structural properties of the agent-based supply chain risk framework. It was given an example application of the proposed framework and findings demonstrated that this model is feasible and can be used as a mitigation tool to deal with the supply chain disruption of the manufacturing firms.

Distribution Transformer with Integrated Electric Energy Measuring System 161
Luiz Felipe R. Barrozo Toledo; Lucas Pinheiro

This article describes the development of a R&D project of a distribution transformer with integrated electricity measuring system. The transformer has as main objective the energy measurement of the transformers customer consumption and offers various information related to electrical distribution network to the utility and informs in real time the occurrence of any event. This R&D project was executed to CEMAR Utility by LACTEC through the ANELL R&D program.

A Feasibility Study of the Classical Computational Model used to Represent Power Capacitors by Comparing the Simulation Response and the Real Power Capacitors Response Tested in a Controlled Laboratory Environment 166
Alexandre Silva; Mário Oleskovicz; Ricardo Augusto Souza Fernandes; Flavio Garcia

This paper has as aim to present a comparative study between the classic power capacitors model implemented in the software dedicated to power quality analysis and the real power capacitors response tested in a controlled laboratory environment. This classic model is composed by a resistance connected in series with a capacitive element and is not sensitive to harmonic distortion. MATLAB - Simulink was used to model the systems components and to simulate the processes. The two regular technologies applied to manufactured power capacitors, well-known as all-film capacitor and as metalized polypropylene capacitor, were used for the laboratory tests. The simulation results were analyzed and compared to the laboratory tests data. Results show that the classical model capacitor has excellent accuracy when fed by a sinusoidal waveform. However, when fed by a nonsinusoidal waveform, it has demonstrated limitations that will be reported in this paper.

Simulated Annealing with Crystallization Heuristic Applied to Aircraft Conceptual Design 171
André Sato; Diego Movio; Marcos Tszuzki; Edson Ueda; Thiago Martins; Antonio Mariani

Simulation-based optimization is an area where techniques from optimization and simulation analysis are integrated. This work uses a simulation based optimization technique to determine the best aircraft conceptual design according to the constraints imposed by the SAE AeroDesign competition. The optimization was performed by the Simulated Annealing (SA) algorithm. The SA has two main parameters to be configured: the cooling schedule and the next candidate determination. This work researches three different strategies to implement the crystallization heuristic, that is used to determine the next candidate. According to the obtained results it is possible to observe that design parameters with different sensibilities can be self-tuned without the necessity of manual configurations.
Development of a low cost smart meter to collecting data and in-place tests
Haroldo Amaral; André Nunes de Souza

The development of society, technology and changes in consumer behavior has led to changes in the techniques and technologies used for measuring electricity. Currently there are many studies concerning the benefit related to the use of smart meters. Besides its use for billing, the smart meters can be used to collect data from the power grid, allowing continuous monitoring. In market there are many electronic meters available in addition to development kits, however, depending on the application might become limited or inflexible about modifications in their characteristics. This paper presents the development of a smart meter with flexible structure and which can be suitable for different situations. One of the main goals was to develop a smart meter that combines precision and capacity to store collected data for further analysis. This goal was achieved and the equipment developed proved to be a very efficient tool for monitoring the network, their magnitudes and also the behavior of consumers.

Discrete Smith Predictor Design and Performance Improvement of PID Tuning
Antonio Coelho; Rejane Araujo; Daniel Cavalcanti; Camilo Suárez

The paper presents a discrete design method for tuning of proportional-integral-derivative control loops by using the Smith predictor with feedback filter in order to guarantee better dynamic and loop specifications for setpoint tracking and disturbance rejection acting on the process with long dead-time. Simulation and experimental essays show that the effectiveness of the dead-time compensating PID tuning over standard PID controller tuning methods is improved to meet the desired performance and to decrease the impact of the dead-time over the closed-loop stability.

Evaluation of Surface Mounted PM Machines Parameters on Load Conditions Using Frozen Permeability Method. Part. III
Geyverson Teixeira de Paula

This work deals with the influence of magnetic saturation on machine parameters of a surface mounted permanent magnet synchronous machine driven by an ideal sixstep three-phase inverter. In this third part, a special attention is given to each torque component on load condition, i.e., mutual torque, reluctance torque, cogging torque and a comparison between the electromagnetic torque and the summation of these components.

Inverter-based DG impact on fault location for energy distribution system
Cesar Orozco; Arturo S. Bretas; Andrés Herrera; Roberto Chouhy Leborgne; Daphne Schwanz

This paper presents an analysis about the impact of the inverter-based distributed generation on the fault location for distribution power systems. This work analyses the fault response in distributed generation and how it impacts in the fault location formulation. Additionally, is presented an analysis of the electrical models of DG and how it will influence in the fault location performance. This study is performed in the IEEE 34 Node Test Feeder. The obtained results show that not consider the DG current contribution of the inverter or use inadequately the DG electrical model to determine its impact in the fault location affect strongly the fault location performance, since the fault distance computed dependent of the estimation of DC current contribution in the fault point.

Adaptive control of PV boost converter for minimal passive components and fast maximum power point tracking
Lucas Bellinaso; Rodrigo Padiha Vieira; Hilton Gründling; Leandro Michels

This paper proposes control improvements in boost converters used in photovoltaic applications. The proposed current controller is suitable for continuous and discontinuous conduction modes, and is independent on the
input node model. Thus, minimal input capacitance and boost inductance can be used, which improves converters lifetime and reduces costs. The proposed voltage controller is online adapted according to the operation point of the photovoltaic I-V curve. Thus, it works for low and high irradiance, without compromising stability and dynamics, and allowing a fast maximum power point tracking algorithm. Simulation results demonstrate the feasibility of the proposed controllers.

Labview FPGA FOC Implementation for Synchronous Permanent Magnet Motor Speed Control 210
Matheus Bevilaqua; Ademir Nied; Jose Oliveira

This paper describes an implementation of FOC (Field Oriented Control) algorithm for speed control of a Permanent Magnet Synchronous Motor - PMSM. The motor considered is a Brushless-AC type - BLAC, with sinusoidal back-electromotive force - BEMF waveform, and the application intended for this motor is the direct drive - DD type of washing machines. The FOC algorithm is implemented using a National Instruments Labview FPGA System. This system is composed of a high level/high productivity tool for FPGA logic synthesis. The paper describes the design principles for FOC algorithm and then explains the implementation of the designed controllers in the Labview FPGA platform.

Theoretical and Practical Analysis of the Fuel Cell Integration of an Energy Storage Plant Using Hydrogen 218
Frank Gonzatti; Vinicius Nizolli Kuhn; Fredi Ferrigolo; Maicon Miotto; Felix Alberto Farret

The energy generated by alternative sources is often not constant throughout the day. Thus, the use of energy storage in conjunction with these generation sources can minimize problems caused by the intermittency of the primary source (sun, wind, etc.). Among the various options, the energy storage in form of hydrogen has been very promising. This paper deals with the analysis of fuel cells (FC) to be integrated with energy storage power plants using hydrogen. Initially a simulation is performed using the electrochemical model of the FC. Next, some practical data are obtained using FC with the same parameters used in the simulation. Thus, it is possible to validate the model by comparing practical and theoretical results, by getting the actual FCs performance and operation data.

Efficiency Optimization of an Interior Permanent Magnet Synchronous Generator with an Adaptive Fuzzy Controller 224
Durval Souza

This paper presents a new technique for the efficiency optimization of an interior permanent magnet synchronous generator, IPMSG, working at variable speed and load. For a given operating condition, characterized by a given turbine speed (wT) and electric torque (Te), the search control is implemented via the Rosenbrock method, which determines the level of the flux current component that results in maximum output power. Once the optimal level of the flux current component is found, this information is used to update the rule base of a fuzzy controller, which plays the role of an implicit mathematical model of the system. As the optimum points associated with the different operating conditions are identified, the rule base is progressively updated, so that the fuzzy controller learns to model the optimal operating conditions for the entire torque-speed plane. After every rule base update, the Rosenbrock controller output is reset, but it is kept active to track possible minor deviations from the optimum point. If compared with other techniques proposed in the scientific literature, this method shows better performance, because once the fuzzy controller learns, the search for the optimum point is immediate.
Model-Based Functional Safety for the Embedded Software of Automobile Power Window System

Max Mauro Santos; Felipe Franco; Sergio Stevan; Alexandre Lugli; Wesley Torres

Model-Based Development is a design methodology widely used for automotive embedded software, where the engineering process involving OEM and suppliers can bring benefits taking for a good information exchange, workflow and toolchain adequately in a standardized way. However, with the growing demand for new functions for next generation of vehicles, we encounter with a complex system that require for use a function safety standard as defined by the ISO 26262. We present a model-based functional safety applied power window system that is considered an important function in vehicle hosted on electronic control module. This function was developed and tested in model-in-the-loop stage of development, from the supplier side, only with the purpose demonstrate that in preliminary or virtual phase is important being able to find bugs preliminary and generate a software quality when deploying on target system. The approach purposed consider the software tool for verification and validation the function with a set of test case that validates the preliminary requirements.

Improvement of a Coal Power Plant Performance: Auxiliary Services Power Demand Reduction

Daphne Schwanz; Mauren Silva; Roberto Chouhy Leborgne; Arturo S. Bretas; Marcelo Gaidzinski

This paper proposes method to improve the electric power available in a thermoelectric plant. The proposed improvement is based in a reduction of the auxiliary services demand. This demand reduction is obtained by improving the power factor and reducing the active power losses in the auxiliary services. The power factor is improved by the installation of capacitors to supply reactive power and filters to reduce harmonic distortion. The measurements and simulations of the electrical system show the most critical non-linear loads and low displacement power factor loads presented in the industrial plant and the best location to improve the power factor and the power quality.

An Integrated Insulated Buck-Boost-Flyback Converter to Feed LEDs Lamps to Street Lighting with Reduced Capacitances

Ricardo Prado; Paulo Cesar Luz; Priscila Bolzan; Thiago Maboni; Marcelo Cosetin

This paper presents the project of an integrated insulated converter to feed a LEDs lamp to street lighting systems. An integrated Buck-Boost-Flyback was designed, as well a control technique to reduce the capacitances value and the paper also presents the parameters and experimental results of the integrated converter.

A New Flicker Mitigation Technique for Zero-Crossing AC Power Control

Michel Iserhardt; Jumar Russi

The zero-crossing AC power control usually does not generate harmonics and Electromagnetic Interference (EMI) since it does not chop the voltage signal. In contrast, it is almost inevitable the emergence of flicker on the electric grid, mainly due to the large electrical power consumed by heating equipment, comprised by long ON and OFF state intervals, characteristic of the technique. Regarding this matter, this paper presents an algorithm that improves this technique concerning the generation of flicker. Besides reducing the problem of flicker in the power grid, this proposal also allows the use of multiple power levels using a single heating element. Theoretical and experimental comparisons that demonstrate the feasibility and the gains achieved by the proposed algorithm are presented. By means of the technique proposed in this paper is possible to obtain a reduction on flicker up to 350% compared to the traditional technique.
Comparison among Methodologies for Identification of Pilot Buses and its Impact on the Steady State Secondary Voltage Control

Paula Oliveira La Gatta; João Alberto Passos Filho; José Luiz R. Pereira

This paper presents a comparison analysis among some methodologies in which aims to solve the selection of pilot buses for Secondary Voltage Control. For this purpose, a brief review of methodologies for both identifying voltage control areas and pilot buses selection are described. The validation of the results is done through the standard deviation applied to the variation of the voltage magnitude of the system buses before and after a given disturbance, reactive power generation and active power transmission losses. In this paper, the disturbance is the application of a load curve applied in reactive power demand of the load buses consists of 168 load levels. Results are presented using the well known IEEE 118 buses system.

Automation of Thermal Exchanges of Metal Hydrides Cylinders Integrated with Energy Storage

Frank Gonzatti; Fredi Ferrigolo; Vinicius Nizolli Kuhn; Diogo Franchi; Felix Alberto Farret

The primary sources of renewable energies such as sun and wind are intermittent. Therefore, the electricity provided by these sources can compromise stability and reliability of the electric system when operating at the interconnected mode. These sources are often underutilized or they stay idle when used in stand-alone systems and in periods of low demand. The use of energy storage in conjunction with this type of generation can mitigate these effects on the electric grid. Among the various types of energy storage, hydrogen storage has been very promising. This work discusses an integrated hydrogen energy storage reservoir in the form of metal hydrides (MH) capable of delivering its contents in a few seconds. It is described the operation and automation of the whole plant with lots of experimental results.

Robust Generalized Predictive Control Applied to the Rotor Side Converter of a Wind Power Generator System Based on DFIG

Samuel Dias; Wellington Silva; Laurinda Reis; José C. Teles

This paper presents the model and the control of the rotor current loop a double-fed induction generator based on a robust generalized predictive controller. The controller is designed to ensure the reference tracking quickly and with a minimum of overshoot. Furthermore, it is proposed a new methodology for controller tuning based on a single parameter that allows a balance between noise attenuation of the control signal, disturbance rejection and robustness of the system during operation. Through computer simulation, the relationship between the tuning parameter and the system dynamics is analyzed. The simulations results validate the performance of the proposed controller when applied to a DFIG-based wind generation system.

Mineirão World Cup Stadium PV Plant A Case Study

Andre Silva; Sidelmo Magalhães Silva; Braz J. Cardoso Filho; Bruno Lopes

This paper presents a case study about a PV plant installed on the Mineirão world cup stadium located in Belo Horizonte, Brazil. An unstable behavior on the line to neutral voltage has been identified on the commissioning of the inverters threatening the loads connected to the transformer and the equipment of the power systems. The root cause of the system has been identified and a solution to it proposed. Simulation and measurements taken on the actual plant validate the solution and are also presented.

Real Time Simulations of Wind Turbine Pitch Angle Control Using Fuzzy Logic

Ana Vitória Macêdo; Wellington Mota

In this work, wind turbine pitch angle control using a Fuzzy controller in real time simulation is presented. This controller is implemented in RTDSTM (Real Time Digital Simulator). It was built based on knowledge of
operation principles of wind turbines equipped with variable pitch angle control, not requiring mathematical
models for this. It is presented as an alternative for the Proportional-Integral (PI) controllers currently used. The
control was developed using the CBuilder which is the C program compiler of RTDSTM. It was used a
Permanent Magnet Synchronous Machine (PMSM) equipped with PI controllers for pitch control. Simulations
was performed varying the incident wind speed on a wind turbine equipped with PMSM. These simulations
prove the efficiency of the pitch control using Fuzzy Logic in real time simulations.

Input-Series and Output-Series Connected Modular Full-Bridge PWM DC-DC Converter with Capacitive Output
Filter and Common Duty Cycle

Ivo Barbi; Antonio Bottion

This paper proposes a modular isolated dc-dc converter, based on the input-series and output-series (ISOS)
association of the full-bridge PWM (FB-PWM) dc-dc converter with capacitive filter. The main attribute of the
proposed architecture is its ability to provide self-balance of the input and output voltage across the individual
converters, without voltage loop control scheme, both in the steady state and transient operations. Circuit
operation, theoretical analysis and modeling are included in the paper, along with experimental results taken
from a laboratory prototype with four modules, 1600 Vdc total input voltage, 1600 Vdc total output voltage, 4 kW
output power, and 40 kHz switching frequency. Possible applications include high voltage power supplies, solid
state transformers, dc current distribution systems, and renewable electric energy systems.

Instrumentation to Detect Contamination of Insulating Oil in Motors Applied to Electrical Submersible Pump

Andrés Salazar; Diego Fonsêca; André Maitelli; Francisco Fontes; Filipe Quintaes

The purpose of this paper is to presents a design of a magnetic sensor capable of detecting contamination of
insulating oil used in the artificial lift method of oil-type electrical submersible pump (ESP). The sensor generates
an alarm signal at the moment when the contamination oil is present. This signal is transmitted to the surface by
communication system which uses the tree-phase motor power. This diagnostic information enables the
implementation of predictive maintenance (condition monitoring) functions. For plant operators, this therefore
makes it possible to detect faults in advance and implement measures to improve operational reliability and keep
the downtimes of plants to a minimum. The prototype was designed to work in harsh conditions to reach a depth
of 2000 m and temperatures up to 200 C. It used simulator software to define the mechanical and
electromagnetic variables. Results of field experiments were performed to validate the prototype. The final
results performed in an ESP system with a 62-HP motor showed a good reliability and fast response of the
prototype.

AC-DC Single-Switch Three-Phase Converter with Peak Current Control for Power LEDs

Marcel Mendonça; Edilson Sá Jr.; Ronaldo Coutinho; Fernando Antunes

This paper presents the development of a three-phase AC-DC flyback converter without electrolytic capacitor
with power factor correction applied on street lighting using power LEDs. Recent studies suggest that the lifetime
and reliability of an electronic ballast may be improved removing the electrolytic capacitors, considering that the
lifetime of these devices suffer strong influence of the operating temperature. A single-switch three-phase
topology is proposed, and a prototype is developed. The experimental results evidence the feasibility of using
this technology in electronic ballasts for LEDs. The prototype has an output power of 54 W, with power factor of
up to 0.99 and efficiency up to 77%, depending on the operating conditions. This prototype can operate in a full
range of input voltages and also has a peak current control strategy, which reduces design costs due to the use
of a low cost controller.
Hybrid Single-phase Inverter with Flying Capacitor and Reduced Number of Components 312
Juliano Silva; Edison da Silva

This paper proposes a single-phase four-level converter comprising one two-level leg and one flying capacitor three-level leg. The two arms are connected via coupled inductors, forming a single-phase inverter half-bridge. When compared to other four-level inverters, the proposed topology has just one flying capacitor, lower losses and harmonic distortion, and a smaller number of semiconductor devices, each one supporting the same blocking voltage. The paper presents the model of the converter, its modes of operation, as well as the PWM strategy used for its command. Simulation results are given and experimental results validate the theoretical study.

Least Squares Optimization of Zero Crossing Technique for Frequency Estimation of Power System Grid 319 Distorted Sinusoidal Signals
Thiago Mendonça; Milena Pinto; Carlos Duque

Reliable frequency estimation is considered crucial for several industrial applications, such as power control, power system protection and monitoring. In certain applications is required an accurate and fast frequency estimations of the sinusoidal signals. Several algorithms are found in literature able to solve this task. However, their responses under low Signal to Noise Ratio (SNR) are not reliable. In this paper is proposed an optimization by least squares of the well-known zero-crossing technique in order to enhance performance under such condition. To validate the algorithm, it was performed some comparisons with others method using different values of frequency. The presented technique has shown better results regarding the estimation error.

Performance Indexes for Assistance in Retuning Multivariable Model Predictive Controllers 325
Paulo Eduardo Falleiros Cortez; Agustinho Plucenio; Daniel M. Cruz; Julio Elias Normey-Rico; Luis Paulo S. Vasconcellos

This paper presents a new methodology to assist in the tuning of Multivariable Model Predictive Controllers. It is based on the definition of several performance indexes which are averaged over long intervals using recursive filters. The computational load to obtain the indexes is very low. The indexes analysis can guide the engineer to achieve the control objective. A case study is presented to show the feasibility and practicality of the method.

Integrating Technologies for Building a Wireless Home Automation System: A Practical Implementation 333
Flavio Valentim; Celso José Munaro

In recent years, the development of technologies for automating homes and buildings has highly increased, boomed mainly by wireless communication and microcontrollers development. The problem is that the cost is hardly attractive resulting in applications usually in fancy buildings. However, a great variety of features is currently available on mobile devices, resulting in good candidates to reduce cost and to improve acceptance. Several researches have discussed about the architecture and design of Building Automation Systems, but only a few discuss the reuse of easily available technologies. This paper describes a practical implementation of a Building Automation System which combines the use of technologies available on smartphones with Wireless Sensor Network and low cost microcontrollers. A prototype was developed and can be applied to houses or buildings. The prototype was tested with the more usual appliances and the performance of communication was evaluated.

All electric propulsion system model based on a levitated flywheel machine 340
Arthur dos Reis; Janaina Goncalves de Oliveira; Francisco Gomes; Johan Abrahamsson

Flywheel systems are attractive in hybrid and electric vehicles due to their ability to handle power during acceleration and braking. The combination of a flywheel device with a battery source has several advantages
such as high peak power capacity, high energy density and reduction of the number of charge/discharge cycles of the battery. The novelty of the system in development at the Uppsala University is the use of a high-speed flywheel machine prototype as a kinetic energy storage system. The prototype is a double wound three-phase permanent magnetic synchronous machine, levitated axially with four units of Halbach arrays in a repulsive configuration. This paper presents the simulation of the proposed driveline configuration: a series connection of the battery, flywheel and vehicle motor. Power converters are needed to handle the power flow in the driveline and the adjustment of the control system is one of the studies of the present work. This work presents a small-scale simulation, validating the possibility of use of the machine in real vehicular applications.

Low Cost Heading Sensing System for an Autonomous Aquatic Surface Vehicle  346
Thales Portes de Almeida; José Roberto Monteiro; Geyverson Teixeira de Paula; Marcelo Patricio de Santana; William César Andrade Pereira; Carlos Matheus Rodrigues de Oliveira

This work describes the development of a heading reference system composed of low cost inertial sensors with MicroElectroMechanical Systems (MEMS) technology, which present high noise levels. Thus, filtering and sensor's measurements fusion is done in order to achieve a reliable estimation, through an extended Kalman filter. The system is used for navigation and control of an autonomous aquatic surface vehicle. In this work, the principles of inertial navigation, orientation representation as well as the coordinate frames involved are investigated, presenting the quaternion method, and the update procedure according to the heading changes. The developed system was tested in the lab and on a trimaran shaped vessel navigating on a dam.

Smart Modules for Lighting System Applications and Power Quality Measurements  352
Milena Pinto; Guilherme Soares; Thiago Mendonça; Henrique Braga

Smart lighting applications are designed to provide management and control of the whole interconnected system, ensuring reliability, cost saving and high efficiency. In this work is proposed a simple intelligent module to be connected in the street lighting system in order to simultaneously control and measure the lamps parameters. All the data transmission procedure was developed based on the mesh network topology. By taking advantage of the communication structure used for the smart lighting system and coupling sensors to the module, it is possible to gather data regarding the power grid as well. Moreover, for experiments purposes, it was also developed a specific driver capable to communicate by DALI protocol in order to receive and send information from the smart module to the lamp. The results have proven the efficiency, flexibility and interoperability of the proposed smart device.

A Fast Dynamics and PWM-Dimmable LED Driver for Accurate Control of Illumination in Plants Physiology Experiments.  360
Camila Almeida; Pedro Almeida; Milena Pinto; Rodolfo Lacerda Valle; Carlos Martins; Henrique Braga

This work presents an electronic system in order to provide a simplified and efficient alternative for plants physiology experiment as well as for its utilization in greenhouses. Initially, it is shown a brief description regarding the artificial lighting and plants cultivation interaction, aiming for the interpretation about plants behavior in botanic studies and to help the oriented and commercial crops purposes. Based on some previous work, it is proposed an autonomous system comprised of a white LEDs lighting fixture. Moreover, this paper includes the prototype experimental results in order to evaluate converter efficiency and radiometric lamp behavior. Thus, the results has shown that the developed system is able to integrate flexibility, accurate control and relevant radiometric for some selected crops.
3SCC (Three State Commutating Cell) Converter to Charge Batteries of the Micro-Grid with Photovoltaic Modules

Walbermark dos Santos; Henrique Rocha e Mamede; Thiago Antonio Pereira; Denizar Martins

This paper presents a new form to charge batteries with photovoltaic modules. The main element of the system is a buck-boost converter based on three state commutating cell (3SCC). Here, the converter is used as voltage divider of dc bus battery bank of the micro-grid with photovoltaic modules.

A Low-Cost GPRS Based Communication System for a Smart Transformer

Abel Gehm; Josemar de Oliveira Quevedo; Mário Lúcio Martins; Rafael Concatto Beltrame

One of the most important challenges for the development of smart grids is the online communication among different suppliers and consumers in order to guarantee its efficiency and reliability. Among the current set of communication technologies suitable for smart grids, those based on cellular communication systems present an advantage of low investment from the power distribution company, since mobile network operators provide most of the required infrastructure. In this context, this work presents a communication device that makes use of the General Packet Radio Service (GPRS) to transmit/receive data, through the internet, to/from a local data server. The proposed solution is applied to a distribution transformer with on-load tap changer, allowing the development of a smart transformer, which enables voltage regulation and grid management.

Day Ahead Schedule of Remote Microgrids with Renewable Energy Sources Considering Battery Lifetime

Santosh Chalise; Reinaldo Tonkoski

Remote microgrids are a viable option for electrification where the main grid expansion is either impossible or not economical. Typically, remote microgrid consists of diesel generator as a primary source of energy which has a high fuel cost. Renewable energy sources can be used to reduce the fuel consumption with proper coordination and scheduling methods. Storage devices, usually battery, used in remote microgrid are expensive and toxic in nature; therefore battery lifetime is another important parameter to be considered during microgrid scheduling. In this paper, four test cases were developed for the study of fuel consumption. Problems were formulated as mixed integer programming (MIP) and solved using GAMS/CPLEX 12.6 solver. Furthermore, the battery lifetime model was included in the optimization model and fuel consumption was compared with other cases. Results show the slight increment in fuel consumption when the battery lifetime model was included.

Indirect Control of Luminous Flux and Chromatic Shift Methodology Applied to RGB LEDs

Rodrigo Cordeiro; Alexandre Cardoso; Renan Duarte; Dieter Soares; Guilherme Pereira; William Vizzotto; Vitor Bender; Tiago Marchesan

This paper presents a methodology of control for RGB LED systems, modeling and equating of a system of LEDs are shown in detail in order to obtain constant output luminous flux information for each color, reducing the color shift with the temperature variation. Also the paper discusses the control strategy employed and the methodology employed to eliminate the temperature influence on the color shift. Some simulation results are shown in order to prove the methodology, followed by some practical results.

Reviewing of Anti-Islanding Protection

Sâmara Paiva; Flávio Costa; Huilman Sanca; Benemar Souza

Distributed generation (DG) has grown over the years mainly due to environmental issues. DG are many varieties and sizes. This article presents an approach to some of these techniques, pointing out their advantages and disadvantages. The arrival of these new generation sources allowed greater variety in sources of energy, however this brought problems of control, protection, operation of the electrical system, reliability and energy
quality. Of these problems the unintentional islanding is the most dangerous problem in DG. An islanding occurs due to intentional or unintentional disconnection of DG network. If the utility grid is disconnected from the distribution grid (i.e. as a consequence of a short circuit) an unintentional island is formed and of great importance that the DG is disconnected from the utility grid, may cause risks to consumers and the utility. Due to its undesired effect, there are many techniques that have emerged to solve this problem. These techniques are divided into: remote techniques, are communication-based methods; and local techniques, which can be passive or active techniques.

**Power Measurement Using the Maximal Overlap Discrete Wavelet Transform** 400

Denis Alves; Cecilio Neto; Flávio Costa; Ricardo Lúcio Ribeiro

This paper proposes the estimation of active power, reactive power, apparent power, and power factor using the scaling and the wavelet coefficients of the Maximal Overlap Discrete Wavelet Transform (MODWT). The performance of the proposed wavelet-based power measurement was assessed and compared with the IEEE Standard 1459-2010 and the power estimation through the Discrete Wavelet Transform (DWT). As advantage, the MODWT provides power estimation every sampling, which is ideal for real-time analysis.

**Planning Passive Filters using NSGA II for Industry Applications** 407

Jandecy Leite

Abstract Passive shunt harmonic filters are a convenient means of power quality preservation as well as effective reactive power compensators. The problem formulation for the optimization of passive filters has been addressed using various approaches as a single-objective or a multi-objective optimization problem. The present paper considers a new multi-objective formulation for the multiple passive filters selection and placement problem that includes the maximization of the reactive power compensation benefits accomplished by the passive filters as reactive compensators. While previous contributions solve the multi-objective problem by the minimization of a single objective function composite by several sub-objectives, the present paper use the Non-Dominated Sorting Genetic Algorithm (NSGA II) for solving the problem. The algorithm is capable to determine the location and configuration of each filter (type, branch number, frequency tuning and quality factor). The presented algorithm find the best solution for all the buses simultaneously using many filters and also search the reactive power distribution by branch which offers the best results. The effectiveness of the proposed procedure is tested by solving a practical example.

**Sensorless Current Shaping Control Technique for Shunt Active Filters** 415

Marcos Ketzer; Cursino Jacobina

This paper presents a sensorless control strategy for shunt power active filter. The proposed technique, already presented for PWM rectifiers, has the capability to reject harmonic components from the load and grid. An adaptive algorithm is employed to achieve a high power factor in the grid even for uncertain parameters of the circuit impedance and load power. A selective harmonic compensation is obtained by using multiple resonant control tuned in the desired components. Simulation and experimental results are presented for validation of the presented methodology.

**Integrated Quadratic-Boost-Zeta Converter for High Voltage Gain Applications** 422

Antonio Andrade; Rafael Concatto Beltrame; Luciano Schuch; Mário Lúcio Martins

This paper proposes a novel high step-up DC/DC converter named Integrated Quadratic-Boost-Zeta converter. It is based on combination of two DC/DC converters, the Isolated Zeta converter and the Quadratic-Boost converter. The idea presented in this paper is to sum the output voltage of the Zeta and the Quadratic-Boost in such way that each part of the output keeps the same characteristic of its former converter. That topology is
derived from a simple integrated converter topology which has reduced number of the switches and associate circuits. According to the project, it can be possible obtain a low output current ripple due to the output inductor. Preliminary results from simulation in PSIM demonstrate the operation and characteristic of the proposed converter.

PV Module-Integrated Single-Switch DC/DC Converter for PV Energy Harvest with Battery Charge Capability

Antonio Andrade; Rafael Concatto Beltrame; Luciano Schuch; Mário Lúcio Martins

This paper proposes a novel PV module integrated system with energy storage capability. The topology is based on the Future Renewable Electric Energy Delivery and Management (FREEDM) System, where Distributed Renewable Energy Resources (DRER) comprised by a single power stage, are responsible for the Maximum Power Point Tracking (MPPT) of each PV module and also the charging method of a centralized battery pack. Due to the characteristics of the PV module and the DC-bus, the single power stage must provide low current ripple in the input and output terminals, must operate with output current and voltage regulation and present a high voltage conversion ratio. To achieve such features, this paper proposes a novel boost-Zeta integrated converter. The analysis of the operation of this converter is carried out in details. The MPPT algorithm and the charging method are discussed in detail. The DC-DC converter is designed to ensure low ripple and limited charging current, as well as voltage regulation when the batteries are fully charged. In this version of the paper, preliminary simulation results are presented for the converters confirming the theoretical analysis. In final version of the paper, experimental results will be presented.

Saving Energy on Shop Floor Control Level - Prerequisites for Energy-Related Scheduling within Manufacturing Execution Systems

Werner Herfs; Adam Malik; Stephan Gsell; Wolfram Lohse

Energy efficiency is becoming an important topic for the manufacturing industry. Nowadays the unique features of production systems like precision, endurance, flexibility and initial costs must be extended by the energy efficiency. Using different control strategies on shop floor control level promises energy savings and prevention of unwanted high power peaks. This paper focuses on the investigation of prerequisites required to implement energy saving on shop floor control level within a manufacturing execution system. Electrical energy measuring methods together with evaluation heuristics and energy consumption models for robots and machine tools are shown. The concepts are validated using a production scenario based on a machine tool, two robots and a band conveyor. An application of the energy saving methods for manufacturing execution systems is shown.

Multifunctional Converter for Power Quality and Power Flow Control in Wind Distributed Generation Systems

Filipe Braga; José Pomilio; Jakson Bonaldo

This paper presents a shunt-connected converter for interfacing a distributed generation system and the grid, with focus on uncontrolled small power wind power generators. The objective is to show that the converter, with a suitable control strategy, is able to impose sinusoidal voltage and, in most cases, guarantee the compliance of the grid voltage with the THD standard levels. The strategy allows, simultaneously, the power flow regulation, current harmonic.

Portable system for monitoring and recording multivariate workplace environmental variables in hydroelectric power plants

André Andreoli; Marcelo Franchin; José Cagnon

This paper presents research and development results of a prototype portable system designed for monitoring and recording HPP (Hydroelectric Power Plant) workplace environment data (noise, vibration, pressure,
temperature, gas concentration and light level), related to working health conditions observing the requirements from current national and international standards. This has been achieved by using a series of dedicated sensors connected via wireless network to a portable intelligent computing platform in order to diagnosis the risks which workers are subjected to and also for improving the quality of life at work. The main contributions of this work are highlighted by technological innovation in state of the art of hardware and software components used (sensors, microcontrollers, computer, operating system, etc.), simultaneous multivariate acquisition and recording of environment workplace data, a novel methodology able to measure, record, analyze and diagnose risks, automatic generation of technical reports and risk maps, and creation of an innovative database for planning and following preventive and corrective maintenance actions over workplace conditions. The final product may be used by any company of electricity generation, especially HPP. Furthermore, it will be of great value to the whole electric power industry, particularly power generation, as it will allow an integrated real-time and continuous monitoring of occupational risks, helping work-related injury and illness preventive actions as a permanent preventive occupational safety and health program, thus resulting in an increasing of quality and reliability aimed for excellence. The research and development prototype was successfully designed, produced and tested through P&D funding from a HPP company at Sao Paulo.

Steganographic Safety Layer over IP  460
Paulo Pisani; Nunzio Torrisi

Industrial communications have been evolving and, nowadays, in view of the demands for horizontal and vertical integration, the number of applications consuming safety data over IP networks have also been increasing. In light of this scenario, instead of using a safety fieldbus protocol over IP, this paper proposed the use of some principles from IEC 61784 over a common TCP/IP channel. As the optimization of bandwidth use is a key factor in Internet communication, this paper proposes a lightweight safety layer in terms of both computational and bandwidth costs, with the use of concepts from steganography to provide safety. Through the paper, some measures to allow such a safety communication over TCP/IP are presented and, finally, an evaluation of the proposed protocol for safety data is performed, showing it may be able to reach both SIL3 and SIL4 depending on the BER of the considered communication channel.

Street Lighting LED Luminaires Using Telemenagement Systems: Study of Case  467
Fernando Nogueira; Vinicius Albuquerque; Luiz Gouveia; Cristiano Gomes Casagrande; Danilo Pinto; Henrique Braga; Igor Melo

The main purpose of this paper is to analyze the performance of LED luminaries and to analyze the remote management integrated into them. These luminaires come with a remote monitoring system based on ZigBee protocol, and it allows wireless communication using GSM / GPRS, the most used technology around the world provided by mobile network operators. With photometric tests, electrical and performance analysis of the luminaires in according to the standards, this paper aims to study the operation of the whole system in a pragmatic way and to evaluate the actual performance and the possible positive and desired results on the public lighting system.

Preliminary evaluation of Bollinger deadband filtering using upper and lower bands  475
Nunzio Torrisi

In this paper, the author investigates the use of the Bollinger Bands theory to compute the deadband sampling algorithm of unbounded variables. In this scenario the dead-band algorithm has to be adapted to compute the filtering using a new dynamically preset interval derived from the Bollinger Bands theory for financial applications. The number of filtered samples and the integral absolute error are adopted as metrics to compare performance results of the new original deadband proposed, named Bollinger Deadband, with the results of the classic absolute deadband algorithm. The signals adopted for the simulation are based on the pseudo periodic
time series. For these signals the effectiveness of the Bollinger deadband is explored as alternative sampling method when the signal limits are unknown a priori.

A Proposal for Time-Current Curves Elaboration based on Modern Commercial Softwares
Fernando Grigoletto

The use of dedicated Time-Current softwares for Protection Coordination Studies experiences a constant increase. The ever growing appliance, along with the Time-Current curves design degrees of freedom, demands a standardization of the whole process. In this scenario, we introduce in this work electrical system devices modeling techniques for Protective Coordination Studies. Also, we suggest rules for Time-Current curves design.

Low cost implementation of a inverted pendulum control system
Adalberto Lazarini; Jean Ribeiro; Marcus Jorgetto

Motivated by the need of testing control strategies, where students can observe the importance of practical test in control theories, and the high price of testing platforms, this study target the classic inverted pendulum control system construction and implementation using wasted components from printers and hard drives, electronic components and an open source microcontroller, resulting in a low cost didactic plant, that not only can be used by graduate students, but even for high-level control theories. In this paper, method of modern control by placement poles with help Ackerman's method is presented.

Off-line a Single-Stage Resonant Switched Capacitor High-Power-Factor LED Driver
Esio Eloi dos Santos Filho; Edilson Sá Jr.; Rodrigo Linhares dos Santos; Pedro H. A. Miranda; Fernando Antunes

This paper proposes a resonant switched capacitor-based converter to driver high power light emitting diodes (LEDs). Unlike the traditional switched capacitor based one, the proposed converter uses an inductor to avoid the forced charging and discharging operation reducing stress current in circuit. The proposed converter provides inherent power factor correction (PFC) and the switched capacitors are used as isolation capacitors. The basic description of the topology is presented and a 48 W, 220 V ac grid laboratory prototypes has been implemented. The experimental results presented demonstrate the technical feasibility of the proposed converter applied as LED driver.

A Comparative Study Regarding Linear Fluorescent and LED Lamps for Indoor Lighting
Mateus Braga; Fernando Nogueira; Marcos Fidelis; Henrique Braga; Luiz Gouveia

A study methodology to compare the two technologies, fluorescent and LED for T8 tube lamps is presented. Electrical parameters and effects of temperature are compared as well as an analysis of the results obtained in simulations concerning photometric characteristics. A new method for measuring photometric parameters is proposed to replace the current standards. A payback retrofit study concerning LED technology to be applied in a building of the Federal University of Juiz de Fora is also given.

Street Lighting LED Luminaires Replacing High Pressure Sodium Lamps: Study of Case
Fernando Nogueira; Laís Vitoi; Luiz Gouveia; Cristiano Gomes Casagrande; Danilo Pinto; Henrique Braga

This paper deals with the study of the pilot project of street lighting using LED luminaires on the campus of Federal University of Juiz de Fora. Over nine months the system was monitored in order to evaluate the performance of this technology that is gaining ground in the lighting industry. Photometric and electrical results obtained during this period will be presented as well as a comparison with the old lighting system that employs high-pressure sodium lamps based on classical photometry and mesopic photometry, which takes into account
the dynamic visual response of the human eye. In addition, will be done an simplified economic analysis aiming to show the saving generated by the new lighting system and a calculation of payback of the new luminaires.

**Active Power Management in Multiple Microgrids Using a Multi-Agent System with JADE**  507

Frank Ibarra Hernandez; Carlos Canesin; Anurag Srivastava; Ramon Zamora

This paper presents a Multi-Agent System (MAS) to model and enable an active power management in a multiple microgrids system consisting of batteries, photovoltaic and diesel micro sources in islanded or grid-connected operation. The multi-agent system was developed in JADE (Java Agent DEvelopment Framework), a Foundation for Intelligent Physical Agents (FIPA) and a compliant open source multi-agent platform. All the six case studies presented in this paper were modeled using JADE. The cases were chosen considering the real life possible scenarios, such as: discharging the battery (boost mode), energy export from the microgrid, charging the battery (buck mode), energy import from diesel generator, energy import from the grid and the system halt. However, considering that the results for the first two cases can demonstrate the performance and features of the proposed MAS, this paper focuses on the results of these cases. The results demonstrate the effectiveness of the proposed control algorithms, necessary for coordinated control and power management, and show the possibility of autonomous built-in operation of a microgrid with a multi-agent system using JADE.

**Characterization of Solar Panel Using Capacitive Load**  515

Erick Brito; Adriano Antonio; Allan Cupertino; Heverton Pereira

This work aims to design and assemble a characterization of solar panel using capacitive load. This device provides information that allows the user to increase the efficiency of power generation in photovoltaic systems. The detection of operation issues or abnormal conditions such as partial shading caused by dirt or objects can affect adversely the maximum power point. In the first step, simulation results were used to validate the model and allowed the development of the device, in the second step. Tests were realized with the prototype in a panel of 48 W. The measured results present accuracy when compared with the simulated results validating the prototype.

**Adaptive Saturation Scheme for a Multifunctional Single-Phase Photovoltaic Inverter**  522

Lucas Xavier; Allan Cupertino; Heverton Pereira

Power inverters are essential components of the photovoltaic systems. During many operational conditions the inverters have a current margin which can be used in reactive power and harmonics compensation. However, it has a maximum limit of current which cannot be exceeded during the compensation. This work proposes a strategy of current dynamic saturation for ensure the inverter workings below of the rated current. In order to detect the saturation point, it is proposed a peak detection algorithm to determine if the inverter current reached the limit. It is used a scheme based on the Conservative Power Theory (CPT) to separate the load current components. Simulation results show the performance of the proposed dynamic saturation technique, providing adequate operation of the inverter.

**A high accuracy Fuzzy-Logic based fault classification in double-circuit transmission corridors**  530

Ezequiel Oliveira; Alexandre Anzai; Wander Gaspar

In this paper, a Fuzzy-Logic based fault classification technique is proposed. The technique was tested and validated in double-circuit transmission lines considering ten fault types simulated in Simulink SimPowerSystems® package in MATLAB® software. Obtained results indicate that the proposed technique has a high accurate rate in fault classification using only measures of three phase phasor currents at one end of the transmission line. The high accuracy rate was confirmed through extensive simulations considering several pre-fault operations conditions and applied fault types.
60W Incandescent Lamp Alternatives Found in Brazilian Market  537
Mateus Braga; Thainan Theodoro; Jorge Felipe; Claudiomiro Junior; Yuri Calil; Henrique Braga
The first incandescent lamp was made available on the world market for more than 130 years and today is one of the most used in Brazilian residences. But their efficiency in lighting is very low and the emergence of other more efficient technologies and the major concern with its use energy efficiency is becoming obsolete even being very cheap. The Brazil following the global trend established limits of energy efficiency for light bulbs sold in the market, thereby prohibiting the production and import of incandescent lamps. This gradual ban has been occurring since 2010. In July of this year it was the time of the 60W bulb, the most used. This paper aims to analyze the photometric and electrical characteristics of the alternatives of the incandescent lamp of 60W found in the Brazilian market, providing additional information for a better choice.

Comparison of control strategies for grid-connected photovoltaic systems during unbalanced voltage dips  545
Edmar Cota; Lucas Xavier; Allan Cupertino; Heverton Pereira
Unbalanced voltage dips are common disturbances in power systems. Therefore, grid-connected photovoltaic systems need to be able to work during these disturbances. Conventional control strategies do not consider the negative sequence current control. This is an important limitation. In this context, this paper compares through simulations performed in Matlab/Simulink environment four strategies of negative sequence current control: Notch filter based strategy, measured signals decoupling based strategy, reference and error signals decoupling based strategy and resonant controllers based strategy. To represent the point of common couple (PCC), experimental measurements of an unbalanced voltage dip are used. These techniques are compared during unbalanced voltage sags and the impact of harmonics in PCC voltage are analyzed. The obtained results shows resonant controllers based strategy has a superior behavior, in terms of robustness and simplicity.

Comparison Between K-Nearest Neighbors, Self-organizing Maps and Optimum-Path Forest in the Recognition of Packages using Image Analysis by Zernike Moments  553
Rodrigo da Silva; David Coelho; George The; Marcel Mendonça
The recognition of objects using images industrial sensor is an important tool, that have been motivated by the development of systems that can automatically recognize any type of objects, to the industrial automation. An interesting problem is the automatic reading and the high reliability in the classification of objects. In this context, this paper presents a comparison between k-Nearest Neighbors Classifier using Euclidean, City Block, Cosine and Correlation distance metric, the Self-Organizing Map (SOM) - Artificial Neural Network (ANN) and the Optimum-Path Forest, for classification of images taken from a low-resolution industrial sensor. Classification performance has been compared in terms of extraction time and accuracy using image analysis by Zernike moments.

Wind Power Generation Control System with Squirrel Cage Induction Generator  559
Marcelo Granza
This paper presents a control system of the wind power generation with squirrel cage induction generator (SGIG). The control system is based on the back-to-back converter between the generator and grid. The vector control of the generator-side and grid-side converter was implemented in Matlab/ Simulink/SymPowerSystems. In this work, it is proposed an indirect method, using a model, to obtain the terminal voltages, which reduces the number of require sensors and save overall costs. The simulation results show the effectiveness of this approach.
AC Drive Systems Based on Six-Phase Machine with Three Neutrals  565
Reuben Rezende de Sousa;  Cursino Jacobina;  Victor F. M. B. Melo;  Nayara Freitas

This paper presents an AC drive system based on six-phase machine with three neutrals. The machine side converter has nine power legs and can be connected to the grid through one single DC-link or three isolated DC-links. Compared with the conventional back-to-back AC six-phase machine drive system, the proposed drive system permits to reduce the DC-link voltages, to eliminate the step-up transformer, and the voltage at the grid side converter has higher amplitude than that of the machine side, permitting to reduce the transmission I2R losses. The system model and PWM strategy are presented and experimental results demonstrate the feasibility of the system.

Detection of High Impedance Faults in Overhead Multi Grounded Networks  573
Juan Garcia Arias;  Valdomiro VEGA-GARCÍA;  Nelson Kagan

This article presents a methodology for detection of high impedance faults (HIF). HIF occurs when e.g. a cable makes contact with objects of high electric resistance, resulting in a nonsignificant increase in current. Such faults cannot be detected by traditional protection devices that operate due to overcurrent. The developed methodology is based on making use of variables from a power quality meter (PQM), such as harmonic and sequence components of the currents measured at a substation. Such variables compose descriptors for decision making in artificial neural networks (ANN). In order to test the proposed method HIF events were simulated as well as other common network events using the ATP software. The proposed framework is part of a HIF detection system to be implemented in a substation of an electric utility in the state of São Paulo.

Performance Comparison of Buck-boost Family Converters for Driving LED Lamps  579
Paulo de Faria;  Fernando dos Reis;  Henrique Cabral;  Ana Marques;  Guilherme Pedrollo

This paper establishes a comparative study between drivers based on the DC-DC SEPIC, Čuk and Buck-boost converters operating in the Continuous Conduction Mode (CCM) when coupled with photovoltaic (PV) panels to drive an LED lamp as load. The main goal of this study lies in the investigation of the efficiency, component stress and performance achieved by each topology. The modeling and simulation of the computational models were made in a standard PSIM software environment. Physical prototypes were then developed in order to carry out the proposed comparison.

Additional Paper

A Decentralized Current Sharing Control Strategy for Output Parallel-Connected Dc-dc  587
Converters with True Redundancy

V. P. Oberto;  M. D. Depexe;  T. C. Naidon;  A. Campos

This work presents a decentralized current sharing control technique for a modular power supply composed of n output parallel-connected DC-DC converters. Each converter is connected to the load through individual line resistance. A phase shifted PWM signal, whose phase is proportional to each converters measured output resistance, is used to control switch state, generating a small power flow at switching frequency between connected units. In order to provide proper load sharing, a voltage reference adjustment for the main control loop is done through the weighted sum of measured reactive power at switching frequency and load current controller output. A distributed power system with three buck converters feeding a 75 W Light Emitting Diode (LED) street lighting fixture is tested with simulations to prove the feasibility of the idea.