GaAs IC SYMPOSIUM

IEEE GALLIUM ARSENIDE INTEGRATED CIRCUIT SYMPOSIUM
Co-Sponsored by The IEEE Electron Devices Society
and The IEEE Microwave Theory and Techniques Society

16th ANNUAL

TECHNICAL DIGEST 1994

PHILADELPHIA, PENNSYLVANIA

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WELCOME TO THE 1994 IEEE GaAs IC SYMPOSIUM

It is with great pleasure that I welcome you to the 16th annual IEEE GaAs IC Symposium and to one of the countries most historical and cultural cities, Philadelphia. As in past years the Symposium offers comprehensive coverage of all aspects of the GaAs IC industry, from the latest breakthroughs in manufacturing technology to the hottest new wireless and digital products and applications. The organizers of this year's Symposium have put special emphasis on both promoting the GaAs industry through the Vendor Product Forums and the Exhibit as well as providing a forum for outstanding exchange of the latest technical breakthroughs. We hope you share our enthusiasm for this year's technical program and associated activities.

The Technical Program Committee, under the direction of TPC Chairman George Bechtel, has organized a full and comprehensive technical program. Sixty one abstracts were selected from a high quality pool of 125 submitted papers. In addition 17 industry experts have been invited to describe their latest work in such diverse areas as the growth of III-V materials in space, the status of SiGe HBTs and discussions of high performance ADCs.

The technical sessions span an equally broad spectrum of topics, with 2 sessions on commercial applications, 2 on process technology and manufacturing, 2 on mixed signal, 3 on microwave and millimeter wave ICs and 2 on digital circuits and systems. In addition to the technical sessions, you will be able to choose from five panel sessions ranging in areas from HBT reliability to ramping up manufacturing capacity for commercial applications.

Don't miss this year's special features including the Short Course, organized by TPC Vice-Chair Elissa Sobolewski on Mixed Signal Design, the Primer Course on the Basics of GaAs ICs on Sunday evening and the Vendor Product Forums on Monday Evening highlighting products for wireless and digital telecommunications applications.

The informative and popular Industry Exhibit will open on Monday evening with a reception. Some of the industries major vendors will display products ranging from materials and process equipment to CAD tools, test equipment and of course GaAs ICs.

If you're feeling overwhelmed with technical information than be sure to take advantage of the social events starting with the Sunday Evening Opening Reception and highlighted by the Tuesday Evening Symposium Party at the world renowned Franklin Institute.

I'd like to take this opportunity to acknowledge the many individuals whose hard work have made this Symposium a success. The volunteers, working on the Executive Committee and the Technical Program Committee and our International advisors who promote the Symposium in Europe and Japan, have put in many hours to bring you a well organized and high quality Symposium. This year's Symposium organizers would also like to express our appreciation to the past chairmen who have created a lasting organizational framework which has helped to make our jobs much easier.

On behalf of the Executive and Technical Program Committees I would like to sincerely welcome you and thank you for attending the Symposium.

Donald C. D'Avanzo
Chairman
1994 IEEE GaAs IC Symposium

1994 IEEE GaAs IC Symposium

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SYMPOSIUM HEADQUARTERS
Wyndham Franklin Plaza Hotel
Philadelphia, Pennsylvania

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Monday, October 17

PANEL SESSION 2:
HBT RELIABILITY

12:30 p.m.-2:00 p.m.
Wyndham Ballroom D

Organizer: Ken Nakano, *Wright Laboratory, Wright-Patterson AFB, OH*
Moderator: Burhan Bayaktaroglu, *Westinghouse, Pittsburgh, PA*

HBT technology has reached a certain degree of maturity. There are potential near- and long-term military and commercial applications for these devices. However, there is little device reliability data available to warrant a wide spread acceptance of this class of devices in modern electronics systems. HBT reliability issues are still not yet well defined and openly discussed in the technical literature. An urgen need exists in establishing a credible reliability baseline for GaAs and InP-based HBTs.

This panel session will survey the current knowledge of HBT reliability issues, and discuss the requirements for some specific systems applications. The emphasis will be on the GaAs HBTs because of its relative technological maturity, but information on InP-based and Si:Ge HBTs will be welcomed. Audience participation is invited.

Panelists:

Frank Yamada, *TRW, Redondo Beach, CA*
Raj Sahai, *Rockwell, Thousand Oaks, CA*
Stretch Camnitz, *Hewlett-Packard, Palo Alto, CA*
Aditya Gupta, *Westinghouse, Baltimore, MD*
Hirohiko Sugahara, *NTT LSI Labs, Kanagawa, JAPAN*
Hans Stork, *IBM T.J. Watson Res, Ctr., Yorktown Heights, NY*
Madjid Hafizi, *Hughes Research, Malibu, CA*

PANEL SESSION 3
GaAs VLSI COMES OF AGE -- WHERE ARE THE GaAs MICROPROCESSORS?

12:30 p.m.-2:00 p.m.
Philadelphia Ballroom

Organizer & Moderator: Mark Wilson, *Motorola SPS, Phoenix, AZ*

The past decade has seen a radical change in the classical distinction between supercomputer systems, mainframes, and high end work stations. The thirst for and success of providing more and more computing power in continually shrinking physical space has resulted in a smearing of the class distinction between these types of systems. Tasks once considered sacred ground for large supercomputers are evolving into routine tasks for super-workstations. The fuel at the very core of this evolution, is advanced microprocessor technology which is providing a new generation of microprocessor every two years. Only in the past 2 to 4 years has GaAs digital IC technology been able to provide the densities necessary to produce a formidable microprocessor as compared to Si fabrication technology. The goal of this panel session is to explore if there is a place in this evolution for GaAs, and if so, why there are no commercial GaAs microprocessors available today.

We intend to explore the following issues and those supplied by the audience, so please bring your questions and comments:

- Can GaAs technology continue to provide a performance advantage over Si?
- Does the lack of large embedded RAM impact the capability of GaAs mp's?
- What role can MCM technology play to minimize the lack of embedded RAM?
- Do any GaAs suppliers have the infrastructure to compete in this dynamic market?
- Has the slow progress of GaAs mP's been a financial or technical issue?

Panelists:

Richard Brown, *Univ. of Michigan, Ann Arbor MI*
Ira Dehimy, *Vitesse Semiconductor, Camarillo, CA*
Peter Zdebel, *Motorola SPS, Phoenix, AZ*
TBD Si Jock, *Sun, HP, DEC, etc., Silicon Valley, CA*
Richard Hollingsworth, Digital Equipment Corporation, Hudson, MA
Bill Robinette, MicroModule Systems, Cupertino, CA

AUTHOR INDEX

SYMPOSIUM AT A GLANCE

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SHORT COURSE: "Mixed-Signal Design"	7:45 a.m.-5:15 p.m.	Wyndham Ballroom D
Short Course Lunch	12:15 p.m.-1:30 p.m.	Wyndham Ballroom C
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Symposium Opening Reception	5:00 p.m.-8:00 p.m.	Horizons Ballroom
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SESSION C: New Technologies and Design Approaches for Digital Circuits	2:10 p.m.-5:00 p.m.	Wyndham Ballroom D
GaAs IC Technology Exhibition Opening Reception	5:00 p.m.-7:30 p.m.	Wyndham Ballrooms A&B
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Wireless Products	7:30 p.m.-10:00 p.m.	Wyndham Ballroom C
Digital Telecom / Signal Processing Products	7:30 p.m.-10:00 p.m.	Wyndham Ballroom D
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SESSION E: Manufacturing Technology	8:30 a.m.-10:05 a.m.	Wyndham Ballroom D
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SESSION J: Reliability and Dispersive Phenomena	8:15 a.m.-11:20 a.m.	Wyndham Ballroom D
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PANEL SESSION 5: Efficient Power Amplification in the Upper Ku-Band: HBTs and PHEMTs	12:30 p.m.-1:50 p.m.	Wyndham Ballroom D
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SESSION L: High-Frequency / High-Performance Devices	2:00 p.m.-5:00 p.m.	Wyndham Ballroom D
Close of Symposium	5:10 p.m.	

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SESSION B: SIGNAL AND CONTROL COMPONENTS

2:30 p.m.
Wyndham Ballroom C

Chairmen: M. Madihian, NEC , Kawasaki, JAPAN
J. Komiak, Martin Marietta, Syracuse, NY

SESSION C: NEW TECHNOLOGIES AND DESIGN APPROACHES FOR DIGITAL CIRCUITS

2:10 p.m.
Wyndham Ballroom D

Chairmen: M. Helix, *Vitesse, Camarillo, CA*
J. Kasahara, *Sony Corporation, Kanagawa, JAPAN*

Monday, October 17

VENDOR PRODUCT FORUMS:
7:30 p.m.-10:00 p.m.

Wireless Products
Wyndham Ballroom C

Chairmen: P. Staecker, *M/A-COM, Lowell, MA*
W. Mickanin, *TriQuint Semiconductor, Beaverton, OR*

Wireless products continue to gain momentum as new applications undergo explosive growth. However, many of these applications are in highly cost-sensitive products that stress efficiency in all areas of IC development: design, processing, packaging and test. This forum will feature descriptions of some of the newest and most innovative products available as well as applications examples. Companies represented will include:

GEC-Marconi (D.C. Smith)
Siemens (J. E. Mueller)
Samsung Microwave Semiconductor (J. Tenedorio)
TriQuint Semiconductor (J. Skovron)
Raytheon Advanced Device Center (D. Maki)
NEL (H. Kikuchi)
Anadigics (To be announced)
Celeritek (To be announced)

Digital Telecom / Signal Processing Products
Wyndham Ballroom D

Chairman: P. Robertson, *Sandia Nat. Labs, Albuquerque, NM*

The ever-increasing demands of bandwidth, speed and low power continue to spur a broad range of users into GaAs IC technology. Demand for fiber optic systems, high speed computer clocking and communications products continues to expand. Products that offer a wide range of speeds, gate counts, and packaging costs are responding to these requirements. The "information superhighway" will require the high throughput of GaAs ICs to avoid gridlock. Companies presenting products will include:

Rockwell Microelectronics Technology Center (T. Dugan)
TriQuint Semiconductor (B. Woodruff)
Texas Instruments Defense Syst. & Elec. Grp. (P. Schurr)

Tuesday, October 18

SESSION D: MILLIMETER-WAVE HEMTS
8:30 a.m.
Wyndham Ballroom C

Chairmen: A. Oki, *TRW, Redondo Beach, CA*
J. Meyer, *Sandia National Laboratories, Albuquerque, NM*

8:35 a.m.
D.1 DEVELOPMENTS IN TRANSPORT TELEMATICS IN EUROPE, (Invited Paper), P. Hills, *University of Newcastle Upon,Tyne, UK*

9:05 a.m.
D.2 W-BAND MONOLITHIC SINGLE SIDEBAND TRANSCEIVER FOR AUTOMOTIVE RADAR APPLICATIONS, K.W. Chang, H. Wang, G.S. Dow, D.C.W. Lo, M. Biedenbender, B. Allen,*TRW, Redondo Beach, CA* and T.H. Chen, *Haxawave Photonic System, Inc., Taiwan, ROC*

9:25 a.m.
D.3 60-GHZ HEMT-BASED MMIC RECEIVER WITH ON CHIP LO, T. Saito, N. Hidaka, *Advanced Millimeter Wave Technologies Co.* Ltd, Kawasaki, JAPAN, Y. Ohashi, *Fujitsu Laboratories Ltd., Kawasaki, JAPAN* and Y. Aoki, *Fujitsu Limited, Kawasaki, JAPAN*

9:45 a.m.
D.4 A NOVEL W-BAND MONOLITHIC PUSH-PULL AMPLIFIER, H. Wang, G.S. Dow, M. Aust, K.W. Chang, R. Lai, M. Biedenbender, D. Streit and B. Allen, *TRW, Redondo Beach, CA*

10:40 a.m.
D.5 A 16-DB DC-50GHZ IN ALAS/INGaAs HEMT DISTRIBUTED BASEBAND AMPLIFIER USING A NEW LOSS COMPENSATION TECHNIQUE, S. Kimura, Y. Imai, Y. Umeda, T. Enoki, *NTT LSI Laboratories, Kanagawa, JAPAN*

11:00 a.m.
D.6 A MONOLITHIC BROADBAND 10 - 50 GHZ DISTRIBUTED HEMT MIXER INCLUDING ACTIVE LO-RF COMBINER, D. Hollmann, G. Baumann, R. Heilig, *Alcatel Sel Ag., Pforzheim, GERMANY*

11:20 a.m.
D.7A 60 GHZ HEMT-MMIC ANALOG FREQUENCY DIVIDER BY TWO, J.C. Sarkissian, R. Quere, J. Obregon, *IRCOM-IUT, Brive, FRANCE*, M. Camiade, P. Savary, *THOMSON-TCS, Orsay, FRANCE*, and A. Suarez, *Universidad de CANTABRIA, ESPAGNE*

11:40 a.m.
D.8 On-Wafer HEMT Characterization to 110GHz, R. Anholt, *Gateway Modeling, Inc., Minneapolis, MN*, J. Pence and E. Godshalk, *Cascade Microtech, Beaverton, OR*

SESSION E: MANUFACTURING TECHNOLOGY

8:30 a.m.
Wyndham Balllroom D

Chairmen: W. Mickanin, *TriQuint Semiconductor, Beaverton, OR*
J. Turner, *GEC-Marconi, Caswell, UK*

SESSION F: POWER TECHNOLOGY

10:40 a.m.
Wyndham Ballroom D

SESSION G: COMMERCIAL APPLICATIONS OF GaAs ICs

1:40 p.m.
Wyndham Ballroom C

Chairmen: D. Fisher, *3COM Corporation, Santa Clara, CA*
E. Reese, *Texas Instruments, Dallas, TX*

Tuesday, October 18

SESSION H: HIGH DATA RATE ICs FOR OPTICAL COMMUNICATIONS

1:40 p.m.
Wyndham Ballroom D

Chairmen: M. Wilson, *Motorola, Tempe, AZ*
J. Sitch, *Bell Northern Research, Ottawa, CANADA*

Wednesday, October 19

SESSION I: ADVANCED ANALOG TO DIGITAL CONVERTERS

8:15 a.m.
Wyndham Balllroom C

Chairmen: P. Robertson, *Sandia National Laboratories, Albuquerque, NM*
G. Chang, *Bellcore, Red Bank, NJ*

SESSION J: RELIABILITY AND DISPERSIVE PHENOMENA

8:15 a.m.
Wyndham Ballroom D

Chairmen: K. Mac Williams, *The Aerospace Corporation, Los Angeles, CA*
K. Nakano, *Wright Laboratories, Wright-Patterson, OH*

PANEL SESSION 4: RAMP UP TO MANUFACTURING

12:30 p.m.-1:50 p.m.
Wyndham Ballroom C

Organizer & Moderator, John Parsey, *Motorola SPS, Phoenix, AZ*

Representatives from an number of leading GaAs facilities will address issues of the challenges, their successes and not-so successful efforts in the transitions from "pilot line" configurations to commercial volumes, transitions from government to commercial focus, and challenges in balancing multiple processes and device families on the same fabrication lines.

Panelists:

Jim Dilorenzo, *Raytheon, Lexington, MA*
Jai Hakhu, *Rockwell, Thousand Oaks, CA*
Tom Cordner, *Texas Instruents, Dallas, TX*
Lou Tomasetta, *Vitesse, Camarillo, CA*
Masahiro Hagio, *Matsushita, JAPAN*

PANEL SESSION 5: EFFICIENT POWER AMPLIFICATION IN THE UPPER Ku-BAND: HBTs and PHEMTs

12:30 p.m.-1:50 p.m.
Wyndham Ballroom D

Organizers and Moderators:
Fazal Ali, *Westinghouse, Baltimore, MD*
Jan-Eric Muller, *Siemens AG, Munich, GERMANY*

Recently, there has been a considerable interest in developing highly efficient solid state transmitters in the upper Ku-band for advanced communication systems. High power MMIC amplifiers with high efficiency and high yield are critical components for achieving performance and cost objectives of these high frequency transmit modules.

Heterojunction Bipolar Transistors (HBTs) and Pseudomorphic High Electron Mobility Transistors (PHEMTs) are both potential candidates for this application where the traditional MESFET devices are running out of "GaAs." This panel discussion will focus on various issues related to device processing and circuit performance for PHEMTs and HBTs in the upper Ku-band, especially at 18 GHz.

Panelists:

Aditya Gupta, *Westinghouse, Baltimore, MD*
Lisa Aucoin, *Raytheon, Lexington, MA*
Aiden Higgins, *Rockwell, Thousand Oaks, CA*
Phil Smith, *Martin-Marietta, Syracuse, NY*

SESSION K: GaAs HBTs: COOL DEVICES WITH HOT PERFORMANCE

2:00 p.m.
Wyndham Ballroom C

Chairmen: F. Ali, *Westinghouse, Baltimore, MD*
J. Mueller, *Siemens AG, Munich, GERMANY*

SESSION L: HIGH-FREQUENCY / HIGH-PERFORMANCE DEVICES

2:00 p.m.
Wyndham Ballroom D

Chairmen: R. Sadler, *ITT Corp., Roanoke, VA*
C. Sweeney, *Alpha Industries, Woburn, MA*