

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

OCTOBER 16-19, 1994

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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

SYMPOSIUM OPENING

8:00 a.m.-8:15 a.m.

Wyndham Ballroom C & D

1994 Symposium Chairman

Donald C. D'Avanzo, Hewlett-Packard Co., Santa Rosa, CA

1994 Technical Program Chairman

George Bechtel, Litton Solid State, Santa Clara, CA

PLENARY SESSION A: EMERGING SYSTEM APPLICATIONS AND TECHNOLOGY TRENDS

8:15 a.m.

Wyndham Ballroom C & D

Chairmen: W. Stanchina, *Hughes Research Laboratories, Malibu, CA*
C. Weitzel, *Motorola, Tempe AZ*

8:20 a.m.

A.1 MMIC'S FOR SPACE-BORNE SYSTEMS: STATUS AND PROSPECTIVES, (Invited Paper) J. Cazaux, *Alcatel Espace, Toulouse, FRANCE* **3**

8:50 a.m.

A.2 GIGABIT NETWORKING TECHNOLOGIES AND BEYOND, (Invited Paper), N. Cheung, *Bellcore, Morristown, NJ* **7**

9:40 a.m.

A.3 PROGRESS IN QUANTUM FUNCTIONAL DEVICES TO OVERCOME BARRIERS TO ULSI SCALING, (Invited Paper) H. Goronkin, *Motorola, Tempe, AZ* **9**

10:10 a.m.

A.4 ADVANCED III-V MATERIALS PROCESSING IN THE VACUUM OF SPACE, (Invited Paper), A. Ignatiev, **13**

10:40 a.m.

A.5 GAAS PERFORMANCE IN SI TECHNOLOGY: SIGE HBTs FOR MIXED ANALOG-DIGITAL APPLICATIONS, (Invited Paper), J. Stork, *IBM T. J. Watson Research Center, Yorktown Heights, NY* **17**

PANEL SESSION 1: SILICON-GERMANIUM HBTs: OPTION IN MICROWAVE ACTIVE CIRCUITS?

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

Wyndham Ballroom C

Organizer & Moderator:

Peter Staecker, *M/A-COM, Lowell, MA*

In this conference last year, we heard lively discussions about which technologies would be important for wireless applications and SATCOM flight power amps. The usual suspects were rounded up: GaAs MESFETs, HBTs, PHEMTs for efficient power, with silicon bipolar, MOS and BiCMOS entries gaining grudging acknowledgement as viable alternatives for wireless markets, at least to frequencies as high as 2.4 GHz.

In the past 12 months, however, the microwave performance of Si:Ge HBTs has been demonstrated, which would seem to allow pushing beyond the 2.4 GHz band. Because this new technology shares the existing silicon-based processing infrastructure, Si:Ge devices and ICs have emerged as an instant contender for many microwave markets.

This panel, composed of circuit designers (users) of GaAs and silicon technology, will examine and compare Si:Ge with current approaches for use in a number of microwave analog functions.

Panel Members:

Christian Kermarrec, *Analog Devices, Wilmington, MA*

Dave Lutz, *Motorola, Phoenix, AZ*

Jim Moniz, *M/A-COM, Lowell, MA*

Allen Podell, *Pacific Monolithics, Sunnyvale, CA*

**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 urgent 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 Dehmy, *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*

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SYMPOSIUM AT A GLANCE

SATURDAY, OCTOBER 15, 1994

REGISTRATION (Short Course & Primer Course Only)

6:00 p.m.-8:00 p.m.

Wyndham Foyer

SUNDAY, OCTOBER 16, 1994

REGISTRATION (Short Course & Primer Course Only)

7:00 a.m.-8:00 a.m.

Wyndham Foyer

Continental Breakfast for Short Course

7:00 a.m.-7:45 a.m.

Wyndham Foyer

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

REGISTRATION for Symposium

5:00 p.m.-8:00 p.m.

Wyndham Foyer

Symposium Opening Reception

5:00 p.m.-8:00 p.m.

Horizons Ballroom

PRIMER COURSE: "Basics of GaAs ICs"

6:30 p.m.-9:30 p.m.

Wyndham Ballroom D

MONDAY, OCTOBER 17, 1994

REGISTRATION

7:00 a.m.-5:00 p.m.

Wyndham Foyer

Continental Breakfast

7:00 a.m.-8:00 a.m.

Wyndham Foyer

SYMPOSIUM OPENING

8:00 a.m.-8:15 a.m.

Wyndham Ballrooms C&D

PLENARY SESSION A: Emerging System Applications
and Technology Trends

8:15 a.m.-11:10 a.m.

Wyndham Ballrooms C&D

Panel Lunch

11:15 a.m.-12:15 p.m.

Horizons Ballroom

PANEL SESSION 1: SiGe HBTs: Option in
Microwave Active Circuits?

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

Wyndham Ballroom C

PANEL SESSION 2: HBT Reliability

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

Wyndham Ballroom D

PANEL SESSION 3: GaAs VLSI Comes of Age --
Where are the GaAs Microprocessors?

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

Philadelphia Ballroom

SESSION B: Signal and Control Components

2:30 p.m.-4:40 p.m.

Wyndham Ballroom C

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

VENDOR PRODUCT FORUMS:

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

TUESDAY, OCTOBER 18, 1994

REGISTRATION

7:00 a.m.-5:00 p.m.

Wyndham Foyer

Continental Breakfast

7:00 a.m.-8:00 a.m.

Wyndham Foyer

GaAs IC TECHNOLOGY EXHIBITION

9:30 a.m.-4:00 p.m.

Wyndham Ballrooms A&B

SESSION D: Millimeter-Wave HEMTs ICs

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

Wyndham Ballroom C

SESSION E: Manufacturing Technology

8:30 a.m.-10:05 a.m.

Wyndham Ballroom D

SESSION F: Power Technology

10:40 a.m.-12:00 noon

Wyndham Ballroom D

Exhibition Lunch

12:00 noon-1:30 p.m.

Wyndham Ballrooms A&B

SESSION G: Commercial Applications of GaAs ICs

1:40 p.m.-5:20 p.m.

Wyndham Ballroom C

SESSION H: High Data Rate ICs for Optical Communications

1:40 p.m.-5:00 p.m.

Wyndham Ballroom D

Symposium Party

6:30 p.m.-10:00 p.m.

Franklin Institute

WEDNESDAY, OCTOBER 19, 1994

REGISTRATION

7:00 a.m.-12:00 noon

Wyndham Foyer

Continental Breakfast

7:00 a.m.-8:00 a.m.

Wyndham Foyer

SESSION I: Advanced Analog to Digital Converters

8:15 a.m.-11:20 a.m.

Wyndham Ballroom C

SESSION J: Reliability and Dispersive Phenomena

8:15 a.m.-11:20 a.m.

Wyndham Ballroom D

Panel Lunch

11:20 a.m.-12:15 p.m.

Conference Center Ballroom

PANEL SESSION 4: Ramp up to Manufacturing

12:30 p.m.-1:50 p.m.

Wyndham Ballroom C

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

SESSION K: GaAs HBTs: Cool Devices with Hot Performance

2:00 p.m.-5:10 p.m.

Wyndham Ballroom C

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 C:	New Technologies and Design Approaches for Digital Circuits
VENDOR PRODUCT FORUM:	Wireless Products
VENDOR PRODUCT FORUM:	Digital Telecom/Signal Processing Products
SESSION D:	Millimeter Wave HEMTS
SESSION E:	Manufacturing Technology
SESSION F:	Power Technology
SESSION G:	Commercial Applications of GaAs ICs
SESSION H:	High Data Rate ICs for Optical Communications
SESSION I:	Advanced Analog to Digital Converters
SESSION J:	Reliability and Dispersive Phenomena
PANEL SESSION 4:	Ramp up to Manufacturing
PANEL SESSION 5:	Efficient Power Amplification in the Upper Ku-Band: HBTs and PHEMTs
SESSION K:	GaAs HBTs: Cool Devices with Hot Performance
SESSION L:	High Frequency High-Performance Devices

SESSION B: SIGNAL AND CONTROL COMPONENTS

2:30 p.m.
Wyndham Ballroom C

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

2:35 p.m.

B.1 MMIC PHASE LOCKED L-S BAND OSCILLATORS, J. W. Smuk, and P. Katzin, *Hittite Microwave Corp., Woburn, MA*

2:55 p.m.

B.2 A V-BAND AlGaAs/InGaAs HETEROJUNCTION FET MMIC DIELECTRIC RESONATOR OSCILLATOR, M. Funabashi, K. Ohata, K. Onda, *Advanced Millimeter Wave Technologies Co., Ltd, Shiga, JAPAN*, K. Hosoya, T. Inoue, M. Kuzuhara, *NEC Corp., Shiga, JAPAN*, K. Kanekawa and Y. Kobayashi, *Saitama University, Saitama, JAPAN*

3:15 p.m.

B.3 AN 800 MHZ MONOLITHIC GaAs HBT SERRODYNE MODULATOR, L. J. Kushner, *Massachusetts Institute of Technology, Lexington, MA*, G. Van Andrews, W.A. White, J.B. Delaney, M.A. Vernon, M.P. Harris, and D.A. Whitmire, *Texas Instruments, Dallas, TX*

4:00 p.m.

B.4 MMIC GYRATOR BANDSTOP FILTER WITH ULTRA-WIDEBANDTUNING, S.P. Marsh and R.G. Arnold, *GEC-Marconi, Caswell, UK*

4:20 p.m.

B.5 ACTIVE, SELF-ADJUSTING L-S BAND MMIC FILTERS, P. Katzin and V. Aparin, *Hittite Microwave Corporation, Woburn, MA*

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*

2:15 p.m.

C.1 A GaAs BIFET LSI TECHNOLOGY, W.J. Ho, M.F. Chang, S.M. Beccue, P.J. Zampardi, J. Yu, A. Sailer, R.L. Pierson and K.C. Wang, *Rockwell Science Center, Thousand Oaks, CA*

2:35 p.m.

C.2 ULTRA LOW POWER AlGaAs/InGaAs HJFET SCFL CIRCUIT FOR 10 GBPS APPLICATIONS WITH 1.3V SUPPLY VOLTAGE, M. Fuji, T. Maeda, Y. Ohno, M. Tokushima, M. Ishikawa, M. Fukaishi and H. Hida, *NEC Corporation, Tsukuba, JAPAN*

2:55 p.m.

C.3 0.9V DSP BLOCKS: A 15NS 4K SRAM AND A 45NS 16BIT MULTIPLY/ACCUMULATOR, J. A. Hallmark, C. Shurboff, B. Ooms, R. Lucero, J. Abrokwa and J. Huang, *Motorola, Tempe, AZ*

3:15 p.m.

C.4 COMPLEMENTARY GaAs JUNCTION-GATED HETEROSTRUCTURE FIELD EFFECT TRANSISTOR TECHNOLOGY, A.G. Baca, J. C. Zolper, M.E. Sherwin, P.J. Robertson, R.J. Shul, A.J. Howard, D.J. Rieger and J.F. Klem, *Sandia National Laboratories, Albuquerque, NM*

4:00 p.m.

C.5 2.5GB/S 8X8 SELF-ROUTING SWITCH GaAs LSIS FOR ATM SWITCHING SYSTEMS, H. Yamada, M. Tunotani, F. Kaneyama and S. Seki, *Oki Electric Industry Co., Ltd., Tokyo, JAPAN*

4:20 p.m.

C.6 A 500 MHz Variable-Voltage Bidirectional I/O Pad for Digital GaAs APPLICATIONS, P. J. Sherhart, M.D. Upton, R.J. Lomax and R.B. Brown, *University of Michigan, Ann Arbor, MI*

4:40 p.m.

C.7 POWER RAIL LOGIC: A LOW POWER LOGIC STYLE FOR DIGITAL GaAs CIRCUITS, A. Chandna, R.B. Brown and D. Putti, *University of Michigan, Ann Arbor, MI*

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)

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 TRANSCIEVER 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 Ballroom D

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

8:35 a.m.
E.1 WAFER FAB LINE YIELD IMPROVEMENT AT TRI-QUINT SEMICONDUCTOR, (Invited Paper) T. Smith, *TriQuint Semiconductor, Inc., Beaverton, OR* 115

9:05 a.m.
E.2 MANUFACTURABILITY OF DUMMY-GATE SELF-ALIGNED LDD GaAs MESFETS FOR HIGH VOLUME PRODUCTION, S. Nakajima, G. Ishii, Y. Saito, N. Kuwata, K. Fukuzawa, K. Koike and H. Nishizawa, *Sumitomo Electric Industries, Yokohama, JAPAN* 119

9:25 a.m.
E.3 SELF-ALIGNED INGaP/INGaAs/GaAs HETEROSTRUCTURE MESFET TECHNOLOGY FOR ANALOG-DIGITAL HYBRID TYPE ICS, S. Sugitani, Y. Yamane, T. Nittano, H. Yamazaki, K. Nishimura, K. Yamasaki, *NTT LSI Labs, Kanagawa, JAPAN* 123

9:45 a.m.
E.4 MANUFACTURING TECHNOLOGY FOR HIGH PERFORMANCE HBT LINEAR POWER AMPLIFIERS, L.W. Yang, J.J. Komiak, D.P. Smith, M.Y. Kao, R.S. Brozovich, K.J. Nordheden, D.R. Helms, D.E. Houston and F.R. Bardsley, *Martin Marietta Labs, Syracuse, NY* 127

SESSION F: POWER TECHNOLOGY

10:40 a.m.
Wyndham Ballroom D

10:40 a.m.
F.1 2.3V GaAs POWER MESFET WITH 68-PERCENT POWER-ADDED-EFFICIENCY, J. Lee, H. Kim, J. Mun, J. Lee, H. Park and S. Park, *Electronics & Telecommunication Research Institute, Taejon, KOREA* 133

11:00 a.m.
F.2 K-BAND HIGH GAIN AND HIGH RELIABILITY GaAs POWER FET WITH SUB-HALF MICRON WSI/AU T-SHAPED GATE, Y. Kohno, T. Kunii, T. Oku, R. Hattori, J. Udomoto, M. Komaru, K. Yajima, A. Inoue, K. Itoh, H. Takano, O. Ishihara and S. Mitsui, *Mitsubishi Electric Corporation, Hyogo, JAPAN* 137

11:20 a.m.
F.3 LARGE-SCALE, COMPUTER-AIDED THERMAL DESIGN OF POWER GaAs INTEGRATED DEVICES AND CIRCUITS, F. Bonani, G. Ghione, M. Pirola and C.U. Naldi, *Politecnico di Torino, Torino, ITALY* 141

11:40 a.m.
F.4 GaAs MULTI-CHIP POWER AMPLIFIER MODULE USING A MUTLI-LAYER TAB TAPE, Y. Notani, Y. Nakajima, Y. Ohta, Y. Mitsui, M. Nakayama, S. Murakami, O. Ishihara and S. Mitsui, *Mitsubishi Electric Corporation, Hyogo, JAPAN* 145

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*

1:45 p.m.
G.1 APPLICATIONS OF GaAs ICS IN VIDEO DISTRIBUTION, (Invited Paper) R. Gold, *Pacific Monolithics Inc., Sunnyvale, CA* 151

2:15 p.m.
G.2 APPLICATIONS FOR GaAs ICS IN NEXT GENERATION WIRELESS COMMUNICATIONS SYSTEMS, (Invited Paper) L. Burns, *3Com Corporation, Santa Clara, CA* 155

2:45 p.m.
G.3 GaAs CONVERTER IC FOR C BAND DBS RECEIVERS, T. Miya, S. Yoshida, T. Umemoto, K. Satoh, H. Hirayama, K. Miyagaki, *NEC Corporation, Kawasaki, JAPAN*, J. Leong, *Micoelectronics Technology, Inc. Kawasaki, JAPAN* 159

3:05 p.m.
G.4 1.5V ULTRA-WIDE BAND GaAs MONOLITHIC AMPLIFIER FOR PORTABLE WIRELESS LAN AND SATELLITE COMMUNICATION APPLICATIONS, K. Youn, C. Lee, M. Kim, J. Yang, S. Kang, S. Park, D. Kim, C. Park, H. Park and S. Park, *Electronics and Telecommunication Research Institute, Taejon, KOREA* 163

3:50 p.m.
G.5 IMPACT OF THE EMF CONTROVERSY ON EMERGING TECHNOLOGIES: GOOD OR BAD?, (Invited Paper) J.M. Osepchuk, *Raytheon Research Division, Lexington, MA* 167

4:20 p.m.
G.6 LOW VOLTAGE, HIGH EFFICIENCY CLASS E GaAs POWER AMPLIFIERS, C.A.T. Salama, T. Sowlati, *University of Toronto, Toronto, CANADA*, J. Sitch, G. Rabjohn, D. Smith, *Bell Northern Research, Ontario, CANADA* 171

4:40 p.m.
G.7 A 1.2 W, 65% EFFICIENT POWER AMPLIFIER IC FOR COMMERCIAL APPLICATIONS, J. Naber, J. Griffiths and J. Salvey, *ITT Gallium Arsenide Technology Center, Roanoke, VA* 175

5:00 p.m.
G.8 A HIGH EFFICIENCY COMMERCIAL GaAs MESFET POWER AMPLIFIER FOR PCM/CIA APPLICATIONS AT 2.45 GHZ, T. Quach and J. Staudinger, *Motorola, Tempe, AZ* 179

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*

1:45 p.m.
H.1 HIGH-SPEED ALGaAs/GaAs HBTs AND THEIR APPLICATIONS TO 40-GBIT/S-CLASS ICs, (Invited Paper), Y. Matsuoka and E. Sano, *NTT LSI Laboratories, Kanagawa, JAPAN* **185**

2:15 p.m.
H.2 A 40 GHZ D-TYPE FLIP-FLOP USING AlGaAs/GaAs HBT'S, Y. Kuriyama, T. Sugiyama, S. Hongo, J. Akagi, T. Tsuda, N. Iizuka and M. Obara, *Toshiba Research and Development Center, Kawasaki, JAPAN* **189**

2:35 p.m.
H.3 A NOVEL HIGH-SPEED LATCHING OPERATION FLIP-FLOP (HLO-FF) CIRCUIT AND ITS APPLICATIONS TO A 19GB/S DECISION CIRCUIT USING 0.2 UM GaAs MESFET, K. Murata, *NTT Transmission Systems Labs, Kanagawa, JAPAN*, T. Otsuji, E. Sano, *NTT LSI Laboratories, Kanagawa, JAPAN*, M. Ohhata, M. Suzuki, *NTT Electronics Technology Corporation, Kanagawa, JAPAN* and M. Togashi, *NTT Communications Switching Laboratories, Kanagawa, JAPAN* **193**

2:55 p.m.
H.4 HBT TRANSMITTER AND DATA REGENERATOR ARRAYS FOR WDM OPTICAL COMMUNICATIONS APPLICATION, K.D. Pedrotti, F. Zucca, P.J. Zampardi, K. Nary, S.M. Beccue, K. Runge, R.T. Huang and K.C. Wang, *Rockwell International Corporation, Thousand Oaks, CA* **197**

3:50 p.m.
H.5 SURFACE EMITTING LASERS AND OTHER BUILDING BLOCKS FOR OPTOELECTRONIC INTEGRATED CIRCUITS, (Invited Paper), K. Lear, *Sandia National Laboratories, Albuquerque, NM* **201**

4:20 p.m.
H.6 10 GB/S MONOLITHIC OPTICAL MODULATOR DRIVER WITH HIGH OUTPUT VOLTAGE OF 5 V USING InGaP/GaAs HBTs, Y. Yamauchi, K. Nagata, T. Makimura, O. Nakajima, H. Ito and T. Ishibashi, *NTT LSI Laboratories, Kanagawa, JAPAN* **207**

4:40 p.m.
H.7 A DECISION CIRCUIT WITH PHASE DETECTORS FOR 10GB/S OPTICAL COMMUNICATION SYSTEMS, M. Shikata, A. Nishino, R. Shigemasa, H.I. Fujishiro, S. Nishi and T. Ushikubo, *Oki Electric Industry Co., Ltd., Tokyo, JAPAN* **211**

SESSION I: ADVANCED ANALOG TO DIGITAL CONVERTERS

8:15 a.m.
Wyndham Ballroom C

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

8:20 a.m.
I.1 ANALOG-TO-DIGITAL CONVERTER TECHNOLOGY COMPARISON, (Invited Paper), R. Walden, *Hughes Research Laboratories, Malibu, CA* **217**

8:50 a.m.
I.2 GaAs FOR ADCs: SYSTEM NEEDS AND DEVICE REQUIREMENTS, (Invited Paper) J. Sauerer, F. Oehler, G. Rohmer and U. Schlag, *Fraunhofer Inst für Integrierte, Erlangen, GERMANY* **220**

9:20 a.m.
I.3 DOUBLE HETEROSTRUCTURE INP HBT TECHNOLOGY FOR HIGH RESOLUTION A/D CONVERTERS, J. F. Jensen, A. Cosand, W.E. Stanchina, R.H. Walden, T. Lui, Y.K. Brown, M. Montes, K. Elliott and C.G. Kirkpatrick, *Hughes Research Laboratories, Malibu, CA* **224**

9:40 a.m.
I.4 IMPLEMENTATION OF GaAs E/D HEMT ANALOG COMPONENTS FOR OVERSAMPLING ANALOG/DIGITAL CONVERSION, S. Feng, J. Sauerer and D. Seitzer, *Fraunhofer Inst for Integrated Circuits, Erlangen, GERMANY* **228**

10:20 a.m.
I.5 SECOND ORDER & MODULATORS USING AL-GaAs/GaAs HBTs, K.R. Nary, S. Beccue, R. Nubling, R. Pierson, K. Wang and P. Zampardi, *Rockwell Intl Science Center, Thousand Oaks, CA* **232**

10:40 a.m.
I.6 An 800 MSps Track and Hold Using a 0.3 um AlGaAs-HEMT-Technology, G. Rohmer, J. Sauerer, D. Seitzer, *Fraunhofer-Institute for Integrated Circuits, Erlangen Germany*, Y. U. Nowotny, B. Raynor and J. Schneider, *Fraunhofer-Institute for Applied Solid State Physics, Freiburg, GERMANY* **236**

11:00 a.m.
I.7 A 6-BIT, 4GSA/S ADC FABRICATED IN A GaAs HBT PROCESS, K. Poulton, K. Knudsen, J. Corcoran, *Hewlett-Packard Laboratories, Palo Alto, CA*, K. Wang, R. Nubling, R. Pierson, M. Chang, *Rockwell International Science Center, Thousand Oaks, CA*, R. Huang, *Rockwell Microelectronics Technology Center, Thousand Oaks, CA* **240**

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*

8:20 a.m.
J.1 DEGRADATION OF GaAs PHEMT UNDER HYDROGEN 247
CONTAINED ATMOSPHERE, W. Hu, T. Yu, P. Chao and
A. Swanson, *Martin Marietta Corp., Syracuse, NY*

8:40 a.m.
J.2 HUMIDITY RESISTANCE OF GaAs ICS, W.J. Roesch, R.A. 251
Winters, A.L. Rubalcava and B. Ingle, *TriQuint Semiconductor,*
Beaverton, OR

9:00 a.m.
J.3 THREE-TERMINAL BREAKDOWN EFFECTS IN 255
POWER MESFETS, C. Hanson, H. Fu and M. Golio, *Mo-*
trola, Tempe, AZ

9:20 a.m.
J.4 HOT-ELECTRON-INDUCED DEGRADATION OF MET- 259
AL- SEMICONDUCTOR FIELD-EFFECT TRANSIS-
TORS, Y.A. Tkachenko, Y. Lan, D.S. Whitefield, C.J. Wei,
J.C.M. Hwang, *Lehigh University, Bethlehem, PA*, T.D. Harris,
R.D. Grober, *AT&T Bell Laboratories, Murray Hill, NJ*, D.M.
Hwang, *Bellcore, Red Bank, NJ*, L. Aucoin and S. Shanfield,
Raytheon Research, Lexington, MA

9:40 a.m.
J.5 MODELING AND SUPPRESSION OF THE SURFACE 263
TRAP EFFECT ON DRAIN CURRENT FREQUENCY
DISPERSIONS IN GaAs MESFETS, Y. Kohno, H. Mat-
subayasi, M. Komaru, H. Takano, O. Ishihara and S. Mitsui,
Mitsubishi Electric Corporation, Hyogo, JAPAN

10:20 a.m.
J.6 AN EQUIVALENT CIRCUIT MODEL FOR DEEP-TRAP 267
INDUCED DRAIN-CURRENT TRANSIENT BEHAV-
IOURS IN HJFETS, K. Kunihiro, and Y. Ohno, *NEC Corpora-*
tion, Ibaraki, JAPAN

10:40 a.m.
J.7 RELIABILITY OF A HIGH PERFORMANCE MONO- 271
LITHIC IC FABRICATED USING A PRODUCTION
GaAs/ALGaAs HBT PROCESS, F. M. Yamada, A.K. Oki,
D.C. Streit, Y. Saito, A. Coulson, W. Atwood and E.A. Rezek,
TRW Inc., Redondo Beach, CA

11:00 a.m.
J.8 GaAs MMIC THERMAL ANALYSIS FOR EPOXY- 275
MOUNT COMPARED WITH AUSN-MOUNT, K. Nishi-
hori, K. Ishida, Y. Kitaura and N. Uchitomi, *Toshiba Research*
& Development, Kawasaki, JAPAN

**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 Dilonenzo, *Raytheon, Lexington, MA*
Jai Hakhu, *Rockwell, Thousand Oaks, CA*
Tom Cordner, *Texas Instruments, 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*

- 2:05 p.m.
K.1 THERMAL MODELING, MEASUREMENTS AND DESIGN CONSIDERATIONS OF GaAs DEVICES AND MMICS, (Invited Paper), D. Dawson, *Westinghouse Electric Corporation, Baltimore, MD* **285**
- 2:35 p.m.
K.2 A HIGHLY-LINEAR HIGHLY EFFICIENT HBT FOR COMMUNICATIONS CIRCUITS, R.S. Brozovich, D.R. Helms, L.W. Yang, R.S. Chase and J.J. Komiak, *Martin Marietta Laboratories, Syracuse, NY* **291**
- 2:55 p.m.
K.3 HIGHLY LINEAR EFFICIENT HBT MMIC POWER AMPLIFIERS, J.J. Komiak and L.W. Yang, *Martin Marietta Laboratories, Syracuse, NY* **295**
- 3:15 p.m.
K.4 DC TO 40 GHZ BROAD-BAND AMPLIFIERS USING AlGaAs/ GaAs HBT'S, Y. Kuriyama, J. Akagi, T. Sugiyama, S. Hongo, K. Tsuda, N. Iizuka and M. Obara, *Toshiba Research and Development, Kawasaki, JAPAN* **299**
- 4:00 p.m.
K.5 SUB-2.5 DB NOISE FIGURE GaAs HBT DIRECT-COUPLED LNAs FOR HIGHVOLUME COMMERCIAL APPLICATIONS TO 6 GHZ, K.W. Kobayashi and A.K. Oki, *TRW, Redondo Beach, CA* **303**
- 4:20 p.m.
K.6 A KA-BAND HBT TWO-STAGE LNA, S.L.G. Chu, R. Wohler, R. Pucel, G. Jackson, M. Adlerstein, J.B. Cole and M. Zaitlin, *Raytheon Company, Lexington, MA* **307**
- 4:40 p.m.
K.7 INTEGRATED ALGaAs/GaAs HBT HIGH SPEED OPERATIONAL AMPLIFIER, D. Yi, Z. Qingming, C. Keli and Z. Keqiang, *Hebei Semiconductor Research Institute, Hebei, P.R. CHINA* **311**
- 5:00 p.m.
K.8 A DOUBLE-DOUBLE BALANCED HBT SCHOTTKY DIODE BROADBAND MIXER AT X-BAND, K.W. Kobayashi, R. Kasody, A.K. Oki, S. Dow, B. Allen and D.C. Streit, *TRW, Redondo Beach, CA* **315**

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*

- 2:05 p.m.
L.1 SUB-2 MICRON GATE LITHOGRAPHY USING E-BEAM, X-RAY AND OPTICAL TECHNOLOGIES - AN OVERVIEW, (Invited Paper) L.G. Studebaker, *Hewlett Packard Company, Santa Rosa, CA* **321**
- 2:35 p.m.
L.2 A 0.1 UM W-BAND HEMT PRODUCTION PROCESS FOR HIGH YIELD AND HIGH PERFORMANCE LOW NOISE AND POWER MMICS, M. Biedenbender, R. Lai, J. Lee, S. Chen, K.L. Tan, P.H. Liu, D.C. Streit, B. Allen and H. Wang, *TRW Inc., Redondo Beach, CA* **325**
- 2:55 p.m.
L.3 MONOLITHIC HEMT-HBT INTEGRATION FOR NOVEL MICROWAVE CIRCUIT APPLICATIONS, D.C. Streit, D. K. Umemoto, K.W. Kobayashi and A.K. Oki, *TRW Inc. Redondo Beach, CA* **329**
- 3:15 p.m.
L.4 A 94 GHZ GaAs MONOLITHIC SWITCH WITH A VERTICAL PIN DIODE STRUCTURE, J. Putnam, M. Fukuda, P. Staecker and Y. Yun, *M/A-COM, Burlington, MA* **333**
- 4:00 p.m.
L.5 DEVICE TECHNOLOGIES FOR INP-BASED HEMT'S AND THEIR APPLICATIONS, (Invited Paper), T. Enoki, *NTT LSI Laboratories, Kanagawa, JAPAN* **337**
- 4:30 p.m.
L.6 HIGH RESOLUTION INP VIA HOLES FOR MILLIMETER WAVE DEVICE APPLICATIONS, K. Hur and T. Kazior, *Raytheon Company, Lexington, MA* **341**
- 4:50 p.m.
L.7 ULTRA-HIGH FMAX AND FT INP/INGaAs DOUBLE-HETEROJUNCTION BIPOLAR TRANSISTORS WITH STEP- GRADED INGaAsP COLLECTORS, S. Yamahata, K. Kurishima, T. Kobayashi, Y. Matsuoaka, *NTT LSI Laboratories, Kanagawa, JAPAN*, H. Nakajima, *NTT Radio Communication System Laboratories, Kanagawa, JAPAN* **345**