

科技资料

15570

**Seventh Annual Applied Power
Electronics Conference and Exposition**

APEC '92

**Seventh Annual
Applied Power
Electronics
Conference and
Exposition**

**Sponsored by the
IEEE Power
Electronics Society, the
IEEE Industry Applications
Society and the
Power Sources Manufacturers Association**

**Conference
Proceedings
1992**



February 23-27, 1992

**Westin Hotel-Copley Place
Boston, Massachusetts**

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1992 IEEE 7th Applied Power Electronics Conference

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FOREWORD

On behalf of the APEC '92 Conference Committee, I would like to welcome you to the Seventh Annual Applied Power Electronics Conference and Exposition. We are proud to present this conference which has been specifically tailored to address the needs of the practicing power electronics professional.

This is the second year that APEC is co-sponsored by the IEEE Power Electronics Society, the IEEE Industry Applications Society, and the Power Sources Manufacturers Association. The broad and complementary interests of these three sponsors combine to create a unique forum for addressing all major aspects of applied power electronics incorporating product design, manufacturing, and marketing. This breadth is reinforced by the wide range of product applications discussed during the course of the conference extending from miniature dc-to-dc power supplies to multi-Megawatt industrial motor drives.

This year's APEC qualifies as the "biggest ever" in several regards. More technical papers—a total of 114—are being presented at APEC '92 than ever before, selected by peer review from the nearly 200 submitted digests, another APEC record. This year's APEC is also more international than ever before with authors from 14 countries, and we extend a special welcome to all of our guests from outside the USA. The quality of the technical program is further enhanced by the inclusion of seven invited papers presented by well-known authorities in the field.

Another major aspect of the APEC technical program is the set of nine Professional Education Seminars offered on Sunday and Monday, presenting up-to-date information on topics spanning the breadth of APEC attendee interests. In addition, three rap sessions scheduled for Wednesday evening provide thought-provoking forums for participants to hear and be heard discussing important issues and trends affecting all of us in the power electronics profession.

The APEC '92 Exposition also merits special notice as the biggest ever, providing attendees a valuable opportunity to examine product offerings of more than 40 different power electronics manufacturers and service suppliers. In addition to the annual opening reception Monday evening, the Exhibition Hall plays host to lunches and afternoon refreshments on both Tuesday and Wednesday. Wednesday afternoon also brings the ever-popular Micro-Mouse contest in addition to informative product application seminars offered by several of the exhibitors.

The climax of the APEC '92 social calendar will occur Tuesday evening at Boston's excellent Museum of Science. The evening's events will include an Italian buffet dinner, a special showing of the Museum's Lightning! show, and ample opportunity to enjoy your colleagues' company while strolling among the Museum's many intriguing exhibits. For those interested in exploring Boston's rich historic and cultural heritage, the Westin Hotel is centrally located in downtown Copley Place to provide ready access to many of the most popular sights.

Finally, I would like to personally thank all of the members of the APEC Committee who have volunteered so much of their time and effort to organize every aspect of this conference. In addition, I wish to thank the staff of Courtesy Associates who have worked closely with our Committee to make this year's APEC the best ever, and we hope we have succeeded. That being said, APEC is still a young conference and we are anxious to receive new ideas from APEC attendees for future improvements. Even better, I invite you to consider volunteering to join our APEC '93 Committee to turn your ideas into action.

So . . . Welcome to APEC '92! May your week with us here in Boston be as enjoyable and personally rewarding as possible.

T.M. Jahns
General Chair

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On behalf of the APEC Committee, I would like to thank the following individuals for contributing the time and effort that went into preparing the outstanding technical program of APEC '92.

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CONFERENCE SCHEDULE

SUNDAY, February 23 **Professional Education Seminars**

- 9:30 a.m.—1:00 p.m. **SEMINAR 1:** **Performance and Design of Brushless DC Motor Drives**
T.J.E. Miller, SPEED Laboratory
- SEMINAR 2:** **Snubber Circuits for Power Electronics**
Rudy Severns, Springtime Enterprises
- SEMINAR 3:** **Principles of Power Electronics**
Martin F. Schlecht, MIT
- 2:00 p.m.—5:30 p.m. **SEMINAR 4:** **Latest Developments in (and Optimal Selection of) Schottky Diodes, Power MOSFETs and IGBTs**
Carl Blake and Chris Ambarian, International Rectifier Corporation
- SEMINAR 5:** **Active Power Factor Correction**
Ray Ridley, Ridley Engineering
- SEMINAR 6:** **Design for Manufacturability**
Ted Squires, Motorola University
-

MONDAY, February 24 **Professional Education Seminars and Plenary Session**

- 8:30 a.m.—12:00 p.m. **SEMINAR 7:** **PWM Methods for AC Drives**
Joachim Holtz, Wuppertal University
- SEMINAR 8:** **Ferrites: Tips, Tricks, Techniques, and Trends**
Magnetic Materials Producers Association (MMPA)
Chairman: John Breckner, Siemens Components
- SEMINAR 9:** **Strategies for Successfully Marketing Switching and Uninterruptible Power Supplies**
Constance Heath, Venture Development Corporation
- 1:30 p.m.—5:00 p.m. **SESSION 1:** **Plenary Session**
- 5:30 p.m.—8:00 p.m. **EXHIBITORS RECEPTION and Open Exhibition**

TUESDAY, February 25
Technical Sessions

8:30 a.m.—12:00 p.m.	SESSION 2:	High-Frequency DC-DC Converters
	SESSION 3:	Variable Reluctance and Induction Motor Drives
	SESSION 4A:	Manufacturing Technologies
	SESSION 4B:	Line Filter Design
12:00 p.m.—2:00 p.m.		OPEN EXHIBITION and Lunch in Exhibition Hall
2:00 p.m.—5:30 p.m.	SESSION 5:	Resonant Converters
	SESSION 6A:	Brushless Permanent Magnet Motor Drives
	SESSION 6B:	Utility Power Quality Issues
	SESSION 7A:	Roadmap to Quality
	SESSION 7B:	Magnetics
5:00 p.m.—7:00 p.m.		OPEN EXHIBITION and Refreshments
6:30 p.m.—11:00 p.m.		EVENING at the BOSTON MUSEUM of Science

WEDNESDAY, February 26
Technical Sessions and Exhibition Activities

8:30 a.m.—12:00 p.m.	SESSION 8:	Control Techniques
	SESSION 9:	Discrete Power Devices: Applications Protection, Modeling
	SESSION 10:	High Power Converters
12:00 p.m.—2:00 p.m.		OPEN EXHIBITION and Lunch in EXHIBITION HALL
1:30 p.m.—5:30 p.m.		EXHIBITOR SEMINARS
2:00 p.m.		MICROMOUSE CONTEST
5:00 p.m.—7:00 p.m.		OPEN EXHIBITION and Refreshments
6:30 p.m.—8:00 p.m.		RAP SESSIONS

THURSDAY, February 27
Technical Sessions

- 8:30 a.m.—12:00 p.m. **SESSION 11A: Power Integrated Circuits Applications**
SESSION 11B: Power Factor Correcting Boost Converters
SESSION 12: Uninterruptible Power Systems
SESSION 13A: Power Circuit Packaging
SESSION 13B: Aerospace and Military Applications
2:00 p.m.—5:30 p.m. **SESSION 14: Soft-Switched Converters**
SESSION 15: Modeling & Simulation for Power Electronics
SESSION 16: Active Filters and Harmonic Minimization
-

APEC '93

Eighth Annual IEEE Applied Power Electronics Conference and Exposition Announcement and Call for Papers

March 6-12, 1993

Town & Country Hotel,

San Diego, California

The IEEE Power Electronics and Industry Applications Societies and the Power Sources Manufacturers Association are sponsoring the Eighth Annual Applied Power Electronics Conference and Exposition (APEC '93). APEC '93 will address the practical application of new components and circuits, design-oriented analysis techniques and current trends in the design and manufacture of power electronic products and systems.

Papers and Seminars are Solicited in All Areas of Power Electronics Including:

DC-DC Converters	Battery Applications	Thermal Design
DC-AC Converters	EMI and EMC Issues and Considerations	Modeling, Analysis and Control
High Power Factor AC-DC Converters	Harmonic Reduction Techniques	Novel Methods for Sensing and Control
Adjustable-Speed Motor Drives	Regulatory Agency Issues	Simulation of Power Electronic Circuits
Motion Control and Servo Systems	Power Systems for Electronic Equipment	CAD/CAE Tools and Applications
Brushless Electronically Controlled Motors	Power Semiconductors & Application Issues	Design for Manufacturability
Industrial and Power System Applications	Power Integrated Circuits and ASICs	Marketing Strategies
Commercial and Residential Applications	Magnetic & Electromechanical Components	Quality—6 Sigma and Beyond
Aerospace and Defense Applications	High Frequency Techniques	World Class Manufacturing
Off-Line Power Supplies	High Density Packaging Techniques	Power Supply Basics for Non-Designers
Uninterruptible Power Supplies		Measurement and Instrumentation Techniques

Deadline for Receipt of Abstract and Digest is August 14, 1992

Preparation of Abstracts and Digests:

Prospective authors are asked to submit a 50 word Abstract and a three to five page Digest of their planned presentation. Both the Abstract and digest should be typed, double space on 8½" × 11" paper.

The heading of the Abstract must include:

Title of the presentation
Author(s)
Affiliation(s)
Mailing address
Daytime telephone number

The heading of the Digest should include the title only.

The Digest should clearly state:

- a) The purpose of the work;
- b) The methods used; and
- c) The specific results.

Inclusion of key figures, tables, and conclusions is encouraged.

Eight copies (originals are not required) of all material should be mailed to:

APEC '93
655 15th Street N.W., Suite 300
Washington, D.C. 20005

Papers submitted for consideration will be subjected to a peer review process. The principal criterion in reviewing papers for acceptance will be the usefulness of the presentation to the practicing engineer.

Authors will be notified of acceptance, with instructions for publication by October 16, 1992.

Manuscripts are expected to be from 5 to 10 pages, including diagrams and figures, and are due in final form by for publication in the Conference Proceedings.

APEC '93 Exposition

A comprehensive trade show consisting of exhibits on the latest advances in components, equipment and services will be featured during APEC '93. Exhibitors will include commercial firms and organizations involved in the manufacture, sale or distribution of components, equipment and professional or technical services.

For more information: APEC '93

655 15th Street N.W., Suite 300
Washington, D.C. 20005
(202) 639-4990

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K. Ma and Y. Lee, Hong Kong Polytechnic, Hong Kong
- 7B.4 **Computer Aided Design And Application Of Integrated L-C Filters**
(Invited) M. Ehsani, P. Le Polles, Texas A&M University, College Station, TX, and I. Pitel, Magna Power Electronics, Whippany, NJ, J. Van Wyk, Rand Afrikaans University, Johannesburg, SOUTH AFRICA

SESSION 8: Control Techniques

Wednesday, February 26

Essex Center

8:30 a.m.-12:00 p.m.

- 8.1 **The Importance Of Parasitic Resistances As Stabilizing Agents For Current-Programmed Converters**
M. Johnson, IBM Corporation, Endicott, NY
- 8.2 **Techniques For Minimizing The Input Current Distortion Of The Current-Controlled Single-Phase Boost Rectifier**
J. Salmon, University of Alberta, Edmonton, Alb. CANADA

- 8.3 **A New Feedforward Control Technique For AC/DC Switchmode Power Supplies** 376
H. Jin, Concordia University, Montreal, CANADA, S. Dewan and J. Lavers, University of Toronto, Toronto, CANADA
- 8.4 **A Novel Load Current Control Method For A Leading Power Factor Voltage Source PWM Rectifier** 383
D. Vass, J. Dixon, Universidad Catolica de Chile, Santiago, CHILE, and B. Ooi, McGill University, Montreal, Que., CANADA
- 8.5 **Sliding Mode Motion Control** 389
N. Bengiamin, University of North Dakota, Grand Forks, ND, and M. Magnuson, MB Controls, Inc., Grand Forks, ND
- 8.6 **Performance Optimization Of Cuk Converters By Sliding-Mode Control** 395
L. Malesani, L. Rossetto, G. Spiazzi, and P. Tenti, University of Padova, Padova, ITALY
- 8.7 **Analysis Of Switching Frequency Reduction Methods Applied To Sliding Mode Controlled DC-DC Converters** 403
B. Cardoso A. Moreira, B. Menezes, and P. Cortizo, Universidade Federal de Minas Gerais, Belo Horizonte—MG, BRAZIL

SESSION 9: Discrete Power Devices: Application, Protection, Modeling

Wednesday, February 26

Essex North

8:30 a.m.-12:00 p.m.

- 9.1 **A Study Of IGBT Turn-Off Behavior And Switching Losses For Zero-Voltage and Zero-Current Switching** 411
K. Chen, REM Technologies, Schenectady, NY, and T. Stuart, University of Toledo, Toledo, OH
- 9.2 **A Packaged MOS Power Service with an Integral Protection Chip** 419
D. Miestus, L. Clark and R. Davies, Motorola Semiconductor Products, Phoenix, AZ
- 9.3 **Power Diode Hybrid Model With Forward And Reverse Recovery For Use In Circuit Simulators** 426
H. Goebel and K. Hoffmann, University of Bundeswehr Munich, Neubiberg, GERMANY
- 9.4 **Conduction and Switching Characteristics of III-V Schottky Rectifiers for Low Loss Switching** 433
S. Anderson, B. Almesfer, Motorola, Inc. Phoenix, AZ, L. Murukutla, Arizona State University, Tempe, AZ
- 9.5 **An Optimum Gate Drive For High Power GTO Thyristors** 439
H. Kojori, M. Narui and F. Dawson, University of Toronto, Toronto, CANADA
- 9.6 **Burn-In Requirements, Trends And Testing Procedures On Electrical Components For A Major U.S. Automotive Manufacturer** 445
J. Fureyak, Cherry Semiconductor Corporation, Troy, MI
- 9.7 **Estimating The Temperature Rise Of Power MOSFETS During The UIS Test** 448
J. McGloin and D. Sdrulla, Advanced Power Technology, Bend, OR

SESSION 10: High Power Converters

Wednesday, February 26
Essex South
8:30 a.m.-12:00 p.m.

- 10.1 **A Zero-Voltage DC Bus Commutated High-Frequency High-Power PWM 3-Phase VSI** 457
E. Morad, P. Ziogas, G. Joos, Concordia University, Montreal, Que. CANADA
- 10.2 **An Alternative Bus Clamp For Resonant DC Link Converters** 463
J. Simonelli, Digital Equipment Corporation, Andover, MA, and D. Torrey, Rensselaer Polytechnic Institute, Troy, NY
- 10.3 **High Efficiency Quasi Resonant DC Link Converter For Full-Range PWM** 472
L. Malesani, P. Tenti, P. Tomasini, University of Padova, Padova, ITALY, and V. Toigo, Istituto Gas Ionizzati-CNR, Padova, ITALY
- 10.5 **A GTO Speed-Up Inverter For Fast-Scan Magnetic Resonance Imaging** 479
O. Mueller, P. Roemer, J. Park, S. Souza, R. L. St. Peters, GE Corporate R&D, Schenectady, NY
- 10.6 **An Analysis And Design Of A Force Commutated Three-Phase PWM AC Controller With Input Unbalance Correction Capability** 487
D. Vincenti, P. Ziogas and R. Patel, Concordia University, Montreal, Que. CANADA
- 10.7 **Inverter Nonlinearities And Discrete-Time Vector Current Control** 494
R. Sepe and J. Lang, Massachusetts Institute of Technology, Cambridge, MA
- 10.8 **A Comparison Of The Practical Inverter Circuits For High-Power Low-And-Medium Frequency Power Supplies** †
V. Nguyen, S. Ng, J. Dhyanchand and M. Kuo, Sundstrand Aerospace, Rockford, IL

SESSION 11A: Power Integrated Circuits and Applications

Thursday, February 27
Essex Center
8:30 a.m.-10:15 a.m.

- 11A.1 **Off-Line Power Integrated Circuit For International Rated 60-Watt Power Supplies** 505
R. Keller, Power Integrations, Mountain View, CA
- 11A.2 **New Offline Switching Regulator Achieves $\pm 1\%$ Regulation In A Flux-Sensed Converter** 513
A. Bonte and R. Vinsant A. Bonte, Linear Technology Corporation, Milpitas, CA
- 11A.3 **A 2.0 μ m BiCMOS Process Including DMOS Transistors For Merged Linear ASIC Analog/Digital/Power Applications** 517
J. Erdeljac, B. Todd, L. Hutter, K. Wagensohnner and W. Bucksch, Texas Instruments, Inc., Dallas, TX
- 11A.4 **Single Chip Pulse Width Modulator For Motion Control** 523
D. Soo and M. Izadinia, National Semiconductor Corporation, Santa Clara, CA

SESSION 11B: Power Factor Correcting Boost Converters

Thursday, February 27
Essex Center
10:15 a.m.-12:00 p.m.

- 11B.1 **RMS, DC, Peak And Harmonic Currents In High-Frequency Power-Factor Correctors With Capacitive Energy Storage** 533
R. Redl, ELFI S.A., Onnens, SWITZERLAND, and L. Balogh, Ascom Hasler Energy Systems, Bern, SWITZERLAND
- 11B.2 **A 1-kW Unity-Power-Factor Rectifier With Isolation And Fault Protection** 541
D. Robless and R. King, University of Toledo, Toledo, OH
- 11B.3 **Circuit Topologies For Single-Phase Voltage-Doubler Boost Rectifiers** 549
J. Salmon, University of Alberta, Edmonton, Alb. CANADA
- 11B.4 **High Efficiency Power Factor Correction Using Interleaving Techniques** 557
B. Miwa, D. Otten and M. Schlecht, Massachusetts Institute of Technology, Cambridge, MA

SESSION 12: Uninterruptible Power Systems

Thursday, February 27
Essex North
8:30 a.m.-12:00 p.m.

- 12.1 **A Guide To The Application-Oriented Selection Of AC/AC Converter Topologies** 571
S. Bhowmik and R. Spee, Oregon State University, Corvallis, OR
- 12.2 **Harmonic Cancellation Of Power Signals Using Voltage Amplitude Modulation By Variable Gain: Applications To The AC-AC Regulator** 579
D. Schmid and P. Reischl, San Jose State University, San Jose, CA
- 12.3 **Analysis And Implementation Of A Grey-Noise PWM Technique Based On Voltage Space Vectors** 586
S. Legowski and J. Bei, University of Wyoming, Laramie, WY, and A. Trzynadlowski, University of Nevada, Reno, NV
- 12.4 **High Power Factor Resonant Rectifier For UPS Systems** 594
B. Ignazio, Conegliano, ITALY
- 12.5 **An On-Line UPS With Improved Input-Output Characteristics** 598
G. Joos, Y. Lin, P. Ziogas and J. Lindsay, Concordia University, Montreal, Que., CANADA
- 12.6 **A Simple And Accurate Method Of Computing Average And RMS Currents In A Three-Phase PWM Inverter** 606
R. Thurston and S. Legowski, University of Wyoming, Laramie, WY
- 12.7 **A Zero-Voltage-Switching Bidirectional Battery Charger/Discharger For The NASA EOS Satellite** 614
D. Sable, F. Lee and B. Cho, Virginia Polytechnic Institute and State University, Blacksburg, VA

SESSION 13A: Power Circuit Packaging

Thursday, February 27
Essex South
8:30 a.m.-10:15 a.m.

- 13A.1 New Copper Multilayer Interconnection Technologies For Power Electronics**
M. Curley, N. Rapoport, REMTEC, Inc., Canton, MA, and D. Suconick, API, Arlington, MA
- 13A.2 Insulated Metal Substrates Improve in Performance And Product Implementation**
J. Fishbein and H. Abramowitz, International Rectifier Corporation, El Segundo, CA
- 13A.3 DC-DC Converter Using All Surface-Mount Components And Insulated-Metal Substrate**
M. Sayani, Digital Equipment Corporation, Maynard, MA
- 13A.4 High Frequency Quasi-Resonant Buck Converter On Insulated Metal Substrate For Avionics Distributed Power Systems**
H. Huillet, Sextant Avionique, Saint Medard En Jalles, FRANCE, and C. Zardini, S. Catrou, F. Manns, C. Martin and J. L. Aucouturier, IXL ENSERB Universite de Bordeaux, Talence, FRANCE

SESSION 13B: Aerospace and Military Applications

Thursday, February 27
Essex South
10:15 a.m.-12:00 p.m.

- 13B.1 A New High Efficiency, Zero-Voltage Switched, PWM Converter**
I. Jitaur, ITT Power Systems, Tucson, AZ
- 13B.2 System Design Considerations For A High-Power Aerospace Resonant Link Converter**
T. Jahns, R. DeDoncker, A. Radun, P. Szczesny, F. Turnbull, GE Corporate R&D, Schenectady, NY
- 13B.3 High Efficiency, High Density MHZ Magnetic Components For A Low Profile Converter**
W. Roshen, R. Steigerwald, R. Charles, W. Earls, G. Claydon, and C. Saj, GE Corporate R&D, Schenectady, NY
- 13B.4 Resonant Mode Controllers For Launch Vehicle Applications**
K. Schreiner, General Dynamics, San Diego, CA and M.E. Roth, NASA Lewis Research Center, Cleveland, OH

SESSION 14: Soft-Switched Converters

Thursday, February 27
Essex Center
2:00 p.m.-5:30 p.m.

- 14.1 A High-Density 1-kW Resonant Power Converter With A Transient Boost Function**
R. Steigerwald, W. Roshen and C. Saj, GE Corporate R&D, Schenectady, NY
- 14.2 On The Minimization Of Switching Losses In DC-DC Boost Converters**
L. Salazar, P. Ziogas and G. Joos, Concordia University, Montreal, Que., CANADA

- 14.3 Constant Frequency ZVS Converter With Integrated Magnetics**
J. Bassett, Computer Products-Power Conversion, Fremont, CA
- 14.4 The Family Of DC-to-DC Converters Using The LC-PWM-RDC Cell Without Resonant Cycle Interruption: Analysis, Simulation And Experimental Results**
L. de Freitas, V. Farias and P. Caparelli, Universidade Federal de Uberlandia, Uberlandia-MG, BRAZIL, and M. Miskulin, Universidade Estadual de Campinas, Campinas-SP, BRAZIL
- 14.5 A High-Efficiency 1.5 kW, 390-50V Half-Bridge Converter Operated At 100% Duty-Ratio**
L. Mweene, D. Otten and M. Schlecht, Massachusetts Institute of Technology, Cambridge, MA
- 14.6 A Resonant DC-DC Transformer**
G. Ivensky A. Abramovitz, M. Gulko, and S. Ben-Yaakov, Ben-Gurion University of the Negev, Beer-Sheva, ISRAEL
- 14.7 A Resonant Pulse Gate Drive For High Efficiency Applications**
H. Wiegman, GE Corporate R&D, Schenectady, NY

SESSION 15: Modeling & Simulation for Power Electronics

Thursday, February 27
Essex North
2:00 p.m.-5:30 p.m.

- 15.1 Small-Signal Modeling Of Average Current-Mode Control**
W. Tang, F. Lee, Virginia Polytechnic Institute and State University, Blacksburg, VA, and R. Ridley, Ridley Engineering, Battle Creek, MI
- 15.2 An Alternate Analysis Of The Current Programmed Model Leads To Simplified Input Filter Design Criteria**
R. Tedder, Harris Corporation, Melbourne, FL
- 15.3 The Dynamic Response Of PWM DC-DC Converters With Input Filters**
H. Tsafrin and S. Ben-Yaakov, Ben-Gurion University of the Negev, Beer-Sheva, ISRAEL
- 15.4 Computer-Based Symbolic Circuit Analysis And Simulation**
R. Webster and K. Ngo, University of Florida, Gainesville, FL
- 15.5 Thermal Simulation In Power Electronics**
C. Schaeffer, J. Ferrieux, R. Perret, Laboratoire d'Electrotechnique de Grenoble, FRANCE, and B. Reymond, M. Gerin, Service Recherches, Grenoble, FRANCE
- 15.6 Small-Signal Modeling Of Series and Parallel Resonant Converters**
E. Yang, F. Lee, Virginia Polytechnic Institute and State University, Blacksburg, VA and M. Jovanovic, DELTA Power Electronics Lab., Inc., Blacksburg, VA
- 15.7 A SPICE Compatible Model Of Magamp Post Regulators**
D. Edry and S. Ben-Yaakov, Ben-Gurion University of the Negev, Beer-Sheva, ISRAEL

SESSION 16: Active Filters and Harmonic Minimization

Thursday, February 27
Essex South
2:00 p.m.-5:30 p.m.

- 16.1 **Viability Of Active EMI Filters For Utility Applications** 803
T. Farkas and M. Schlecht, Massachusetts Institute of Technology, Cambridge, MA
- 16.2 **A New Active Power Factor Correction Method For Single-Phase Buck-Boost AC-DC Converter** 814
A. Prasad, SPAR Aerospace Limited, Ste-Anne-De-Bellevue, Que., CANADA, P. Ziogas, Concordia University, Montreal, Que., CANADA, and S. Manias, National Tech. University of Athens, Athens, GREECE
- 16.3 **Analysis And Design Of A Series Connected PWM Voltage Regulator For Single Phase AC Sources** 821
A. Campos, G. Joos, P. Ziogas and J. Lindsay, Concordia University, Montreal, Que., CANADA

- 16.4 **Active Filtering Of Harmonic Currents In Three-Phase, Four-Wire Systems With Three-Phase And Single-Phase Non-Linear Loads** 829
C. Quinn and N. Mohan, University of Minnesota, Minneapolis, MN
- 16.5 **A New Technique Three-Phase Active Power Filter** 837
M. Bou-Rabee, D. Sutano, F. Barone, The University of New South Wales, Sydney, AUSTRALIA, and G.-H. Choe, Kon Kuk University, Seoul, KOREA
- 16.6 **A Flexible Method Of Minimizing Harmonic Distortion In Force-Commutated Converters** 844
D. Deib and H. Hill, Jr., Ohio University, Athens, OH
- 16.7 **A Novel Approach To Minimize Line-Current Harmonics In Interfacing Renewable Energy Sources With 3-Phase Utility Systems** 852
N. Mohan, University of Minnesota, Minneapolis, MN

†Manuscript unavailable for publication.

SESSION 1:

PLENARY SESSION

Monday, February 24, 1992

Essex Ballroom

1:30 p.m.-5:00 p.m.

Chairman:
Kevin J. Fellhoelter
AT&T Bell Laboratories