25^+ Years in Silicon Wireless

Ran Yan

UCSB: 1986 - 1990

- **Have a GREAT Team**
- **Be Persistent**

2272 IEEE JOURNAL OF QUANTUM ELECTRONICS, VOL. 25, NO. 11, NOVEMBER 1989

Analysis and Design of Surface-Normal Fabry–Perot Electrooptic Modulators

RAN-HONG YAN, ROBERT J. SIMES, STUDENT MEMBER, IEEE, AND LARRY A. COLDREN, FELLOW, IEEE

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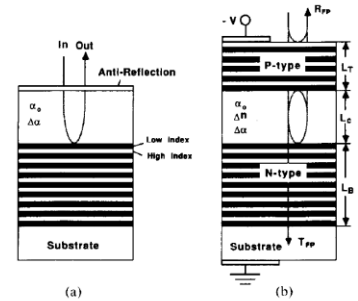


Fig. 1. Schematic drawing of surface-normal modulators. (a) Absorption modulator. (b) Fabry–Perot modulator. Grating mirrors are adapted to enhance the interaction length. The absorption modulator can be implemented as a reflection or transmission modulator with or without the grating, respectively. The Fabry–Perot modulator can be used as both types of modulators as long as the transmitted signal can be collected.

IEEE JOURNAL OF QUANTUM ELECTRONICS, VOL. 26, NO. 2, FEBRUARY 1990 213

Corrections to the Expression for Gain in GaAs

R. H. YAN, S. W. CORZINE, L. A. COLDREN, AND I. SUEMUNE

Abstract—**There have been many papers on the subject of theoretical gain calculations. However, in comparing the expressions for gain derived in various papers, we have found that a number of inconsistencies exist among several publications. These inconsistencies have propagated through the literature and continue to do so. This letter is specifically devoted to explaining how these inconsistencies originated such that they will not be repeated in future work on the subject.**

TABLE I
PREFACTORS THAT SHOULD BE INCLUDED IN THE CITED EQUATIONS OF VARIOUS PUBLICATIONS

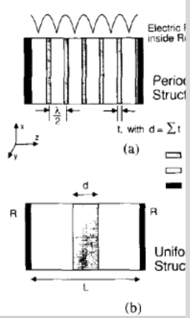
Reference	Prefactor*	Referred Equation
	2	(3.2.33)
	2 x 1.5 (heavy hole)	(9.4.2)
	$\frac{1}{\pi}$	(2)
	$2\left(\frac{1}{4\pi\varepsilon_0}\right)$, c.g.s.)	(3)
	1.5 (heavy hole)	(4)
	$\frac{1}{4\pi^2\hbar^2}$	(7)
	$(v_g)^{-1}$	(6)
	$(\pi L_z)^{-1}$	(7)

IEEE JOURNAL OF QUANTUM ELECTRONICS, VOL. 25, NO. 6, JUNE 1989 1513

Design of Fabry–Perot Surface-Emitting Lasers with a Periodic Gain Structure

SCOTT W. CORZINE, RANDALL S. GEELS, JEFF W. SCOTT, RAN-HONG YAN, AND LARRY A. COLDREN, FELLOW, IEEE

Abstract—**In this paper, we present a detailed analysis of a Fabry–Perot surface-emitting laser (FP-SEL) which utilizes the recently proposed concept of periodic gain. We show that by employing the periodic gain concept, close to a factor of two reduction in threshold current should be possible, the ideal reduction of a factor of two being limited by the internal loss of the cavity. Multiple quantum well active regions are also considered and shown to provide greater than a factor of two improvement over bulk GaAs periodic and uniform gain configurations. The effects of index perturbations within the cavity created by interleaving active and passive segments are treated for different Al mole fractions within the passive segments. The effects are found to be small for $x < 0.3$. In addition, optical pumping results on periodic gain DBR-SEL samples which exhibit very low optical power density thresholds ($< 3 \times 10^4$ W/cm^2) and narrow above-threshold linewidths (<2 Å) are included.**



JOURNAL OF LIGHTWAVE TECHNOLOGY, VOL. 6, NO. 6, JUNE 1988 793

Analysis of Depletion Edge Translation Lightwave Modulators

J. G. MENDOZA-ALVAREZ, L. A. COLDREN, FELLOW, IEEE, A. ALPING, R. H. YAN, T. HAUSKEN, K. LEE, AND K. PEDROTTI, MEMBER, IEEE

Abstract—**In this paper we present a complete analysis of waveguide phase modulators based on the depletion-edge-translation concept. The phenomena taking place inside the depletion region which contribute to changing the refractive index there are studied. It is shown that the behavior of these modulators can be understood in terms of two electric field-related and two carrier-related effects: linear electrooptic, electrorefractive, plasma, and band filling. The sum of the refractive index variations produced by each one of these effects, taking into ac-**

lators [3], although somewhat simpler in concept, are not quite as versatile, and potential problems with heating, wavelength sensitivity, and disposal of the generated carriers exist. In this paper we focus on a particularly desirable geometry for obtaining large phase shifts in optical waveguides in semiconductors. The resulting waveguide phase modulators are directly useful in possible multisec-

Silicon Wireless: Device

IEEE ELECTRON DEVICE LETTERS, VOL. 13, NO. 5, MAY 1992

89-GHz f_T Room-Temperature Silicon MOSFET's

Ran-Hong Yan, *Member, IEEE,* Kwing F. Lee, *Member, IEEE,* Duk Y. Jeon, *Member, IEEE,* Y. O. Kim, B. G. Park, M. R. Pinto, *Member, IEEE,* Conor S. Rafferty, *Member, IEEE,* D. M. Tennant, E. H. Westerwick, G. M. Chin, M. D. Morris, K. Early, P. Mulgrew, W. M. Mansfield, R. K. Watts, Alexander M. Voshchenkov, *Senior Member, IEEE,* Jeffrey Bokor, *Member, IEEE,* Robert G. Swartz, *Senior Member, IEEE,* and A. Ourmazd

Wireless + Low-Power = Mobile Internet !

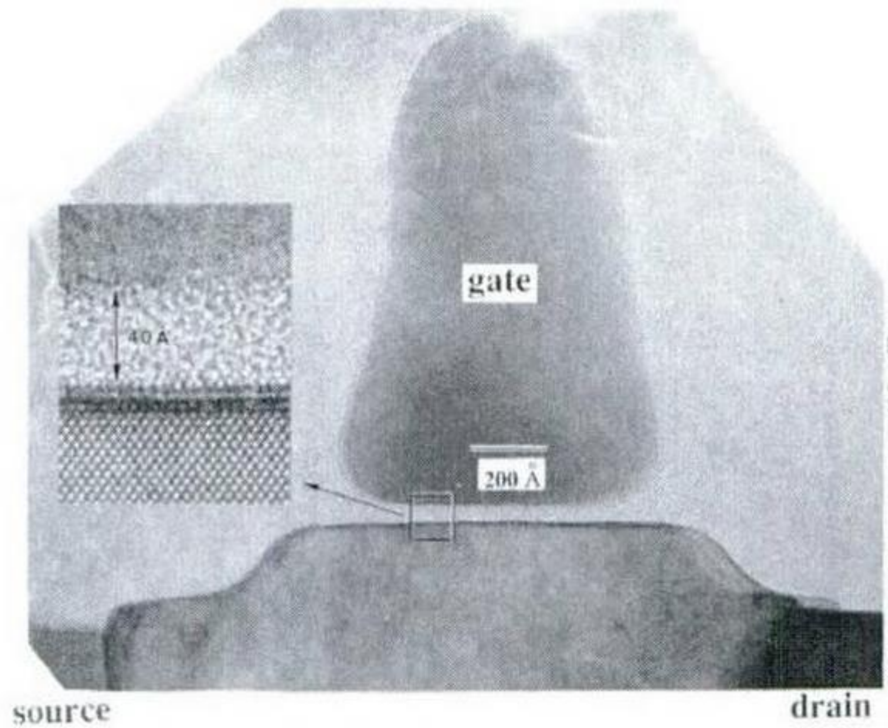
***Abstract*—We report the implementation of deep-submicrometer Si MOSFET's that at room temperature have a unity-current-gain cutoff frequency (f_T) of 89 GHz, for a drain-to-source bias of 1.5 V, a gate-to-source bias of 1 V, a gate oxide thickness of 40 Å, and a channel length of 0.15 μm. The fabrication procedure is mostly conventional, except for the e-beam defined gates. The speed performance is achieved through an intrinsic transit time of only 1.8 ps across the active device region.**

Manuscript received December 20, 1991; revised February 26, 1992.

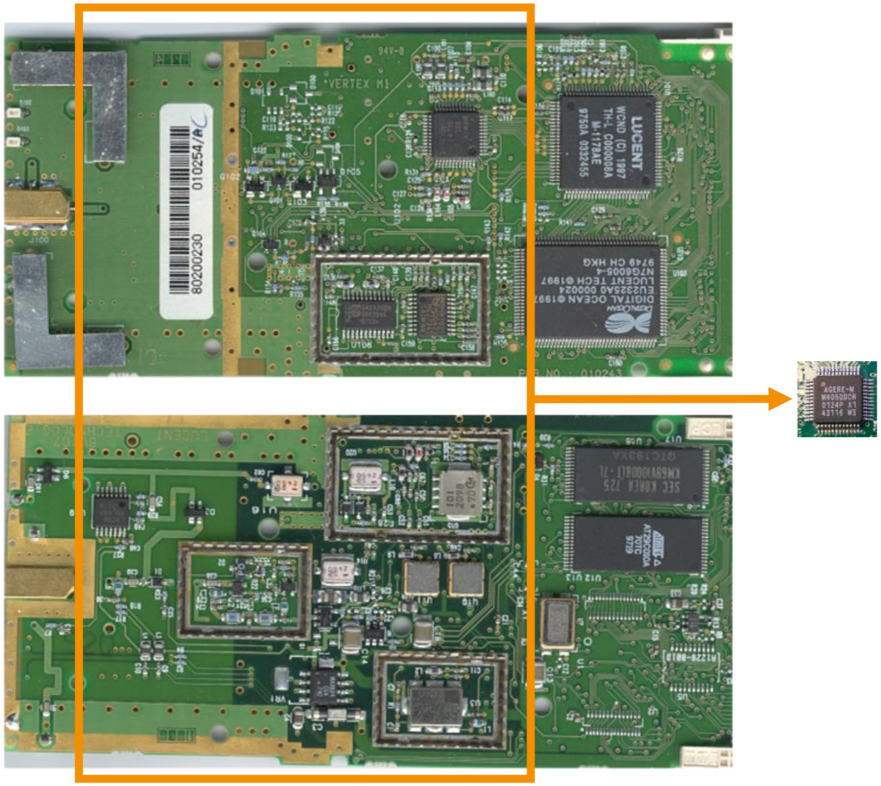
R.-H. Yan, K. F. Lee, D. Y. Jeon, Y. O. Kim, D. M. Tennant, E. H. Westerwick, G. M. Chin, M. D. Morris, K. Early, P. Mulgrew, A. M. Voshchenkov, R. G. Swartz, and A. Ourmazd are with AT&T Bell Laboratories, Holmdel, NJ 07733.

B. G. Park, M. R. Pinto, C. S. Rafferty, W. M. Mansfield, R. K. Watts, and J. Bokor are with AT&T Bell Laboratories, Murray Hill, NJ 07974.

IEEE Log Number 9108349.



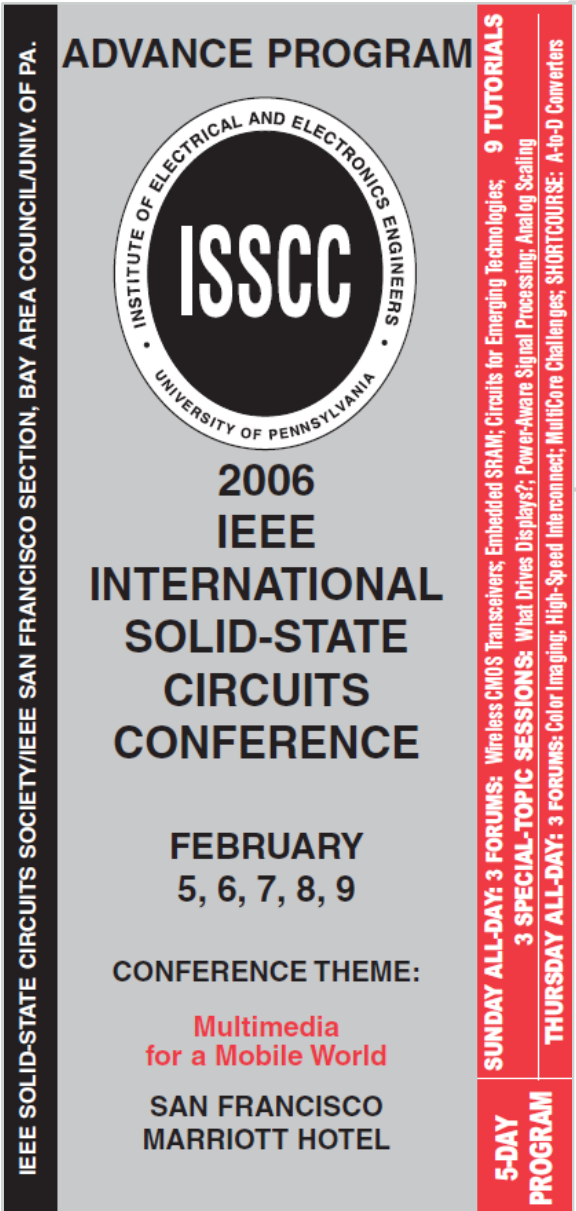
Silicon Wireless: Circuit



Wireless LAN (WiFi) worldwide sales:

- < 0.1 M units in 1997
  - ➢ A card cost ~$130 to make
- An opportunity to grow to > 2 M units
  - ➢ Apple's iBook & AirPort in 1999
  - ➢ Steve Jobs offered $50 to buy
  - ➢ *Productized a 0.35-μm Silicon RFIC (radio frequency integrated circuit) in ~18 months* to reduce overall cost by > 5x

Silicon Wireless: Single-Chip



6.6 A Fully Integrated UWB PHY in 0.13µm CMOS

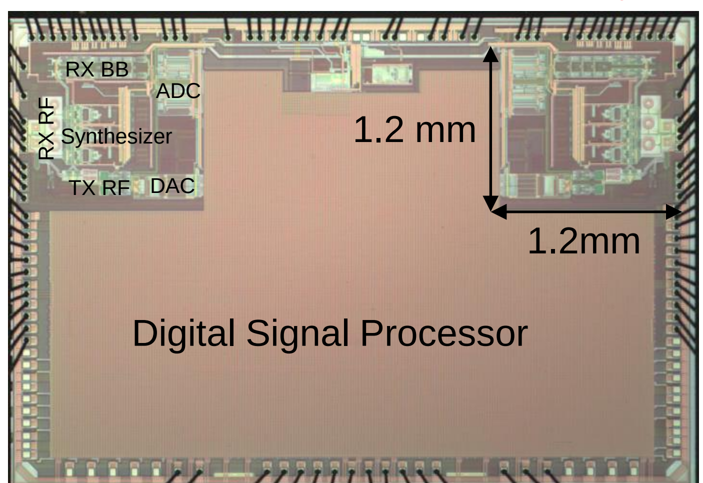
4:15 PM

T. Aytur[1], *H-C. Kang*[2], *R. Mahadevappa*[1], *M. Altintas*[1], *S. ten Brink*[1], *T. Diep*[1], *C-C. Hsu*[2], *F. Shi*[1], *F-R. Yang*[1], *C-C. Lee*[2], *R-H. Yan*[1], *B. Razavi*[3]
[1]Realtek, Irvine, CA; [2]Realtek, Hsinchu, Taiwan
[3]University of California, Los Angeles, CA

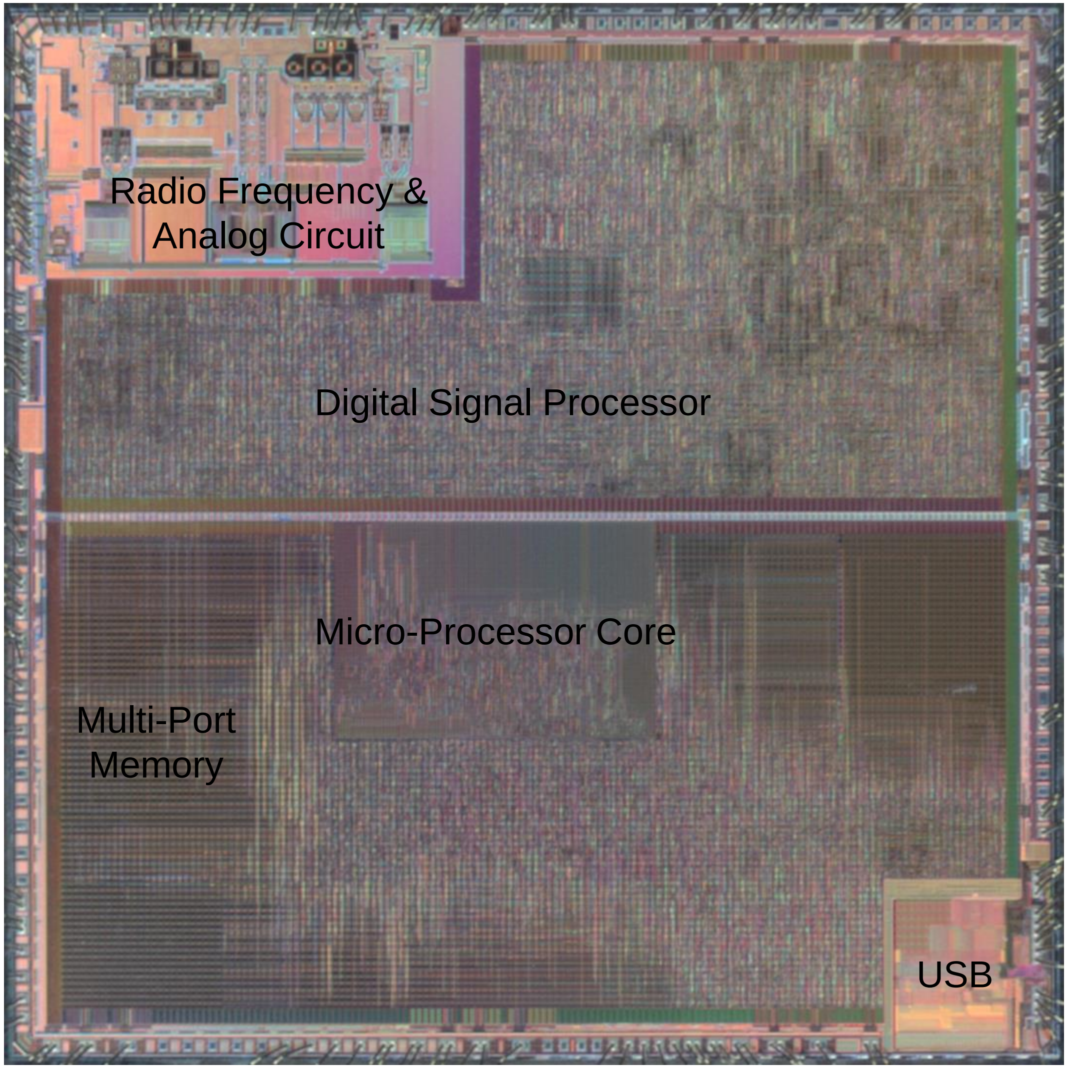
A direct-conversion RF transceiver and digital PHY are integrated in a single 0.13µm digital CMOS chip. Designed for UWB OFDM operation as proposed by the WiMedia Alliance, the device supports both fixed and frequency-hopped modes in the band of 3.1 to 4.8GHz. The RF transceiver draws 100mA in receive mode and 70mA in transmit mode, and the complete chip occupies $17mm^2$.

Technical Significance:

- Single Chip (Digital+RF)
- Support Multiple-Antenna (2x)
- 1 Gbps Data Rate



Silicon Wireless: SOC (System-on-Chip)



6 mm
(For Illustration Purpose Only)

Significance:

- Commercial value
- RF/Hardware complexity removed
- Wireless product engineering becomes software projects
- Enables:
    - ➢ Internet of Things
    - ➢ Wearable sensors