



# 8<sup>th</sup> International Seminar on Electrical Metrology

## Final Program

June 17 - 19, 2009  
João Pessoa, Paraíba - Brazil

Realization  
Realização



## Chairman's Welcome Message

Dear participants and guest of VIII Semetro, it is a pleasure to welcome you all to the city of João Pessoa, in northeast of Brazil. From 17 to 19 of June, 2009, with the support of the Federal University of Campina Grande, of the National Institute of Metrology, Normalization and Industrial Quality and of the Brazilian Society of Metrology we are here for the 8th International Seminary of Electrical Metrology. The VIII-Semetro has the purpose of increasing the development of electrical metrology and instrumentation, particularly in Brazil and Latin America, gathering people and organizations to produce knowledge and scientific culture, encouraging discussions among academics, researchers and specialists from Brazil and abroad.

This 8th edition is consolidating the presence of the Brazilian universities, here represented by UFCG, in the Semetro as one of its pillars, that along with INMETRO and SBM, are contributing to elevate this conference to one of the most important on the measurement science in the south hemisphere.

Similarly to earlier editions, the VIII Semetro also welcomes those working with electrical instrumentation and urges them together with the metrology community, represented by people from the calibration laboratories and metrology networks, to participate in all sections of the event. The association of these two important and highly correlated fields has culminated in paper submission equally divided between both areas.

The electrical instrumentation community in Brazil was demanding a scientific forum where it could present and discuss its works. Some previous attempts were made to overcome this need, among them we can mention three regional meetings on instrumentation and scientific metrology – ERIMC – that took place in the UFCG from 2002 to 2004, with the participation of many academics, researchers and students from the north and northeast regions of Brazil. The association of this community to the already traditional Semetro has come to fulfill this need besides broadening the involvement of this field in the Semetro.

There were more than 120 papers submitted to the VIII Semetro, from 21 countries and from all regions and nearly all states of Brazil. This large increase in the numbers represents an important evolution on the promotion and interaction of all those working on electrical instrumentation and metrology in Brazil, Latin America and in many other countries.

The Federal University of Campina Grande – UFCG, the National Institute of Metrology, Normalization and Industrial Quality – INMETRO and the Brazilian Society of Metrology – SBM welcome and wish that all the participants of the VIII Semetro enjoy the fellowship, the stay in João Pessoa and have a beneficial participation in the Conference.

*Raimundo Carlos Silvério Freire*  
Conference Chairman

## VIII Semetro Executive Committee

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Ivan Souza e Silva, *UFPA, Brazil*  
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Marcelo Werneck, *UFRJ, Brazil*  
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Regis Landim, *Inmetro, Brazil*  
Samuel Benz, *NIST, USA*  
Smail Tedjini, *Grenoble-INP/LCIS, France*  
Tan-Phu Vuong, *INPG, France*  
Yi-hua Tang, *NIST, USA*

## Reviewers

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Ademir França	Francisco Vidal
Adriano Cunha	Gelson Rocha
Adrião Duarte Dória Neto	Giovanna Almeida
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Amauri Oliveira	Gregory Kyriazis
Ana Maria Franco	Guilherme Araujo
Antônio Carlos Borré	Guilherme Garcia
Antonio Petraglia	Gutemberg Lira
Antonio Souza	Helder Paula
Armando Sanca	Helio Schechter
Ayoub Otmani	Hugo Figueroa
Benedito Luciano	Isabel Fraga
Bruno Albert	Ivan e Silva
Caiuby Costa	Janice de Brito Fernandes
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Chantal Gunther	Jean-Marc Routoure
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D. Fernandes Junior	José Ferreira
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Edmundo Hoyle	Kelson Aires
Edson Afonso	Leonardo A Borges Torres
Edson Guedes	Luiz Ribeiro
Eduardo Freire	Marcelo Werneck
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Elyson Carvalho	Marcus Barroso
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Evandro Gomes	Márcio Fontana
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Rosane Debatin  
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Silvangelá Barcelos  
Smail Tedjini  
Stéphane Flament  
Tales Pimenta  
Tan-Phu Vuong  
Vanderson Teixeira  
Vincent Bourguet  
Wallace Couto Boaventura  
Yi-hua Tang

## Social Events

### Opening Cocktail

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Wednesday, 17

The VIII Semetro Opening Cocktail will be held at the swimming pool pergola located at the Tambaú Hotel ground floor, from 19 h to 21 h. During the cocktail there will be a presentation of the musicians of the Grupo Folclórico SESC.

### Conference Dinner

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Thursday, 18

The VIII Semetro Celebration dinner will be held from 20 h to 22 h at the Mangai Restaurante (regional dinner) located at the Av. Edson Ramalho, 696 - Manaíra.



## Tutorials

The VIII Semetro will have two days dedicated for tutorials, The Inter-American Metrology System (SIM) Training and Development on Electrical Metrology, on Monday 15 and Tuesday 16. Tutorials will be held on Cabo Branco Room I, from 9 h to 13 h and from 14 h to 18 h.

### Tutorial 1

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#### *High-accuracy DC Voltage Measurements*

**Carlos Avilés, CENAM, Mexico**

*Monday 15, 9 h – 13 h (Spanish)*

This tutorial will be held on Spanish language and covering the following contents:

- DC voltage traceability;
- Standard based on Josephson effect;
- Zener references; Scaling methods; and
- High accuracy multimeters

### Tutorial 2

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#### *DC Resistance Measurements*

**Randolph Elmquist, NIST, USA**

*Monday 15, 14 h – 18 h (English)*

This workshop will describe dc resistance measurement practices suitable for maintaining traceability in National Measurement Institutes of the SIM region. The basic precepts are that the laboratory obtains traceability through transfers of standard resistors at key levels, maintains and scales the resistance unit to working standards, maintains check standards, and calibrates customer standards with appropriate uncertainties. Topics that are covered include:

- Types and properties of standard resistors;
- Laboratory requirements such as measurement systems and environmental controls;
- Scaling techniques suitable for different resistance levels;
- Uncertainty budgets and types of uncertainty, basic statistical concepts, control charts, and prediction of drift in working standards.

## Tutorial 3

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### *AC-DC Thermal Transfer Standards and Calibrations*

**Peter Filipski, NRC, Canada**

*Tuesday 16, 9 h – 13 h (English)*

This tutorial will concentrate on the practice of the ac-dc transfer measurements. After a short but necessary theoretical introduction, practical aspects of the ac-dc voltage and current transfer will be discussed. The topics will include:

- Primary and secondary standards used by the leading laboratories;
- Practical construction of an ac-dc transfer comparator;
- Extensions of voltage and current ranges;
- Extension of the operating frequency ranges;
- Practice of routine measurements and calibrations;
- Typical components of uncertainty.

If time permits, some more exotic techniques, such as fast reverse dc measurements and ac Josephson voltage standards (ACJVS) will also be introduced.

## Tutorial 4

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### *Power and Energy Measurements*

**Daniel Slomovitz, UTE, Uruguay**

*Tuesday 16, 14 h – 18 h (Spanish)*

This tutorial will concentrate on the general theory on high precision power measurements at national and secondary calibration laboratories. However, some time will be used to discuss the performance of other related meters used for billing purposes. The topics will include:

- Metrology bases of power and energy;
- Traceability to primary standards;
- Voltage dividers, measuring transformers;
- Principles of power measurements: analogue instruments, adding devices, thermal converters, TDM, digital transducers;
- Phase and power-factor measurements;
- Energy measurements in high voltages networks;
- Effects of signal distortion.

## Plenary Sessions

The VIII Semetro will hold six plenary sessions with international invited speakers covering fields on instrumentation and metrology. Plenary sessions will be held during the morning, each with 50 minutes duration.

### Plenary 1

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#### ***Micro-Nanosystems for Electrical Metrology and Precision Instrumentation***

**Alexandre Bounouh, LNE, France**

Results of work undertaken for exploring MEMS capabilities to fabricate AC voltage references for electrical metrology and high precision instrumentation through the mechanical-electrical coupling in MEMS devices are presented. Several first devices have been designed and fabricated using a Silicon On Insulator (SOI) Surface Micromachining process. The measured MEMS AC voltage reference values have been found to be from 5 V to 100 V in a good agreement with the calculated values performed with Coventor and Comsol finite elements software. These test structures have been used to develop the read-out electronics to drive the MEMS and to design new devices with improved characteristics.

### Plenary 2

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#### ***Proposed Changes to the Definition of the Ampere and the Kilogram and their Influence in Electrical and Mass Measurements***

**Hector Laiz, INTI, Argentina**

The proposed redefinition of four base units of the International System of Units (SI) has produced an exciting scientific debate. The electrical metrology community will benefit from the reduction of the uncertainty of fundamental measurements related to the SI.

This presentation analyses the alternatives to the definitions and their impact on electrical and mass metrology.

## Plenary 3

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### ***Bolometric Application at Room Temperature***

**Chantal Gunther, ENSICAEN, France**

In this work,  $\text{La}_{2/3}\text{Sr}_{1/3}\text{MnO}_3$  (LSMO) thin films with high temperature coefficients have been chosen as thermometers for use in bolometric applications at room temperature and their temperature coefficient of resistance and noise characteristics were carefully measured. The Noise Equivalent Temperature (NET) value of  $6.10^{-7} \text{ K}/\sqrt{\text{Hz}}$  at 10 Hz and 150  $\mu\text{A}$  current bias for LSMO has been obtained in the 300 K - 400 K range. Our results are compared to literature and to other types of materials such as semiconductors (a-Si, a-Si:H, a-Ge, poly SiGe) and other oxide materials (semiconducting YBaCuO, VOx and other manganite compounds). The possible use of these thermometers with such low NET characteristics for the fabrication of both membrane-type bolometers for mid-infrared detection and antenna coupled bolometers for THz applications is discussed. Finally, we present the concept of a narrow band THz gas sensor, based on antenna-coupled bolometer.

## Plenary 4

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### ***RFID: State of the Art and Current Developments***

**Smail Tedjini, Grenoble-INP/LCIS, France**

Needs of identification and authentication are topics of great importance in modern societies. Many domains of the society such as economy, health, security and defense, education, among others are demanding the identification and/or the authentication. Sixty years after the proposal of Harry Stockman to use reflected powers as mean to communicate, this concept is widely applied in the identification technology called RFID (RadioFrequency IDentification). The huge advances in both electronic and communication, especially in the integration technologies during the last decade has opened the doors to the development of very efficient tags covering a large variety of applications. Tags are usually composed of a microelectronic chip connected to an antenna. The later serves to harvest energy, receive the reader interrogation and send the information from the tag to the reader. Technically the design of tags still a challenge since it must satisfy many constraints such as low power of activation, large distance of communication, small size and robustness to detuning.

Nowadays, the RFID is used in numerous areas. More than 3000 study cases to implement RFID are pointed out in the literature. They

include Electronic passports, animal and plant tagging, logistic of items and containers, control and security. The RFID continues to advances very rapidly, even if some societal interrogations appear regarding privacy and data security. It is considered in new areas like health and medicine, smart dust and more recently what we called internet of things.

This conference will present the state of the art of RFID and will describe the physics and technology behind the RFID systems. A selection of RFID application will be presented. The last part will address the technological advances, including chipless and printed tags that will increase the attractivity of RFID and enlarge its field of application. Some market perspectives will conclude the conference.

## **Plenary 5**

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### ***Towards Uniformity of DC Voltage Metrology within SIM***

**Yi-hua Tang, NIST, USA**

Josephson voltage standard (JVS) is an intrinsic standard maintained in many National Metrology Institutes (NMIs) around the world. JVS can be widely used to disseminate the Volt, a derived unit in the International System of Units (SI), which is ultimately related to other units in electrical metrology, such as Watt for the electric power, ac voltage via ac-dc difference etc. In order to establish equivalence among JVSs maintained by the NMIs a key comparison or supplementary comparison is necessary to test the measurement techniques, including the hardware and software used by the different JVSs. This paper describes the development of protocols and activities for the JVS comparison over the last several years while focusing the uniformity of DC voltage metrology in the Sistema Interamericano de Metrologia (SIM). A recent development for automatic JVS direct comparison is also presented. This approach for JVS comparison can improve the efficiency of data acquisition and save the cost for the operation. It will be applied to a planned INMETRO-NIST direct JVS comparison to link the INMETRO to BIPM.

## **Plenary 6**

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### ***Analog to Digital Converters Testing***

**António Manuel da Cruz Serra, Technical University of Lisbon, Portugal**

Analog to digital converters (ADCs) are the front end of most of the modern measuring instruments. They affect crucially the interpretation

of signals acquired from the real world into the digital domain. ADCs influence dominantly the accuracy of the instruments and limit their bandwidth. The exact ADC error description using standardized testing procedures are needed to evaluate instruments performance. This will be an important task for metrologists in the next future. The paper is aimed at providing a metrological overview of ADC testing.

## Exhibitors

### FURNAS

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Furnas was created to overcome the energetic crisis that used to threaten, in the 50's, the supply of the main economical Brazilian centers: São Paulo, Rio de Janeiro and Belo Horizonte.

Nowadays, FURNAS operates in Distrito Federal, São Paulo, Minas Gerais, Rio de Janeiro, Espírito Santo, Goiás, Tocantis, Mato Grosso, Paraná and Rondônia. The company holds a complex of eleven hydroelectric power stations and two thermoelectric plants, resulting in a 9.910 MW power that represents nearly 10% of national power production divided in 7.971 MW power applied in own power stations and 1.939 MW in a partnership with the private sector. Furnas also has 19.277,5 km of transmission cables and 46 substations that warrants the supplying of electrical energy in an area where 51% of Brazilian houses are situated and are responsible of 65% of Brazilian GDP.

### Eletróbrás

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The biggest company of the electric power sector in Latin America Created in 1962, Eletróbrás (Centrais Elétricas Brasileiras S.A.) is the leader of a system consisting of six subsidiary companies, six distribution companies, the Electric Power Research Center (Cepel) and Eletróbrás Participações S.A. (Eletrópar) and is also holder of 50% of the capital stock of Itaipu Binacional.

Eletróbrás System acts in an integral form, with policies and guidelines set forth by the Senior Board of Eletróbrás System (Consize), comprised by the presidents of the companies from the System, who meet on a regular basis. Eletróbrás gives support to strategic programs from the federal government, such as the Programa de Incentivo às Fontes Alternativas de Energia Elétrica (Proinfa), the Programa Nacional de Universalização do Acesso e Uso da Energia Elétrica (Luz para Todos) and the Programa Nacional de Conservação de Energia Elétrica (Procel).

### Fluke

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Fluke Corporation is the world leader in the manufacture, distribution and service of electronic test tools and software.

Since its founding in 1948, Fluke has helped define and grow a unique technology market, providing testing and troubleshooting capabilities that have grown to mission critical status in manufacturing and service

industries. Every new manufacturing plant, office, hospital, or facility built today represents another potential customer for Fluke products.

From industrial electronic installation, maintenance and service, to precision measurement and quality control, Fluke tools help keep business and industry around the globe up and running. Typical customers and users include technicians, engineers, metrologists, medical-device manufacturers, and computer network professionals — people who stake their reputations on their tools, and use tools to help extend their personal power and abilities.

Fluke has achieved the number one or number two position in every market in which it competes. The Fluke brand has a reputation for portability, ruggedness, safety, ease of use and rigid standards of quality.

A wholly owned subsidiary of Danaher Corporation (NYSE:DHR), Fluke is a multi-national corporation headquartered in Everett, Washington, USA. Manufacturing centers are located in the USA, the UK, Asia and The Netherlands. Sales and service subsidiaries are located in Europe, North America, South America, Asia and Australia. Fluke Corporation has authorized distributor and manufacturer representative channels in more than 100 countries and employs approximately 2,400 people worldwide.

## **BOHNEN+MESSTEK**

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A company with more than two decades providing solutions for companies in the electrical sector, based on the major global brands (MTE, Haefely/Tettex/Hipotronics) in calibration and electrical testing.

Meet the needs of power utilities, equipment manufacturers, laboratories and providers of services, on solutions in calibration of reference standards, electricity meters, metering systems and measuring instruments and electrical test, measurement and diagnostic, including those in high voltage, stated on national and international standards.

"Calibration and testing is our nature."

## **Rohde & Schwarz**

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Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radio monitoring and radio location, as well as secure communications. Established 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany. Our Test & Measurement instruments are in use around the world. Prime contractors, subcontractors, and military services alike choose Rohde & Schwarz to meet their most demanding test needs. Rohde & Schwarz



develops, produces and markets a wide range of instruments, as measuring receiver, signal source analyzer, spectrum analyzer, signal analyzer, wideband monitoring receiver, analog signal generator, test receiver, external frequency converters, microwave signal generator, vector signal generator, audio analyzer, ILS/VOR analyzer and power sensors among others.

## **Radian Research**

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Radian Research, Inc. is a recognized world leader of Energy Reference Standards, Energy Meter Testing Systems, Current Transformer Testers, DC to AC Transfer Standards, and Automated Laboratory Energy Reference Systems. Radian provides both portable and primary energy reference standards that are absolutely unequaled in accuracy, stability and reliability.

## **Brazilian Society of Metrology**

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Brazilian Society of Metrology, SBM, created in 1995, is a civil association that unites professionals and companies with the objective to develop the Brazilian Metrology and its arrangement with the tendencies in the worldwide trade.

It is a technical-scientific organization created for the metrological cultural development and its applications in standardization, conformity evaluation, essays, calibration, analytical methods, reference materials, metrological reliability, management of laboratorial quality and related areas.

Mission: To promote the metrological culture and its practice as instruments of competitiveness and quality of life.

Vision: To be an independent and representative entity, oriented to the scientific and technological development of metrology, with credibility to the society.

## **Measurements International**

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Measurements International is the world's leading manufacturer of metrology based calibration products for temperature, DC Resistance, DC Voltage and AC Power all of which are used in standards and metrology laboratories worldwide.



## VIII Semetro Tutorials

### SIM Training and Development on Electrical Metrology

	<b>Monday, 15</b>	<b>Tuesday, 16</b>
<b>Time</b>	<b>Cabo Branco I Room</b>	<b>Cabo Branco I Room</b>
09h 00min – 11h 40min	<b>DC Voltage - Part I</b> Carlos Avilés, <i>CENAM, Mexico</i>	<b>AC-DC transfer - Part I</b> Peter Filipski, <i>NRC, Canada</i>
10h 40min – 11h 00min	Coffee Break	
11h 00min – 13h 00min	<b>DC Voltage - Part II</b> Carlos Avilés, <i>CENAM, Mexico</i>	<b>AC-DC transfer - Part II</b> Peter Filipski, <i>NRC, Canada</i>
13h 00min – 14h 00min	(Free time for Lunch)	
14h 00min – 15h 40min	<b>DC Resistance - Part I</b> Rand Elmquist, <i>NIST, USA</i>	<b>Power and Energy - Part I</b> Daniel Slomovitz, <i>UTE, Uruguay</i>
15h 40min – 16h 00min	Coffee Break	
16h 00min – 18h 00min	<b>DC Resistance - Part II</b> Rand Elmquist, <i>NIST, USA</i>	<b>Power and Energy - Part II</b> Daniel Slomovitz, <i>UTE, Uruguay</i>

## VIII Semetro Condensed Program

Start Time	Wednesday, 17		Thursday, 18		Friday, 19	
	Theater	Cabedelo Room	Theater	Cabedelo Room	Theater	Cabedelo Room
07h 30min	Registration <sup>1</sup>					
08h 20min	Welcome coffee		Plenary 3		Plenary 5	
09h 10min			Plenary 4		Plenary 6	
10h 00min	Opening Ceremony		Coffee Break			
10h 30min						
10h 50min	Plenary 1		Session TA1	Session TA2	Session FA1	Session FA2
11h 40min	Plenary 2					
12h 30min	Lunch					
14h 00min	Session WB1	Session WB2	Session TB1	Session TB2	Session FB1	Session FB2
16h 00min	Coffee Break					
16h 30min	Poster Session W <sup>1</sup>		Round Table		Poster Session F <sup>1</sup>	
18h 00min			Reserved to Committee Meetings		Closing Ceremony	
19h 00min	Opening Cocktail					
20h 00min			Conference Dinner			
21h 00min			(Commitment fee applicable)			
22h 00min						

<sup>1</sup>Registration and Poster Sessions will be held on the main lobby.

## Technical Sessions

### Wednesday

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**14h 00min WB1 Automation, Validation and Productivity in  
16h 00min Electrical Metrology**

Chair: Gregory Kyriazis, *Inmetro, Brazil*

Chair: Márcio Sens, *Cepel, Brazil*

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**14h 00min Calibración Semiautomática de Calibradores Multifunción**

Marta Porfiri, Jorge Cioffi, *INTI, Argentina*

Two dedicated softwares for the calibration of multifunction calibrators Fluke 5700A/5720A were developed at our Calibrators and Multimeters Lab. The first one automates the calibration of AC Voltage and AC Current functions. The second one, intended for DC Voltage, DC Current and Resistance calibration, only needs a few external standards and instruments commonly used in metrology labs. With these programs, we reduce the calibration time of precision multifunction calibrators from same weeks to about two days.

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**14h 20min Monitoramento Remoto Via GPRS de Falhas Incipientes  
em Múltiplos Transformadores de Potência**

Mauro E. Benedet, Marco A. M. Cavaco, César A. A. Nogueira, *UFSC, Florianópolis, Brazil*

Régis H. Coelho, *Celesc, Florianópolis, Brazil*

This paper presents the development of a multiple analyzer of gas dissolved in oil. With this equipment it is possible to evaluate the state of deterioration of up to three transformers with a single measurement system. The critical part of this work was the development of remote communication via GPRS (General Packet Radio Service).

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**14h 40min Caracterização de Sistema de Automação de Medição de  
Capacitância**

Renata B. Vasconcellos, Luiz M. Ogino, Anderson D. de Souza, *Inmetro, Brazil*

Neste trabalho é feita a caracterização de sistema de automação para medição de capacitância, tendo por objetivo verificar como medições automatizadas podem influenciar a calibração de capacitores padrão, pontes RLC, pontes de capacitância e décadas capacitivas, em baixa frequência. Para tanto é feito um estudo da influência da automação na incerteza de medição e no sistema de aterramento do laboratório.

**15h 00min**    **Verificação da Exatidão e Linearidade na Medição de Capacitância e Fator de Dissipação**

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Márcio A. Sens, Edson Ueti, *CEPEL/Eletróbrás, Rio de Janeiro, Brazil*

This work describes the experimental procedures for verification of the accuracy and the linearity in the measurement of capacitance and dissipation factor for instruments and systems of measurement. The techniques are applicable to electronic instruments that operate for any principles, as well as the instruments that operate by the bridge system, balanced automatically or manually.

**15h 20min**    **Developing Electrical Metrology in Trinidad and Tobago**

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Francis Hamilton, *Century Drive, Trinidad and Tobago*

This paper provides an overview of the current capabilities and future developmental plans for Electrical Metrology in Trinidad and Tobago. Low frequency electrical metrology is specifically highlighted since the categories of this aspect of electrical metrology are fundamental to building an adequate electrical measurement infrastructure. The five main categories of electrical measurement services emphasized are dc voltage, resistance, time and frequency, impedance, and electric power and energy since these are considered of most importance at this time in the developmental process.

**15h 40min**    **Moving Toward Full Automation of High Accuracy Multifunction Instruments Calibration Systems**

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Vanderson Teixeira, Rodrigo Ventura, Regiane Souza, Renato Afonso Jr., Regis Landim, Edson Afonso, *Inmetro, Duque de Caxias, Brazil*

The main purpose of this paper is to present a simple and straightforward proposal for electronic AC-DC transfer standard (Fluke 792A) automation. It was included in one of our multifunction calibration systems, reducing the calibration time, still keeping the same high accuracy results. Details regarding calibration system as well as ACDC transfer standard automation sub-system and experimental results are shown

**14h 00min WB2 Analysis and Modeling of Measurement  
16h 00min Systems**

Chair: Edson Guedes, *UFCEG, Brazil*

Chair: Eduardo Freire, *UFS, Brazil*

**14h 00min Aspectos de Segurança da Informação em Redes de  
Medidores de energia Elétrica**

Luiz F. R. C. Carmo, Ewerton L. Madruga, Raphael C. S. Machado,  
*Inmetro, Duque de Caxias, Brazil*

No presente trabalho, apresentamos um modelo para a organização de Redes de Medidores de Energia Elétrica e apresentamos abordagens para a avaliação de segurança de tais medidores. Nossa abordagem envolve três etapas: (1) avaliação da arquitetura, protocolos e algoritmos, (2) validação do software da rede de medidores, e (3) avaliação dos mecanismos de verificação de integridade do software. Enquanto as etapas (1) e (2) são tratadas com abordagens convencionais, propomos, para a etapa (3), técnicas inéditas de verificação de integridade, as quais são apresentadas em maiores detalhes.

**14h 20min Simulações de Controle de Polarização do Sinal Óptico**

Janaina Ferreira, Alexandre B. dos Santos, Giovanna Borghi,  
*Inmetro, Duque de Caxias, Brazil*

Jean Pierre von der Weid, *PUC-Rio, Rio de Janeiro, Brazil*

This work presents a simulation tool for calculation of the optical signal polarization. Calculations are performed in time domain, allowing the simulation of the temporal evolution of differential group delay (DGD), principal states of polarization (PSP) and output polarization state (SOP). Results show that using two multiplexed signals we can provide a very good control of the polarization states.

**14h 40min Efeitos dos Erros Não Modelados da Instrumentação de  
Ensaio em Voo na Estimação dos Parâmetros  
Aerodinâmicos de uma Aeronave**

Luiz C. S. Góes, *ITA, São José dos Campos, Brazil*

Ilka R. de Santana, *Empresa Brasileira de Aeronáutica, São José dos Campos, Brazil*

This work presents the analysis of the effects of static and dynamic uncertainties of the flight test instrumentation in the process of aerodynamic parameter estimation through inverse modeling. The M4V methodology for aircraft aerodynamic identification is discussed and the effects of unmodelled sensor dynamics of the flight test instrumentation

in the aerodynamic parameter estimation is analyzed using synthetic flight test data and Monte Carlos simulation. The bias and random errors in the lateral-directional aerodynamic derivatives of a transport aircraft is analyzed for different types of interfering and modifying spurious sensor inputs with the objective to evaluate the important contributions to the polarization of the estimation of the aerodynamic derivatives.

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**15h 00min      New Jitter Measurement Technique Using TDC Principle in a FPGA Component**

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Carlos Marins, *INATEL, Brazil*

Pierre Kaufmann, *Universidade Presbiteriana Mackenzie, Brazil*

Antonio A. A. F. Júnior, Marcelo Paiva, *INATEL, Brazil*

Jacobus Swart, *CTI, Brazil*

The paper presents a new approach for measure and analysis of jitter. The measures are made with the Time to Digital Converters with an electronic implementation that uses VHDL language in a FPGA component. The electronic system data are registered and processed by software that to extract the necessary parameters to characterize this effect in a communication systems.

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**15h 20min      Avaliação da Imprecisão Odométrica em Robôs Móveis Considerando as Incertezas Associadas ao Processo de Fabricação**

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Flavio A. Chagas, Elyson A. N. Carvalho, Eduardo O. Freire, Jugurta R. Montalvao Filho, *UFS, São Cristovão, Brazil,*

Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

Neste artigo e proposto um metodo para avaliar a precisao e a exatidao da odometria de um robo móvel baseado nos erros inerentes ao seu processo de fabricacao. Este metodo consiste na modelagem da estrutura mecânica empregada, e na utilizacao dos conceitos da teoria de propagacao de incerteza.

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**15h 40min      Projeto e Implementação em Silício de um Conversor Analógico/Digital Sigma-Delta de 12 Bits**

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Ronan C. Souza, *DHBH, Belo Horizonte, Brazil*

Diógenes C. da Silva Júnior, Hércules M. Carvalho, *UFMG, Belo Horizonte, Brazil*

Este trabalho apresenta o projeto e implementação de um circuito de sinais mistos de um conversor A/D, de arquitetura Sigma-Delta de 12 bits. A motivação para este projeto é a integração em um die de um medidor de energia elétrica residencial e que seja economicamente viável. Em aplicações reais existe uma grande demanda por interfaces analógicas que por sua vez utilizam conversores analógico-digitais (A/D) e



digitaisanalógicos (D/A). Recentemente uma gama de circuitos analógicos tem sido implementados em processo de fabricação digital permitindo a inclusão de subsistemas analógicos em circuitos integrados predominantemente digitais.

**16h 30min**                      **Poster Session W**  
**18h 00min**Chair: João Bosco Silva, *UFPB, Brazil*Chair: Moema Barbosa, *UFCG, Brazil***Osciloscópio Virtual com dois Canais para Medições de Alta Exatidão**

Patrícia C. O. Vitorio, Marco A. Soares, Ademir M. de França, Luiz N. Pereira, Danielli G. Costa, Giselle C. Moreira, Paulo R. M. Nascimento, *Inmetro, Duque de Caxias, Brazil*

Este artigo é uma descrição sumária da operação do software emulador de um osciloscópio de dois canais, que é parte integrante do sistema de medição adotado pelo Inmetro na calibração de equipamentos em alta tensão CA. O programa trabalha em conjunto com dois multímetros digitais, modelo 3458A, da Hewlett-Packard (HP) ou da Agilent Technologies.

**Calibrador multifunción Fluke 5700A - Diez años de mediciones**

Jorge Cioffi, Marta Porfiri, *INTI, Buenos Aires, Argentina*

A multifunction calibrator Fluke 5700A has been measured during ten years at the Multimeters and Calibrators Laboratory of the Instituto Nacional de Tecnología Industrial (INTI). With the use of the many data obtained due to systematical calibrations, the uncertainty of the measured values has been significantly reduced. In most of the magnitudes and ranges, we obtained a reduction of, at least, one tenth of the accuracy specifications published by the manufacturer.

**Método para a Medição de Balanceamento Longitudinal em Terminais Telefônicos**

Rômulo M. Volpato, Gilberto V. B. Magalhães, *Inatel, Santa Rita do Sapucaí, Brazil*

For the great efficiency at *measure of common-mode suppression*, it is necessary to check the receiver and generator's impedance equipment influence in the circuit. In this way, this paper shows the influence of the receiver impedance of 30 k $\Omega$ , and the generator impedance of 600  $\Omega$  can be used, without great influence in final result. So the values of equipment impedance suggested for ANATEL's 473 standard, can be changed to another procedures.

**Estudo da Eficiência do Consumo Energético de Televisores Tipo CRT e LCD em Modo Standby**

Alex I. S. Maia, Karlo H. F. Santos, Marcelo M. Steinhagen, *Fundação Centro de Análise, Pesquisa e Inovação Tecnológica, Manaus, Brazil*

Alexandre Novgorodcev, *Inmetro, Brasília, Brazil*

Neste trabalho, é avaliado o consumo médio de televisores do tipo CRT e LCD no modo standby (espera) dos modelos produzidos pelos principais fabricantes do Pólo Industrial de Manaus. Estas informações devem ser declaradas pelos fabricantes e são verificadas através de um programa de avaliação de conformidade, indicado pelo Inmetro.

### **Determinação da Energia Cinética de Projéteis Disparados por Brinquedos Utilizando Sensores Ópticos**

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Karlo H. F. Santos, Alex I. S. Maia, Marcelo M. Steinhagen, *Fundação Centro de Análise, Pesquisa e Inovação Tecnológica, Manaus, Brazil*

Neste trabalho, é apresentado um procedimento de determinação da energia cinética de projéteis disparados por brinquedos, de acordo com a Norma ABNT/NBR/NM/300-1 - propriedades gerais, mecânicas e físicas, utilizando sensores de passagem por infravermelho e cronômetro.

### **Implantação da Política de Confiabilidade Metrológica dos Instrumentos de Medição Usados nas Unidades Regionais da Eletronorte**

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Thiago B. P. de Souza, Marcelo M. da Costa, Marco A. S. Sussuarana, André L. C. França, Benedito R. F. Cardoso, Lourival O. da Silva, *LACEN, Belém, Brazil*

This article presents the guidelines for deployment of policy management measuring instruments in ELETRONORTE, addressing strategies for lifting the instrumentation, registration system in EPR, preparation of plans and optimized calibration procedures established with the objective of establish the quality control of instrumentation used in regional units of the company.

### **Comprovação Metrológica dos Medidores de Energia Elétrica do Sistema de Medição de Faturamento da Eletronorte**

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Marcelo M. Costa, Lourival O. Silva, Thiago B. P. Souza, Marco A. S. Sussuarana, *Centrais Elétricas do Norte do Brasil SA, Belém, Brazil*

Este artigo apresenta os resultados das calibrações dos medidores de energia elétrica utilizados no sistema de medição de faturamento da Eletronorte, as quais são realizadas de acordo com os requisitos dos procedimentos de rede do Operador Nacional do Sistema Elétrico – ONS. São enfocados os aspectos relativos à conformidade metrológica dos medidores e à análise da estabilidade temporal dos mesmos. Também são discutidos outros pontos, como os requisitos especificados pelos procedimentos de rede.

### **Análise dos Padrões de Resistência Elétrica do Laboratório de Calibração de Grandezas Elétricas da Eletronorte para Melhoria da Incerteza de Medição**

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Thiago B. P. de Souza, Marcelo M. da Costa, *Centro de Tecnologia da Eletronorte, Belém, Brazil*

Thiago M. Soares, *UFPA, Belém, Brazil*

The main purpose of this work is the assessment of the time stability and the repeatability of a low-resistance decade, used as a working standard in the Laboratório de Calibração de Grandezas Elétricas (CAEL) of the Centro de Tecnologia da Eletronorte, in a period of 3 months for the use of this instrument as transference standard, and the evaluation of the time stability of the laboratory's Reference Calibrator.

### **Caracterização microestrutural em aços utilizando sensores de efeito hall**

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Andre Silva, Eliza Mendonça, Edgard Silva, *CEFET-PB, João Pessoa, Brazil*

Josinaldo Leite, *UFPB, João Pessoa, Brazil*

Neilor Santos, *CEFET-PB, João Pessoa, Brazil*

As técnicas de ensaio mecânicos não destrutivos são uma ferramenta importante para análise e caracterização microestrutural. As vantagens relacionadas a estes ensaios são a obtenção dos resultados rápidos, assim como a preservação da integridade estrutural do material. Neste contexto, o presente trabalho tem como objetivo analisar uma nova metodologia não destrutiva baseada em variações de tensão Hall capazes de identificar o tipo de microestrutura estudada. Os resultados obtidos mostram que a utilização de sensores de efeito Hall para caracterização de aços é bastante promissor.

### **Implantação do Laboratório de Calibração de Bússolas e Magnetômetros do Observatório Nacional**

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Luiz C. C. Benyosef, Ivan M. Silva, *MCT - Observatório Nacional, Rio de Janeiro, Brazil*

The Magnetic Sensors Development Laboratory (MSDL) of the Geophysics Co-Ordination of the National Observatory mission is to develop and to build magnetic sensors and magnetometers of high resolution. The growing necessity for using magnetic navigation systems in airplanes and ships, has given raise to the need to obtain the accreditation in calibration services in accordance with the ISO/IEC 17025:2005 standard. In the present paper is described the principal technical requisites and the Laboratory competence.

### **Sistema de medição da força exercida pela língua na posição habitual e durante a deglutição**

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Jéssica M. C. Silva, Tulimar P. M. Cornacchia, Andréa R. Motta, *UFMG, Belo Horizonte, Brazil*

Márcio F. S. Barroso, *UFSJ, São João Del-Rei, Brazil*

Marco F. A. Rigueira, Estevam B. Las Casas, *UFMG, Belo Horizonte, Brazil*

A capacidade da língua de impor forças é importante para o correto funcionamento das estruturas do sistema estomatognático. Um posicionamento atípico da língua pode alterar o padrão de erupção e o posicionamento dentário. O objetivo do presente estudo é descrever o desenvolvimento de um método para medição objetiva da força da língua na posição habitual e durante a deglutição e sua influência no posicionamento dos dentes. O protótipo desenvolvido é composto principalmente por um sensor de força resistivo, um sistema para condicionamento do sinal, compreendendo, amplificação do sinal, filtragem e acoplamento físico com o sistema de aquisição de dados, placa de aquisição de dados e computador. Para testar o sistema na etapa atual, foi utilizada uma amostra de três pessoas. Realizou-se duas medições para cada sujeito com a língua em posição habitual e durante a deglutição em um intervalo de tempo pré-definido de um minuto para cada medida, de maneira a restabelecer as condições normais do sujeito. Observou-se que o sistema desenvolvido foi sensível para representar de forma objetiva a força exercida pela língua. Com isso, acredita-se que o sistema de medição desenvolvido será importante para auxiliar dentistas e fonoaudiólogos no diagnóstico, prognóstico, acompanhamento e avaliação clínica dos tratamentos propostos em relação à influência da língua no sistema estomatognático.

### **Calibracion de Cronómetros Mediante la Medición de la Frecuencia del Oscilador de Cuarzo**

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Johnny Jiménez, *ITCR, Cartago, Costa Rica*

Harold Sánchez, *ICE, San José, Costa Rica*

Se presenta un sistema de medición de La frecuencia básica del oscilador de cuarzo de cronómetros, para la automatización de la calibración. El sistema detecta la señal básica de oscilación del cristal de cuarzo ( $2^{15}$  Hz), mediante la inducción de una corriente en placas paralelas usando el efecto capacitivo, y procesando la señal para extraer la frecuencia básica dentro de una señal muy ruidosa. Con este método se reduce significativamente la incertidumbre de calibración comparada con el método de comparación de la lectura en pantalla. También se reduce el tiempo del proceso calibración.

### **Implantação e Implementação do Sistema de Referência em Alta Tensão em Corrente Contínua (Sirat CC) Na Faixa de 100 V a 150 KV**

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Ademir M. de França, Paulo R. M. Nascimento, Luiz N. Pereira, Marco A. Soares, Patricia C. O. Vitorio, Danielli G. Costa, Giselle C. Moreira, *Inmetro, Duque de Caxias, Brazil*

Este artigo apresenta a implantação e implementação da padronização em corrente contínua com tensões até 150 kV e com incerteza compatível com as necessidades nacionais. Apresenta ainda as características técnicas dos equipamentos, detalhes do comissionamento e as particularidades exigidas em um serviço de calibração.

### **Servicio Nacional de Metrología – Indecopi, Perú**

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Henry P. Linares, *Indecopi, Perú*

Se describe al Servicio Nacional de Metrología, sus funciones, laboratorios de calibración que tiene, principales servicios de calibración que brinda, el apoyo que realiza hacia el sector público y privado y en forma algo más detallada las actividades Del laboratorio de electricidad.

### **O Sistema de Padronização Primária de Tensão AC do Inmetro**

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Renato Afonso Jr., Regis P. Landim, Edson Afonso, Flávio A. Silveira, *Inmetro, Duque de Caxias, Brazil*

Giovanna Borghi, *Inmetro, Duque de Caxias, Brazil*

O presente trabalho apresenta o sistema de padronização primária de tensão AC desenvolvido no Laboratório de Tensão e Corrente Elétrica (Latce) do Inmetro. A diferença de tensão AC-DC é obtida através da utilização de padrões de transferência térmica planares (PMJTC). Com este novo sistema, o Latce pretende melhorar os níveis de incerteza nesta grandeza.

### **Rede Nacional de Estações de Referência de Tempo**

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Aida Bebechibuli, Selma Junqueira, *MCT - Observatório Nacional, Rio de Janeiro, Brazil*

Two National Time Scales are generated and disseminated by MCT-Observatório Nacional, TA (ONRJ) (Atomic Time) and UTC (ONRJ) (Coordinated Universal Time), from data provided by an ensemble of five industrial caesium clocks. The aim of this project is to develop new methods to remotely include other caesium clocks in order to improve these two time scales.

### **Avaliação do Melhor Desempenho de um Instrumento de Medição**

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Michele O. dos Santos, Fernanda R. de Oliveira, Neivaldo S. Nonato, *Inmetro, Duque de Caxias, Brazil*

Este artigo apresenta o resultado de uma avaliação experimental de todas as configurações operacionais possíveis de um multímetro digital na função resistência, visando buscar o melhor desempenho de um instrumento de medição. A importância em se ter bem definidos todos os fatores de contribuição e ter conhecimento do comportamento de um instrumento de medição é fundamental para que se otimize um processo de medição.

### **La Metrologia Electrica en el INTN**

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Robert D. Rodríguez, *INTN, Asunción, Paraguay*

This work aims to present current situation of electrical metrology implemented in the INTN, describing the actions taken as body responsible or metrological control into the State of Paraguay and as responsible for establishing and maintaining the chain of traceability in the country. The present paper intend to present the starting point since 2 001, when the INTN had not participation en electrical metrology area, until activities and results reached to date, as well programs and projects already confirmed for the short term.

### **O impacto da instabilidade no cálculo do Erro Normalizado (EN) no Programa de Comparação Interlaboratorial do Setor Elétrico Brasileiro**

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Luiz H. P. Junqueira, *Furnas Centrais Elétricas SA, São José da Barra, Brazil*

Dalvir Maguerroski, *Eletrosul Centrais Elétricas SA, Florianópolis, Brazil,*

Kathia A. de Oliveira, *Itaipu Binacional, Foz do Iguaçu, Brazil*

O trabalho apresenta o programa de comparação interlaboratorial de eletricidade e frequência do setor elétrico brasileiro denominado de PCI – Eletricidade. Esse é fundamental para garantia de qualidade do setor, o qual iniciou em 2006 e em 2008 participaram 12 importantes empresas do setor elétrico brasileiro. A evolução, a metodologia e o tratamento matemático para a instabilidade do padrão circulante na determinação do erro normalizado - *En* são temas abordados. As referências são os Laboratórios de Metrologia Elétrica do INMETRO (Tensão, corrente e resistência) e FURNAS (Frequência).

### **Desenvolvimento de um Analisador para Cabos do Tipo Par Trançado (UTP) de baixo custo**

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Guilherme E. Ferri, João O. P. Pinto, *UFMS, Campo Grande, Brazil*

This paper describes the development of a low cost Analyzer for network cables of type twisted pair (UTP - Unshielded Twisted Pair) that carry out the ten tests required by ANSIA/TIA/EIA-568B rules. The physical project is divided in to four blocks, which are, control, sample, transmission and

TDR. The sample, transmission and TDR blocks were simulated with the aid of Proteus software from Labcenter Electronics. The control block, responsible for carrying out the tests, was programmed in C language and it used the MPLAB software from Microchip for its validation. The results obtained in the simulations were satisfactory, showing the effectiveness of the equipment proposed.

### **Padrões Primários de Tempo e Frequência Desenvolvidos no Brasil**

Stella T. Müller, Renato F. Alves, Aida Bebeachibuli, Vanderlei S. Bagnato, Daniel V. Magalhães, *USP, São Carlos, Brazil*

This paper is a progress report of the activities in our time and frequency laboratory. We emphasize the development of two different setups of atomic clocks: the atomic fountain and the compact system based on a cloud of cold atoms in free expansion. We also present the system for comparison and the dissemination of the reference signal.

### **Uso Adequado de Incubadora Neonatal na Assistência em Saúde**

Enilson J. L. Costa, *CEFET-PE, Recife, Brazil*

Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

João B. A. Silva, *UFPB, João Pessoa, Brazil*

Carlos M. P. Cursino, *CEFET-PE e UFPE, Recife, Brazil*

Rodrigo R. A. Galvão, *UFPE, Recife, Brazil*

This paper focuses on the conditions of use of newborn incubator. We made a survey of hospital management policy is examined and the condition of operation of incubators in hospitals in Recife, measuring it within the same, the noise level, temperature, humidity and air speed. It was found that there is not a policy of training on the appropriate use of the incubator, and that only one of the incubators operating analyzed based on NBR IEC 601-2-19. The expectation is to change the way to use the incubator to improve the quality of life of newborns.



## Thursday

### 10h 30min TA1 Quantum Metrology and Fundamental 12h 30min Constants

Chair: Helio Schechter, *Inmetro, Brazil*

Chair: Yi-hua Tang, *USA*

#### 10h 30min The Quantum Metrological Triangle Experiment

S. Sassine, B. Steck, N. Feltn, L. Devoille, B. Chenaud, W. Poirier, F. Schopfer, G. Spengler, S. Djordjevic<sup>1</sup>, O. Séron, F. Piquemal, *LNE, Trappes, France*

S. Lotkhov, *PTB, Braunschweig, Germany*

We present our experimental set-up and discuss the results obtained with the quantum metrological triangle (QMT) experiment. This experiment consists in realizing Ohm's law with the three effects used and investigated in quantum electrical metrology: the Josephson effect (JE), the quantum Hall effect (QHE) and the single electron tunneling effect (SET). The aim is to check the consistency of the phenomenological constants  $K_J$ ,  $R_K$  and  $Q_X$  associated with these effects and theoretically expressed with the fundamental constants  $e$  and  $h$  (elementary charge and Planck constant, respectively). Such an experiment is a contribution for a new definition of the International System of Units (SI). Also, the obtained results are a first step towards a determination of  $e$ .

#### 10h 50min QHE samples characterization

A. Tonina, M. Real, R. Iuzzolino, M. Bierzychudek, *INTI, Buenos Aires, Argentina*

We have studied different GaAs/AlGaAs heterostructures devices, used for measurements of the quantum Hall resistance  $R_H$ , to assure a standard reference of resistance with a relative uncertainty of a few parts in  $10^8$ . The samples studied have different shapes and contacts. The objective was to select the best measurements conditions for each sample for metrological purposes. We show an example where the quantization condition was not totally fulfilled and the calibration value of our primary standards resistors differed in  $5 \times 10^{-7}$  from their expected values.

#### 11h 10min Voltage divider for 10 V - JVS transference

M. Real, M. Bierzychudek, R. Iuzzolino, R. García, A. Tonina, *INTI, San Martín, Argentina*

We have designed and characterized a voltage divider to calibrate 1 V Josephson voltage standard (JVS) with the 10 V output of solid state voltage standards (zeners). This voltage divider is based on tetrahedral junctions and sealed oil-filled commercial resistance elements. The Hamon series-parallel method is used to obtain the divider ratio. This method allows to measure the 10 V zener output in a direct way with the JVS system.

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**11h 30min**    **El Patrón de Efecto Josephson del Cenam: Experiencias en 15 Años de Uso**

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David Avilés, Dionisio Hernández, Enrique Navarrete, *CENAM, Mexico*

Este trabajo sintetiza algunas de las experiencias en el uso del patrón de efecto Josephson del CENAM, así como algunas modificaciones hechas al mismo con el propósito de disminuir su susceptibilidad al ruido electromagnético.

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**11h 50min**    **Avances en la Implementación de un Patrón de Tensión por Efecto Josephson con Superconductores de Altas Temperaturas en UTE**

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Heriguatí de Souza, Leonardo Trigo, Daniel Slomovitz, *Laboratorio de UTE, Uruguay*

Alexander Klushin, *Institut fur Schishten und Grenzflashen, Germany*

Este artículo tiene como finalidad difundir los resultados obtenidos en el desarrollo de un patrón de tensión utilizando superconductores de alta temperatura (YBCO). Estos superconductores trabajan a temperatura del nitrógeno líquido el cual tiene un costo muy reducido y es de fácil adquisición. El desarrollo de este patrón usa un integrado superconductor el cual consta de varias juntas Josephson conectadas en serie a las cuales se puede acceder y seleccionar de acuerdo al nivel de tensión requerido en la salida, desde 10mV a 100mV.

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**12h 10min**    **Implantação da padronização primária de resistência elétrica DC baseada no efeito Hall quântico**

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Zulmara Virgínia de Carvalho, Hélio Schechter, Janice de Brito Fernandes, *Inmetro, Rio de Janeiro, Brazil*

This paper presents the development of a multiple analyzer of gas dissolved in oil. With this equipment it is possible to evaluate the state of deterioration of up to three transformers with a single measurement system. The critical part of this work was the development of remote communication via GPRS (General Packet Radio Service).

**10h 30min TA2 Measurement Applications**
**12h 30min**

 Chair: Sebastian Catunda, *UFMA, Brazil*

 Chair: Benedito Luciano, *UFCG, Brazil*
**10h 30min Determination of the parameters in a model for the magnetic losses in silicon steel sheets**


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 Carlos L. B. Silva, Adalberto J. Batista, *UFG, Goiânia, Brazil*

This paper describes an experimental procedure for determination of the parameters involved in a magnetic losses prediction model in silicon steel sheets. The employed model was developed for sinusoidal and nonsinusoidal magnetic induction waveforms without local minima, which implies in the absence of minor loops in the major B-H loop. Experimental results are presented in order to validate the model.

**10h 50min Rede ZigBee Aplicada à Medição em Agricultura**


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 Fabiano Poderoso, *LSITEC-Nordeste, Salvador, Brazil*

 Victor A. Sobral, Robson N. de Lima, Amauri Oliveira, *UFBA, Salvador, Brazil*

This paper presents an evaluation of the Zigbee as a potential candidate to form a wireless sensor network applied to precision agriculture. This evaluation is conducted by means of development and experimentation of a 6-node network. Relevant mechanisms for agricultural applications, such as communication range, multihop communication, and reliability under multiple path conditions are tested and their performance suggest that Zigbee is a promising standard to constitute a wireless sensor network for agricultural applications.

**11h 10min Medições de parâmetros DC em Circuitos Integrados**


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 José R. Casarini, *CT PIM, Manaus, Brazil*

 Jair F. de Souza, *CEFET-AM, Manaus, Brazil*

 Marcos A. Ferreira, *CT PIM, Manaus, Brazil*

This paper has the objective to present the results obtained for the survey of parametric data DC measured on the Integrated Circuit CD4007UB, at several temperatures with the use of a Pin Tester ATV supported by six SMU KEITHLEY2400. The component access table has 96 pins connector that can be formatted to access pins in groups: supply pins (with more than one voltage); input and output groups defined at High or Low levels. The experiments were designed to define the test parameters and test limits for each I C, in order to qualify the component after Design into a Design House supported by MCT, and produced in an outside foundry, after climatic tests, or after field failure. The circuit

CD4007, a simple inverter, was chosen because the access to individual transistors. More complex logic circuits will be next step.

**11h 30min**      **Monitoramento e Diagnóstico de Pára-raios a ZnO Usando Redes Neurais Artificiais**

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Rex A. C. Medeiros, Raimundo C. S. Freire, Edson G. da Costa, George R. de Lira, Estácio T. W. Neto, *UFCG, Campina Grande, Brazil*  
Marcelo Maia, *CHESF, Campina Grande, Brazil*

We propose in this work a method for monitoring and diagnostic of ZnO arresters by the usage of artificial neural networks (ANN) and thermal images. The ANN is able to analyze the thermal profile, detect and classify patterns, which could be undetected by a simple visual analysis.

**11h 50min**      **Melhoria da Performance em Reconciliação de Dados pela Eliminação de Outliers com Pré-Filtro por Predição Linear**

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José M. Araújo, *Instituto Federal da Bahia, Salvador, Brazil*  
Marcelo Embiruçu, Cristiano H.O. Fontes, Luiz R. P. A. Lima, Ricardo A. Kálid, *UFBA, Salvador, Brazil*

Data Reconciliation (DR) is a very important tool when one wishes adjusting measurement data from mass and/or energy balances. Application of linear prediction filtering on the data corrupted with errors of category so called outliers, harden to be removed, is considered here. The proposed methodology is carried out by simulation in a stationary DR scheme for a industrial reactor, and the results outperforms that encountered in specialized literature.

**12h 10min**      **Efficiency Measurement in Planar Monopole Antenna of Size Reduction with Branches for Wireless Application**

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C. M. Costa Jr, G. Fontgalland, R. C. S. Freire, R. M. Valle, *UFCG, Campina Grande, Brazil*  
N. I. Morimoto, *USP, São Paulo, Brazil*

In this paper we present the radiation efficiency in planar monopole antenna of size reduction with branches for wireless application. These antennas were made using two type of substrate: FR4 and LTCC. The former is most commercially used in PCB circuits and the latter widely used in communication systems. The miniaturized antennas used in this work were obtained after introduced short circuit pin and slots in its structures. To get the radiation efficiency will be used a reverberation chamber and measured the scattering parameters for transmission and reflection coefficient of the excitation in the relation the antenna under test and the reference antenna.

**14h 00min TB1 New Technologies Applied in Electrical  
16h 00min Metrology**

Chair: Regis Landim, *Inmetro, Brazil*

Chair: Ismail Tedjini, *Grenoble-INP/LCIS, France*

**14h 00min Calibração de Transformadores de Corrente em Campo  
Utilizando-se Padrão Baseado em Sensores Ópto-  
eletrônicos**

Pedro H. Mendonça, José A. Teixeira Jr., *LACTEC, Brazil*

Marcelo M. Costa, *Centrais Elétricas do Norte do Brasil S/A, Brazil*

João C. D. de Carvalho, *ELETROSUL, Brazil*

Celso Melo, *Copel, Brazil*

Diogo B. Dahlke, Minoru Ikeda, *LACTEC, Brazil*

Este trabalho apresenta um sistema para a realização da calibração de transformadores de corrente convencionais no campo, utilizando-se um transdutor de corrente ótico como padrão de referência, apto à instalação em extra alta tensão. O transdutor de corrente ótico foi caracterizado em laboratório para verificação de exatidão comparando-se com um transformador de corrente eletrônico padrão. O sistema desenvolvido é apresentado abaixo, bem como os resultados obtidos.

**14h 20min Análise do Comportamento de Sistemas Centralizados de  
Medições de Consumo de Energia Elétrica Submetidos a  
Interferências Eletromagnéticas**

Claiton Colvero, Vinicius Carneio, Frederico Bortotti, *Inmetro, Duque de Caxias, Brazil*

Este trabalho apresenta resultados da análise do comportamento de Sistemas Centralizados de Medições baseados em comunicações digitais de radiofrequência sob interferência eletromagnética. A Divisão de Metrologia em Telecomunicações do Inmetro analisou a influência de interferências na comunicação de dados sem fio do sistema citado no resultado final de medição.

**14h 40min A New Approach for Calibrating High-voltage Capacitance  
and Dissipation Factor Bridges**

Gregory A. Kyriazis, *Inmetro, Duque de Caxias, Brazil*

A new approach for calibrating automated highvoltage current-comparator-based capacitance and dissipation factor bridges is presented. The approach is slightly different from another published previously. It leads to larger uncertainties, but is slightly easier to implement, since the digitizers need not be synchronized to the signal

generators. It is possible to simulate capacitance ratios from 1:1 to 100:1 with relative standard uncertainties of less than  $2.5 \times 10^{-5}$  and dissipation factors from 0 to 0.1 with standard uncertainties of less than  $1 \times 10^{-5}$ .

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**15h 00min      Use of a Single High Speed Analog-to-Digital Converter for Precision Measurements of Three Phase Electrical Power**

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Andrew Wachowicz, Duane Brown, *Measurements International, Precott, Canada*

A Three Phase Digital Sampling Wattmeter (DSWM) is described that uses a Keithley DAQ board KPCI-3116 with a single 16-bit Analog-to-Digital Converter, a computer, and the software developed in LabVIEW. Measurements of power with full power factor range can be made on both sinusoidal and non-sinusoidal voltages and currents with the fundamental frequency from 15 to 420 Hz.

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**15h 20min      Reverberation Chamber with an Asymmetrically Positioned Load**

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Stenio F. Cantalice, G. Fontgalland, R. C. S. Freire, *UFCG, Campina Grande, Brazil*

E. Richalot, *EYSCOM, Marne-la-Vallée, France*

In this paper we present the influence of the load position, represented by a metallic cube, inside the uniform zone of a compact reverberation chamber when it is placed asymmetrically to the chamber's wall. The measurement standard test of the uniform zone requires an empty chamber. The measurements of the chamber statistical electrical field uniformity are made accordingly the IEC61004-21 standard. Unfortunately, no guarantee of the field uniformity is assured when the equipment is positioned inside.

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**15h 40min      AccuBridge™ A Self Calibrating DC Current Comparator Resistance Bridge**

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Andrew Wachowicz, Duane Brown, *Measurements International, Precott, Canada*

An optimized room temperature resistance bridge (AccuBridge™), modeled after the cryogenic current comparator, has been developed to determine current ratios with the highest accuracy. The direct current comparator has been optimized to reduce the leakage effects of the comparator. In addition, new self calibrating direct current sources have been fabricated and tested. AccuBridge™ relies on self calibrating current sources, the self calibrating direct current comparator and self calibrating nanovoltmeter to achieve its accuracy.

**14h 00min TB2 Measurement of Electrical Quantities****16h 00min**Chair: Sebastian Catunda, *UFMA, Brazil*Chair: Amauri Oliveria, *UFPA, Brazil***14h 00min Proposal New Configuration of Ring Resonator to Measure PCB Electric Permittivity**Victor F. M. B. Melo, Adaildo G. D'Assunção Jr, *UFCG, Campina Grande, Brazil*Alfredo G. Neto, *CEFET-PB, João Pessoa, Brazil*Glauco Fontgallan, *UFCG, Campina Grande, Brazil*

In this work it is proposed a ring resonator to characterize with accuracy the electrical properties of dielectric substrates commonly used in the design of printed circuit board and devices, particularly operating at high frequency. This characterization is important for building prototypes. The tests are made on samples supplied by manufacturers and retailers acquired in the trade. The procedure to be applied is based on determining the resonance frequency and its relation with the permittivity of the material. Some results are presented and compared with known ones.

**14h 20min Sensor de Corrente Indutivo à Base de Ligas Nanocristalinas**José G. A. Lira, Euler Macedo, Edson G. Costa, Benedito Luciano, Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*Marcelo J. A. Maia, *CHESF, Brazil*

In this paper the design and application of an inductive magnetic sensor based on nanocrystalline alloys are described. The sensor is adjusted for the measurement and monitoring of currents with intensities from some microamperes to milliamperes. Its functional behavior, performance and a specific application are described. One of the biggest advantages of this current sensor is its noninvasive characteristic that means, no direct contact with the circuit that is being monitored is required. It becomes appropriate for diverse applications where this requirement is necessary. An example of application for this sensor is the metal oxide surge arresters leakage current monitoring.

**14h 40min Desenvolvimento de um Instrumento Aplicado a Medição de Condutividade de Soluções Salinas**Renato A. Freitas, Cristóvão M. O. L. Filho, Reginardo T. L. Júnior, Raimundo C. S. Freire, Eudésio O. Vilar, Kaline M. de S. Viana, Aécio C. O. Feitosa, *UFCG, Campina Grande, Brazil*

Apresenta-se neste trabalho o desenvolvimento de um instrumento aplicado à medição da condutividade elétrica de soluções salinas, destinado a laboratórios de engenharia eletroquímica, para a determinação do Número de MacMullin. A determinação do Número de MacMullin é necessária para a caracterização do diafragma utilizado no processo de produção de cloro-soda. Tais diafragmas são feitos de amianto, material tóxico, por isso torna-se necessária sua substituição por materiais que possuem as mesmas características.

**15h 00min**      **Medições das Perdas e da Corrente de Excitação em Transformadores Monofásicos de Baixa Potência com Núcleo de Liga Amorfa: Antes e Depois do Processo de Oxidação**

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B. A. Luciano, T. C. Batista, R. C. S. Freire, W. B. de Castro, *UFCG, Campina Grande, Brazil*

M. A. G. Camacho, *Grupo Industrial João Santos, Recife, Brazil*

Neste trabalho são apresentadas algumas considerações sobre estudos, teóricos e experimentais, relativos à medição das perdas ativas e da corrente de excitação em transformadores monofásicos de baixa potência (100 VA, 220 V/110 V, 60 Hz): um com núcleo de FeSi e outro com núcleo de liga amorfa, antes e depois do processo de oxidação.

**15h 20min**      **Electromagnetic Frontiers In The Design Of Connections In Printed Circuit Board.**

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Georgina K. M. Freitas, Glauco Fontgalland, Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

In this paper is presented a comparison between a model based on distributed parameters and a circuit model based on localized or concentrated parameters for traces Printed Circuit Board (PCB). The two models are developed from Transmission Line (TL) theory. The analysis is done from the voltage at the terminals of the conductor. The models presented had been simulated to verify the behavior of the voltage and phase when the circuit operates in a band of frequency from 800 MHz to 2 GHz. The simulation results show the amplitude and phase voltage variation as a function of the electrical length of a PCB traces.

**15h 40min**      **Drain Current Calculation using BSIM4 Model Equations**

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Robert R. Brandt, Vincent P. M. Bourguet, Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

In this paper we describe the development of a C++ routine (and several auxiliary subroutines) to calculate the drain current of a MOSFET, based on the BSIM4V6 model equations from Berkeley University.



## Friday

### 10h 30min FA1 Measurement of Non-Electrical Quantities

12h 30min

Chair: Flávio H. Vasconcelos, *UFMG, Brazil*

Chair: Carlos J. T. Criollo, *UFMG, Brazil*

### 10h 30min Tracking in WiMAX Networks depending on RSS-based measurements

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Mussa Bshara, Leo van Biesen, *VUB, Brussel, Belgium*

Tracking in WiMAX networks is gaining a lot of interest; especially after that the mobile WiMAX became one of the emerging technologies promoting low-cost deployment and evolving to provide IP-based services of high mobility including providing location-based services (LBS). Therefore, locating users in a cheap way that depends on the available network resources is becoming more and more interesting and an active topic for researchers. In this paper we consider the problem of tracking in WiMAX networks depending on the available RSS-based information. The type of the information and its accuracy plays an important role in positioning accuracy. The provided examples show that the available RSS-based information with the help of already available data (street maps), allow to achieve plausible results.

### 10h 50min Control de la Deriva en Osciladores de Rubidio

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Leonardo Trigo, Daniel Slomovitz, *Laboratorio de UTE, Motevideo, Uruguay*

Los osciladores atómicos de rubidio se caracterizan por tener bajo ruido en medidas de corto plazo, mientras los sistemas GPSDO (GPS con oscilador disciplinado, generalmente dicho oscilador es de rubidio) además de brindar el servicio de posicionamiento global pueden tener salidas de frecuencia estándar. Dichos equipos poseen alto ruido en medidas de corto plazo, pero a largo plazo no tienen deriva pues el sistema GPS es supervisado desde estaciones terrestres desde las cuales se realizan correcciones a los satélites que compone El sistema.

Este trabajo propone implementar un sistema automático con el cual compensar la deriva características de osciladores de rubidio comparando dicha salida con la salida del GPSDO, con lo cual se obtendría la estabilidad a largo plazo del GPSDO y El bajo ruido a corto plazo típico del rubidio.

**11h 10min Potential Effects of Power Line Communication on xDSL  
Inside the Home Environment**

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Mussa Bshara, Leo Van Biesen, *VUB, Brussels, Belgium*

Jochen Maes, *Bell Labs, Alcatel-Lucent, Antwerp, Belgium*

Power line communication (PLC) is a recent and rapidly evolving technology using the existing electricity power lines for data transmissions at high rates (higher than 1 Mbit/s). As these lines have not been designed for high data rate transmissions, they will produce unintentional radio frequency emissions that may adversely cause high interferences in a wider frequency range than their own bandwidth (due to frequency harmonics and the statistical properties of noise like interference). Digital subscriber line technology is currently used to deliver high data rates to users that are using the existing telephone lines. The lines of the two networks (the electricity power distribution and the telephone) are found close to each other in residential places and offices (sometimes in the same duct). Therefore, service providers are concerned about the influence of the PLC transmission on the delivery of services over VDSL2, where the two technologies overlap in frequency range. In this paper, the interference on telephone lines caused by PLC will be studied. Electrical measurements are presented that show the impact of PLC on xDSL in various scenarios. It is demonstrated that readily available in-line radio frequent interference filters are effective solution to minimize the interference levels.

**11h 30min Features and Application of a Microcontroller-Driven  
Autosampler Applied to a Surface Plasmon Resonance  
Biosensor Platform**

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C. S. Moreira, A. G. S. Barreto Neto, A. M. N. Lima and H. Neff,  
*UFMG, Campina Grande, Brazil*

A microcontroller-driven autosampler, based on simple and low cost components, has been developed and connected to a surface plasmon resonance (SPR) sensor. The device has been applied for determination of the mutual diffusion coefficient of the protein bovine serum albumin (BSA) in aqueous solution. The theoretical background of SPR sensors is briefly outlined and technical alternatives typically used for automatic sample manipulation described. In general, their large device size, difficult handling and high costs are severe disadvantages. Here, a rotating carousel-type storage apparatus for up to 20 sample vials, a vertical Z-drive needle sampler to take out analyte solutions from the vials has been combined with a peristaltic pumping system. All the actuating devices, as stepper motors for the carousel and z-drive, and the pump are controlled by a microcontroller, while an attached bar-code

device is used for vial / sample identification. The system is easily programmable via a user friendly interface.

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**11h 50min Iris Recognition Using One-Dimensional Signal Analysis**

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Edmundo D. H. Delgado, *UFRJ, Rio de Janeiro, Brazil*

Raul Q. Feitosa, *PUC-Rio, Rio de Janeiro, Brazil*

Antonio Petraglia, *UFRJ, Rio de Janeiro, Brazil*

This paper introduces a new, low computational complexity approach for iris recognition function that is able to cope with occlusion, caused by eyelids and eyelashes. The method has been extensively tested using 2500 images, achieving correct recognition rate of 100%, rate recognition of 99.992% and equal error rate of 0.01%.

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**12h 10min Medida de Distância com Acelerômetros (MEMS) em Deslocamento Manual Unidimensional**

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John K. S. de Souza, Carlos J. T. Criollo, *UFMG, Belo Horizonte, Brazil*

Este trabalho apresenta um estudo com acelerômetros que utilizam tecnologia MEMS. Destina-se a medição de distância em deslocamento unidimensional de baixa aceleração ( $1\text{ms}^{-2}$ ), realizado através de movimentos manuais. Para esta faixa de aceleração o sistema é mais susceptível a erros, uma vez que as variações de offset e ruídos inseridos no sinal apresentam em alguns instantes a mesma ordem de grandeza do sinal oriundo dos movimentos manuais aplicados ao acelerômetro. Para realização dos ensaios foi utilizado um deslocamento característico que é constituído de três estágios: repouso-deslocamento-repouso. O processamento do sinal apresenta duas etapas distintas: sendo a primeira responsável pela detecção do movimento (Energia do sinal) e a segunda pelo cálculo da distância (Wavelet). Nos ensaios realizados foi obtido um desvio padrão de 0,693 levando a um erro de 2,83%.

**10h 30min FA2 Electrical Metrology in the Areas of Health,  
12h 30min Environmental and Telecommunications**

Chair: Alexandre Bessa, *Inmetro, Brazil*

Chair: Claiton Colvero, *Inmetro, Brazil*

**10h 30min Calibração de Analisadores de Desfibriladores Cardíacos**

Noara Foiatto, Marcus V. V. Pinto, Rafael Hessel, *PUCRS, Porto Alegre, Brazil*

Este trabalho propõe uma metodologia de calibração para analisadores de desfibriladores cardíacos, a partir da integração de potência, utilizando-se um divisor de tensão e com base em medidas de intervalo de tempo e de sinais de tensão elétrica. Objetiva-se com a metodologia, o estabelecimento de rastreabilidade para a medição de parâmetros que são verificados em desfibriladores cardíacos, utilizados em processos de terapia cardíaca. Como resultado há o fortalecimento da confiabilidade aplicada à verificação do instrumental de suporte hospitalar.

**Medidas de Avaliação de Desempenho da Unidade****10h 50min Conversora para o Sistema Brasileiro de Televisão Digital (SBTVD)**

Pedro V. G. Castellanos, Rodolfo S. L. Sabóia, João A. C. Braz, Claiton P. Colvero, *Inmetro, Duque de Caxias, Brazil*

This paper presents a campaign of RF measurements intended to evaluate the performance of digital terrestrial television broadcasting receivers under different transmission configurations. The experiments were performed in the laboratory controlled environment, so that a more accurate characterization is possible. Finally, the results are compared to those obtained by other authors.

**11h 10min A influência da temperatura na incerteza das medições envolvendo os efeitos da Dispersão dos Modos de Polarização em fibras ópticas**

Alexandre B. Santos, Giovanna Borghi, Janaina Ferreira, *Inmetro, Duque de Caxias, Brazil*

Jean Pierre von der Weid, *PUC-Rio, Rio de Janeiro, Brazil*

Polarization Mode Dispersion (PMD) is the preponderant factor in modern high-speed long-distance optical transmission systems. We propose an analysis of the temperature influence in the uncertainty evaluation and the improvement of PMD effects measurement accuracy.

**11h 30min Transdutor de Pressão, Baseado nas Características de Fase do Efeito GMI, para Detecção de Ondas de Pulso Arterial**

Eduardo C. Silva, Luiz A. P. Gusmão, Carlos R. H. Barbosa, Elizabeth C. Monteiro, *PUC-Rio, Rio de Janeiro, Brazil*

This work focuses on the evolution of a pressure transducer, developed at the Laboratory of Biometrology of PUC-Rio, for the measurement of arterial pulse waves. It is intended to highlight the importance of using the phase of the GMI effect, and the new topology that allowed the increase in sensitivity.

**11h 50min GPS - Independent time transfer technique on a wireless telecommunication link**

Carlos N. M. Marins, Pierre Kaufmann, Antonio A. A. Ferreira Jr., Marcelo C. Paiva, *INATEL, Santa Rita do Sapucaí, Brazil*  
 Jacobus W. Swart, *CTI, Campinas, Brazil*  
 Adonias Silveira, *INATEL, Santa Rita do Sapucaí, Brazil*

We present a newly conceived clock system based on time-to-digital converter (TDC) principle to generate, transfer and compare time coded sequences (TCS) with nanoseconds accuracy, using a wireless telecommunication link. Comparison provided midterm stability comparable to good OCXO oscillators showing the feasibility of a low cost, GPS - independent technique, exhibiting highly performing stability.

**12h 10min Medições do Efeito do Fenômeno de Difração em Transmissões de TV Digital em Regiões Tropicais**

Claiton P. Colvero, Vinicius R. D. Carneio, M. F. Bortotti, *Inmetro, Duque de Caxias, Brazil*

Este trabalho apresenta uma contribuição de procedimentos de medição de difração de sinais de TV Digital para regiões tropicais através de uma metodologia aplicada e uma campanha de medições para validação do mesmo, realizada na cidade do Rio de Janeiro. Esta metodologia é pioneira neste tipo de medição e visa oferecer um incremento dos dados obtidos em pontos de recepção de sinais de TV Digital, oferecendo mais condições de modelagem para ambientes não controlados, resultantes de efeitos de difração em diferentes condições de recepção.

**14h 00min FB1 Calibration of Electrical Standards and  
16h 00min Instruments**

Chair: Hector Laiz, *INTI, Argentina*

Chair: Celso F. de Melo, *Copel, Brazil*

**14h 00min Redução de Perdas Técnicas Resultantes da Adoção de  
Medidores Eletrônicos de Energia para Pequenos  
Consumidores: Comparação com os Medidores  
Eletromecânicos**

Celso F. Melo Jr., Paulo V. Valois, João A. Bonat Jr., Marcelo Fressato, *COPEL, Curitiba, Brazil*

Este trabalho propõe uma metodologia de calibração para analisadores de desfibriladores cardíacos, a partir da integração de potência, utilizando-se um divisor de tensão e com base em medidas de intervalo de tempo e de sinais de tensão elétrica. Objetiva-se com a metodologia, o estabelecimento de rastreabilidade para a medição de parâmetros que são verificados em desfibriladores cardíacos, utilizados em processos de terapia cardíaca. Como resultado há o fortalecimento da confiabilidade aplicada à verificação do instrumental de suporte hospitalar.

**14h 20min Sampling Wattmeter at INTI**

Lucas Di Lillo, Héctor Laiz, Eliana Yasuda, Ricardo García, *INIT, Argentina*

We developed an automated sampling reference system to measure electrical power. The system allows calibration of instruments within an uncertainty of 20  $\mu\text{W}/\text{VA}$  at power frequencies. It can also measure harmonic power. Calibration is fully traceable to national standards. All the components of the system can be separately evaluated and by this means its total uncertainty estimated

**14h 40min Application of a Calorimetric Thermal Converter as a  
Standard of AC-DC Voltage and Current Transfer Difference**

Peter Filipksi, *National Research Council, Ottawa, Canada.*

At the National Research Council of Canada (NRC) the primary standard of AC-DC transfer difference at frequencies from 10 kHz to 100 MHz is a Calorimetric Thermal Voltage Converter (CTVC). Because of a simple design, not unlike a coaxial calorimeter for RF Power measurements, its frequency characteristic can be estimated theoretically from a number of mechanical and electrical parameters. An internal Tee, integrated into the CTVC, improves calibration accuracy of working standards. Over the years several of these converters have been manufactured for different

operating voltages and with different frequency characteristics, leading to an optimized design with a frequency characteristic practically flat over eight decades of frequency. The paper describes details of construction of the CTVC. Results of RF-DC voltage transfer difference measurements, AC-DC current transfer difference and uncertainty evaluation of the converter are discussed..

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**15h 00min Transport Behavior and Characterization of Precision 1  $\Omega$  Resistors for International Comparisons**

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Rand E. Elmquist, G. R. Jones, *NIST, Gaithersburg, USA*

Brian J. Pritchard, *National Measurement Institute, Australia*

The U. S. National Institute of Standards and Technology (NIST) and the National Measurement Institute of Australia (NMIA) have recently examined two types of precision transportable 1  $\Omega$  resistors that are based on different alloys and construction principles to determine characteristics that can reduce the uncertainty of international comparisons. This work focuses on standards manufactured from 1970 through 2000 by the NMIA, and Thomas-type resistors designed in the 1930s by James L. Thomas and manufactured commercially through about 1980. The effects of temperature, barometric pressure, humidity, power loading, and heat dissipation in oil are described in these two types of transportable wire-wound 1  $\Omega$  resistance standards, and the process of characterization of these resistors for use as transport standards is described.

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**15h 20min Transformador Patrón de Tensión de Errores Calculables**

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Ricardo I. Garcia, Jorge J. Quintana, *INTI, Buenos Aires, Argentina*

We describe the design, construction and testing of a standard voltage transformer, with ratio 5.0:0.1 kV, which errors are calculated. The maximum difference between measured and calculated values was 7  $\mu$ V/V in phase and 5  $\mu$ rad in quadrature when input voltage is 120% of nominal value.

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**15h 40min Patrón de Potencia Eléctrica de Alta Exactitud Basado en el Muestreo Digital de Señales de Tensión e Intensidad Alterna**

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Anselmo Araolaza, Julio González, Carlos Espinosa, Luis Mojica, *CENAMEP, Panamá*

A system for the measurement of electric power by means of high accuracy digital sampling is presented. The method applied it's based in the reduction of voltage to a range of 0-10 V using an inductive divider, and also a reduction of the current by means of a current transformer and an incorporated standard resistor to obtain a voltage relative to the

current intensity. With this, two voltmeters are used in the 10 V range, which is accurately calibrated with the standard diode zener of 10 V. So far, deviation less than 50 ppm has been achieved; these results were obtained by comparison with the travel standard of Argentina. The results are promising and it is expected to reach the deviations of less than 30 ppm.



**14h 00min FB2 Sensors and Transducers****16h 00min**Chair: Ivan Souza e Silva, *UFPA, Brazil*Chair: Vincent Bourguet, *UFCG, Brazil***14h 00min Sensor Óptico por Reflexão Difusa com Múltiplas Faixas de Detecção e com Saída Binária Sequencial**Rafael F. A. Silva, José A. D. Costa, *IFPB, João Pessoa, Brazil*

This paper is about the development of a reflective diffuse optical sensor, aiming at detecting the size of boxes on a mat, substituting the method that uses light barrier optical sensor. That sensor attaches output binary values that corresponds to the box size, and allows the adjustment of each range detection. The obtained experimental results with the prototype confirmed the technical and economical advantages in relation to the conventional method.

**14h 20min Instrumento Virtual para Medição de Velocidade de Fluido com Sensor Termo-Resistivo**Renan A. Travi, Amauri Oliveira, *UFBA, Salvador, Brazil*

This paper present a virtual instrument (VI) for fluid flow measurement (Virtual Anemometer) based on a data acquisition board and LabVIEW. This VI uses the principle of electrical equivalence with a heated thermistor at a constant temperature. This is a low cost alternative to fluid flow measurement for these who has a data acquisition system.

**14h 40min Medição de Velocidade Angular Usando PLL: Medidas de Alta Resolução Usando Encoders de Baixa Resolução**José G. N. de Carvalho Filho, Elyson A. N. Carvalho, Lucas Molina, Eduardo O. Freire, *UFS, São Cristóvão, Brazil*Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

Neste artigo é apresentada uma visão geral sobre os métodos clássicos de medição de velocidade angular, bem como é proposto um sistema de medição de velocidade usando PLL. Também são apresentados uma análise do método proposto do ponto de vista metrológico, os resultados teóricos e experimentais obtidos e um estudo detalhado dos problemas do método proposto.

**15h 00min CMOS A/D Converter for SOC in Wireless Sensor Network Applications**Vitor F. Soares, José E. G. de Medeiros, José C. da Costa, *UNB, Brasília, Brazil*

A cyclic 8-bit analog-to-digital converter with a 50 kSamples/s sampling rate, embedded on a system on chip for wireless sensor network applications, was developed. The IC was designed and prototyped. Its analog and digital cores were successfully characterized.

**15h 20min      Algoritmos para Auto-Ajuste de Sensores Utilizando Redes Neurais**

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Marcos A. A. de Oliveira, Jorge L. M. do Amaral, José F. M. do Amaral, *UERJ, Rio de Janeiro, Brazil*

Este trabalho propõe o desenvolvimento de um algoritmo para auto-ajuste de sensores inteligentes a partir do uso de Redes Neurais Artificiais. Através de dados gerados em uma calibração, o algoritmo aprende a corrigir os desvios encontrados. A título de exemplo foi utilizado um sensor do tipo Pt-100. O desafio é fazer uma rede neural aprender uma curva com poucos pontos, como os gerados em uma calibração tradicional.

**15h 40min      Utilização de Algoritmos Genéticos para Interpolação de Valores de Medição de Termoresistências (RTD)**

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Marcos A. A. de Oliveira, José F. M. do Amaral, Jorge L. M. do Amaral, *UERJ, Rio de Janeiro, Brazil*

Este trabalho propõe o uso de Algoritmos Genéticos para gerar a curva de ajuste de termoresistências de Platina.

16h 30min

Poster Session F

18h 00min

Chair: Fernando Sousa, *UFRRN, Brazil*Chair: Gelson Rocha, *Inmetro, Brazil*

### **Influência da Determinação Indireta do Volume Residual Pulmonar Sobre o Percentual de Gordura em Bombeiros**

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Carlos M. P. Cursino, *UFPE, Recife, Brazil*Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*João. B. A. Silva, *UFPB, João Pessoa, Brazil*Enilson J. L. Costa, *CEFET-PE, Recife, Brazil*Fernando J. S. P. Guimarães, *UFPE, Recife, Brazil*

This study aimed to examine the influence of residual lung volume obtained by different protocols on the percentage of fat of 29 fire military, with the age range ( $28 \pm 3$ ) years. Anthropometric information was obtained through this sampling of various protocols. There was previously an exploratory study of data to assess the key assumptions of the statistical analysis. It was found that the residual volume have significant effects when applied to determine the body density by hydrostatic weighing technique.

### **Code Design and Performance Evaluation for Distributed Classification Fusion Based on Algebraic Codes**

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Eline A. Santos, Francisco M. de Assis, Edmar C. Gurjão, Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

Distributed classification fusion using error correcting codes has been proposed for wireless sensor networks to incorporate fault-tolerance capability. Usually, the codewords are obtained by random search in the set of binary strings of length  $N$ , where  $N$  is the number of sensors. In this work it is proposed the use of classical block codes, more specifically BCH codes, to obtain these codewords. The proposed approach allows tailoring decoding algorithms supported by well known algebraic decoding algorithms. In particular, with the new approach it is possible to avoid a massive table look-up-based decoding for a large number of hypotheses, what cannot be achieved with random selected codewords. It is showed that algebraic code-based classification performance is similar to the previous random search-based classification.

### **Estimação de Frequências de Sinais Digitais Baseada no Paradigma Conexcionista**

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Alan V. S. Sá, *UFCG, Campina Grande, Brazil*Jurgurta R. M. Filho, *UFS, Aracaju, Brazil*

Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

Neste trabalho é proposta a utilização e desenvolvimento de um sistema, baseado no paradigma conexionista, para a estimação das componentes de frequências de um sinal digital. Os resultados obtidos são comparados com resultados provenientes de outras abordagens objetivando-se assim uma avaliação do método proposto.

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### **Condicionador Reconfigurável para Medição de Vibração**

Getulio F. Pantoja Neto, Ivan S. Silva, *UFPA, Belém, Brazil*

Neste trabalho apresenta-se um condicionador de sinais, com ganho e frequência de corte reconfigurável, para medição de vibração mecânica através de acelerômetros IEPE, utilizando a tecnologia PSoC. Os valores de ganho e frequência de corte podem ser configurados pelo usuário através de uma interface com um computador tipo PC. A reconfiguração do condicionador torna possível sua utilização para outros tipos de sensores de vibração representando um avanço para os condicionadores de sinais. Para validação desse sistema foi elaborado teste em laboratório onde o acelerômetro foi excitado por uma ampla faixa de frequências e amplitudes de vibração.

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### **Utilização de Modelo ARX e Teoria de Identificação de Sistemas no Estudo e Análise do Comportamento da Temperatura do Retificador Principal de uma Locomotiva Diesel-Elétrica**

Bernardo Nogueira Neto, *Vale, São Luis, Brazil*

Sebastian Y. C. Catunda, João V. da Fonseca Neto, *UFMA, São Luis, Brazil*

Este artigo aborda a Teoria de Identificação de Sistemas na escolha de um modelo polinomial que possibilite a observação do comportamento da temperatura do retificador de corrente elétrica utilizado para suprimento dos motores de tração de uma Locomotiva Diesel-Elétrica. Será observada a estrutura de um modelo ARX, do inglês Autoregressive with Exogenous input. A escolha desse modelo deve-se a sua função de transferência que é bastante simples e das características para controle preditivo. Será utilizado o toolbox de identificação do MATLAB para estimação e validação do modelo. A escolha da ordem do modelo que melhor descreva a resposta dinâmica do sistema físico será feita observando-se a classificação do percentual do ajuste de saída do sistema em relação a sua entrada. Busca-se, portanto um modelo que possibilite ações de controle para otimização entre a potência fornecida através do retificador e a requerida para tração, de tal forma que eventos de downtime do equipamento sejam minimizados

### **On the Measurement of Dielectric Parameters for Paper Substrates for RFID Application**

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Hanane Alamil, Smail Tedjini, *Grenoble-INP/LCIS, Valence, France*

Pascal Borel, David Gurin, *CTP, Grenoble, France*

Glauco Fontgalland, *UFCG, Campina Grande, Brazil*

This work concerns the determination of the electromagnetic parameters of the paper at UHF and RFID bands. A measurement cell in the form of an electromagnetic closed cavity has been designed and realized. The cavity contains a plexiglass test fixture for the paper samples. Dielectric parameters of the paper sample are deembedded thanks to the measurement of resonant frequencies of the cavity

### **Focusing Principle of Phased Array Antennas for Localization Applications**

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Romain Siragusa, Pierre Lemaitre-Auger, Smail Tedjini, *Grenoble-INP/LCIS, Valence, France*

This work concerns the localization of wireless communication systems. The use of focusing principle in order to localize radiation at a given space point is considered. The later is obtained by application of Huygens principle.

### **Processo de Formação de Agentes Fiscais em Instrumentação Elétrica usando Educação a Distância**

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Márcio H. Dezan, Juan C. M. Sánchez, Luciana S. Alves, *Inmetro, Duque de Caxias, Brazil*

Ecivaldo S. Matos, *USP, São Paulo, Brazil*

The main subject of this paper is to propose an innovative distance training program for metrological agents in electrical instruments. Using new information technologies is possible to bring better tools to improve the understanding of relevant concepts for legal metrology like smart metering, telemetry, remote suspension and re-connection of electricity meters. The proposed distance training program is part of an institutional policy of continuous education for metrological agents. Besides the advantages of easy training access in isolated areas of Brazil, the proposed distance training allows to reduce cost and difficulties with traveling, as well as to cover different student's ages and educational skills.

### **Identificação e Caracterização de Modelos ARX para Cubas Eletrolíticas tipo Prebaked via Sinais de Corrente e Tensão**

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Antonio J. Silva, João V. da Fonseca Neto, João I. N. de Moraes *UFMA, São Luis, Brazil*

Carlos A. P. Braga e Fernando Costa, *Alcoa, São Luís, Brazil*

O problema do efeito anódico que ocorre nas cubas eletrolíticas é danoso ao meio ambiente. Os sinais de corrente e tensão de três cubas são analisados e a partir dessas referências são estimados parâmetros que ajustaram uma estrutura ARX. As teorias de identificação e processamento de sinais são utilizadas para dar o suporte teórico e metodológico nesta pesquisa. A partir dos modelos obtidos é feita a simulação dos modelos, seus índices de ajustes são observados e em seguida a validação ocorre nas três cubas envolvidas no processo. Neste trabalho a caracterização dos modelos polinomiais é realizada obtendo uma estrutura de pólos, zeros e atrasos que caracterizam as três cubas. A resposta dos modelos é analisada no tempo com o propósito de saber o quanto os modelos respondem a transitórios.

### **Avaliação de Incertezas na Estimação do Tempo de Trânsito Ultra-sônico para Medição da Velocidade do Vento**

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Juan M. M. Villanueva, Sebastian Y. C. Catunda, *UFMA, São Luis, Brazil*

Ricardo Tanscheit, *PUC-Rio, Rio de Janeiro, Brazil*

In this paper, a procedure for uncertainty evaluation of the Time-of-Flight (ToF) data acquisition system for wind speed measurement is presented. The assessment of uncertainties contributions associated data acquisition system parameters (system clock resolution) and time of flight variance, which is a property of the signal and depends strongly on the signal-to-noise ratio (SNR). To illustrate the procedure for uncertainties evaluation a case study is presented.

### **Sistema Automatizado para Calibração de Analisadores de Fração de Água em Óleo**

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Isabele M. Costa, Bruno B. Costa, Sérgio V. Araujo, Eduardo O. Freire, Leocarlos B. S. Lima, *UFS, Aracaju, Brazil*

This paper presents the design, instrumentation and automation of a calibration unit for the on line water cut monitor. Measures of the water and oil flow, produced in a well, are essentials to control the depletion of the reservoir and oil production optimization, and depend on the measurement of water cut. It is therefore evident the importance of quality assurance of measurement. Aiming at greater efficiency and reliability of these measures, the work in this paper was developed.

### **Desenvolvimento de uma Plataforma Didática de Baixo Custo para o Ensino de Robótica**

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Cristóvão M. O. Lima Filho, Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

Neste trabalho é apresentado o projeto e a implementação de um robô autônomo móvel versátil de baixo custo, construído com materiais de fácil obtenção. Sua locomoção é feita através de servomotores adaptados para rotação contínua e controlados por um módulo principal, baseado no microcontrolador PIC16F877A. O módulo principal recebe os sinais dos sensores externos e os processa conforme a estratégia de controle implementada em linguagem C. A sua alimentação é proporcionada por baterias embarcadas. Esse robô servirá como uma ferramenta para robótica educacional.

### **Estudo Empírico da Contribuição Melódica e Rítmica da Fala para a Percepção da Identidade do Orador**

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José R. S. Leal Junior, Elker A. N. Carvalho, Jurgurta Montavão, *UFS, Aracaju, Brazil*

O resultado de experimentos com voluntários sobre a percepção do ritmo da fala e do contorno da entonação em uma sentença curta (3s de duração) é apresentado e confrontado a resultados obtidos através de sistemas automáticos de reconhecimento de orador, relatados na literatura. Os resultados encontrados com voluntários humanos são apresentados com a finalidade de servir como referência de desempenho para sistemas automáticos, em duas modalidades: (a) usando o contorno da entonação ao longo do tempo, e (b) usando apenas a informação de ritmo (quando a entonação e o conteúdo espectral são mascarados).

### **Projeto de Seletor Eletrônico (scanner) para medições de resistência elétrica**

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Marcos V. S. Garcia, *Inmetro, Duque de Caxias, Brazil*

Este trabalho tem a finalidade de apresentar o equipamento desenvolvido pelo Laboratório de Resistência - Lares - do Inmetro, para a automação do método de calibração de resistores padrão que visa otimizar o processo de medição atendendo ao tópico "Automação, validação e produtividade em metrologia elétrica" do VIII Semetro.

### **Modulador Sigma-Delta Térmico CMOS**

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Will R. M. Almeida, *UFMG, Campina Grande, Brazil*

Diomadson R. Belfort, *Université Paris 6, Paris, France*

Raimundo C. S. Freire, *UFMG, Campina Grande, Brazil*

Sebastian Y. C. Catunda, *UFMA, São Luis, Brazil*

Hassan Aboushady, *Université Paris 6, Paris, France*

In this paper we present the design of an analog-digital converter based on sigma-delta modulation using as the integrator and the comparator the sensor itself. The proposed ADC architecture allows the measurement of the quantities that interact with the sensor:

temperature, thermal radiation and fluid velocity. The proposed system layout is presented for the technology CMOS 0.35  $\mu\text{m}$ . Simulation results from the VHDL-AMS functional model and from the Spice model are presented, showing the viability of the design.

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**Redução de interferência de modo comum na medição de biopotenciais**

Ivan S. Silva, UFPA, Belém, Brazil

Em sistemas de medição de biopotenciais (i.e. ECG, EEG, EMG) na superfície do corpo humano, utilizam-se eletrodos que convertem correntes iônicas, existentes nos fluidos corpóreos, em equivalentes correntes eletrônicas que podem ser tratadas por circuitos eletrônicos. A impedância equivalente desses eletrodos depende, entre outros fatores, da forma em que são aplicados na superfície do corpo do paciente. Além disso, como mais de um eletrodo é utilizado para medição desses biosinais, geralmente, apresentam impedâncias diferentes (desbalanceamento), provocando o aparecimento de um sinal de modo comum nas entradas do amplificador de instrumentação, que é amplificado como um sinal diferencial. Este trabalho apresenta um método de compensação desse desbalanceamento, reduzindo os efeitos das interferências de modo comum na entrada do amplificador diferencial.

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**CCES: a new configuration for electrical substitution for bolometers**

Denoual Matthieu, ENSICAEN, Caen, France

Delaunay Sébastien, Unicaen, Caen, France

Lebargy Sylvain, ENSICAEN, Caen, France

Allègre Gilles, Unicaen, Caen, France

This paper presents a new configuration for electrical substitution for resistive bolometers. A recall of principal problems encountered in conventional heat feedback electrical substitution bolometry introduces this new configuration where the electrical substitution is directly applied to the sensing resistor itself through capacitive coupling. The capacitive coupling allows the independent setting of the electrical and thermal working points. Contrary to conventional one, this new method can be applied to all existing resistive bolometers without material changes (no extra heater needed). The configuration was designed, implemented and evaluated with a 120  $\mu\text{m}$  thick glass membrane gold layer resistive bolometer. Experiments with optical stimulation were done to demonstrate the functionality of the configuration.

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**Clock-Less Analog-to-Digital Converter**

Sabiniano A. Rodrigues, IFPB, João Pessoa, Brazil



Hassan Aboushady, Marie-Minerve Louërat, *Université Paris 6, Paris, France*

José I. C. Accioly, *IFPB, João Pessoa, Brazil*

Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

This article presents a new clock-less analog-to-digital converter (ADC) based on a full analog signal processing. The main innovative feature of the proposed ADC is that, for a sampled input signal, a cascade of identical stages may operate without timing signal (clock) with its analog processing independent of the output digital signal's generation. Clock-less converters are used in the medical area, in control equipment, and portable equipment of low consumption. In this work, time of conversion of 0.5  $\mu$ s was obtained by simulations with spice macromodels, for a converter of 8 bits resolution, with 8 mW consumption. The Signal-to-Noise Ratio (SNR) reaches 60 dB.

### **Reproducing Kernel Hilbert Space Method for Blind Source Extraction**

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Eder Santana, Ewaldo Santana, *UFMA, São Luis, Brazil*

Raimundo C. S. Freire, *UFCG, Campina Grande, Brazil*

Allan Kardec Barros, *UFMA, São Luis, Brazil*

We present a method for extracting a specific signal from a blind instantaneous mixture. The method is developed using a priori information about the temporal structure of the desired signal in the Reproducing Kernel Hilbert Space. The approach here carried yields better results than methods present in the literature for Blind Source Extraction using temporal structure

### **Distortion Analysis for Energy Measurement Equipment - Performance estimation based upon simple distortion prototypes**

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David Bobick, Marcus Zickefoose, *Radian Research, USA*

The intended audiences are ISO 17025 Calibration Laboratories, ISO 9001 Meter Manufacturers, Electric utilities, and Organizations involved with electricity measurement. Participants will gain insights in recognizing the need to better define methods of energy measurement in order to have a better understanding on why errors may be present during power or energy calibration of equipment and how various error sources effect measurements. This paper will show the possible differences and potential influences associated with industry accepted measurement algorithms associated to electricity measurement. Radian Research is a world leading manufacturer of primary energy reference standards for electric power and has done extensive studies to help ensure that accurate testing of electrical power and energy measurement is maintained over a broad range of testing conditions.

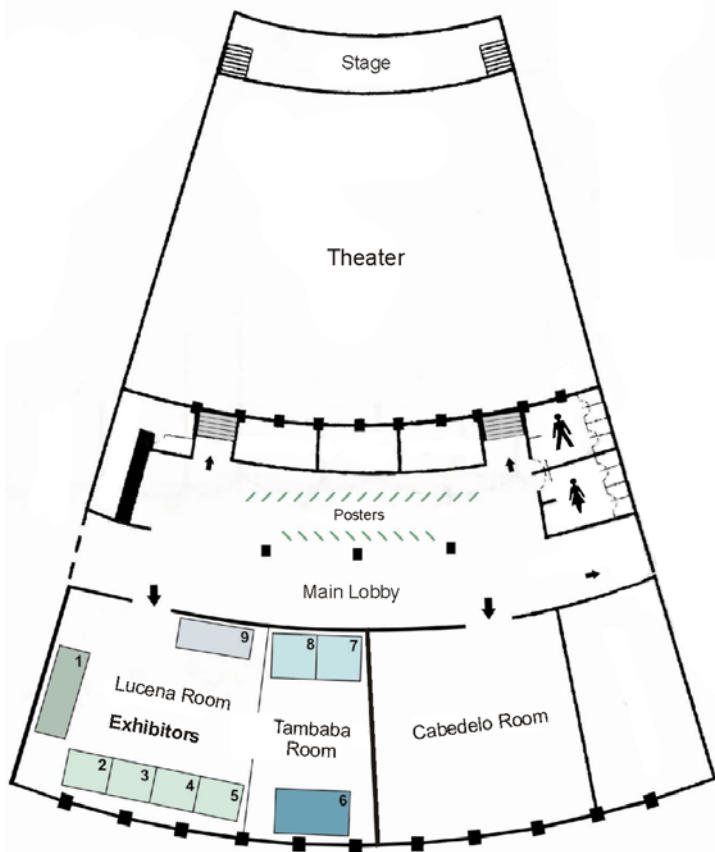
## **Reflexões Sobre Ensino de Medição e Instrumentação em Cursos de Engenharia Elétrica**

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Flávio H. Vasconcelos, Elson J. da Silva, Wallace C. Boaventura,  
*UFMG, Belo Horizonte, Brazil*

Metrologia e instrumentação são disciplinas oferecidas separadamente na maioria dos cursos de engenharia na área elétrica de universidades do Brasil e do exterior. Convicto de que estes temas são partes de um todo e, portanto, devem ser tratados em conjunto e motivado a desafiar as posições contrárias, este artigo levanta questionamentos e traz propostas, abordando questões como o foco do ensino, a avaliação, as estratégias de ensino/aprendizado no laboratório, dentre outras.

## VIII Semetro Plan



### EXHIBITORS:

- |               |                               |
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| 1. Eletrobrás | 2. ROHDE & SCHWARZ            |
| 3. RADIAN     | 4. Measurements International |
| 5. SBM        | 6. FURNAS                     |
| 7. FLUKE      | 8. BOHNEN + MESSTEK           |
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9. Media Desk

# 8º Seminário Internacional de Metrologia Elétrica

## Programa Final

17 - 19 de junho de 2009  
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