

reasonable assumptions that the highest operating frequency is inversely proportional to the system size and the current-level requirements of the logic circuits. An optimized design is presented for powering 16K circuits at an 80-percent duty cycle and a 1.7-ns logic cycle with maximum current levels of 300 mA.

To avoid lowering the systems lowest resonant frequency the power I/O line must be matched in impedance to the power source. In addition, to obtain a flat frequency response of the system currents to near the resonant frequency it is necessary to match the source impedance and the power I/O line impedance to the impedance of the primary windings of the highest level transformer. However, this may be undesirable because of the high supply-current level required. In the present design a mismatch was chosen—leading to a peaked response of the chip current as the lowest resonant frequency is approached and consequently, a lowering of the supply-current level.

This design of the power system will tolerate 5-percent variations in power-system line widths and insulation thickness at the cost of an additional skew of 1.2 percent of the logic cycle. (Actual tolerances achieved in this

technology are well within the 5-percent figure.) Some variation in logic load is tolerated provided the power lines are terminated in the prescribed manner.

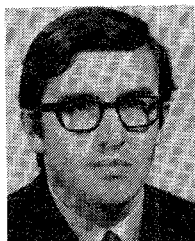
ACKNOWLEDGMENT

The authors are indebted to W. H. Chang for the use of his computer programs for calculating the inductances of conductors in geometrically complex structures.

REFERENCES

- [1] T. Gheewala, "Josephson logic circuits based on non-linear current injection in interferometer devices," *Appl. Phys. Lett.*, vol. 33, pp. 781–783, Oct. 1978.
- [2] —, "Delay measurement of experimental 2.5 μm Josephson current injection logic (CIL)," *Appl. Phys. Lett.*, vol. 34, pp. 670–672, May 1979.
- [3] W. Anacker, "Computing at 4 degrees Kelvin," *IEEE Spectrum*, pp. 26–37, May 1979.
- [4] D. J. Herrell, P. C. Arnett, and M. Klein, "High performance Josephson interferometer latching logic and power supplies," in *Proc. American Inst. Phys.*, no. 44, pp. 470–478, Oct. 1978.
- [5] P. C. Arnett and D. J. Herrell, "Regulated AC power for Josephson interferometer latching logic circuits," *IEEE Trans. Magn.*, vol. MAG-15, pp. 554–557, Jan. 1979.
- [6] C. P. Wen, "Coplanar waveguides: a surface strip transmission line suitable for nonreciprocal gyromagnetic device applications," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-17, pp. 1087–1090, Dec. 1969.

Contributors



Nicolaos G. Alexopoulos (S'68–M'69) received the B.S.E.E., M.S.E.E., and Ph.D. degrees from the University of Michigan, Ann Arbor, in 1964, 1967, and 1968, respectively.

He is currently an Associate Professor with the Electrical Sciences and Engineering Department with the University of California, Los Angeles. His research interests are in the area of Applied Electromagnetic Theory with emphasis on integrated microwave circuits, printed-circuit antennas, and integrated optics. He is the author

of over forty publications in the scientific literature.

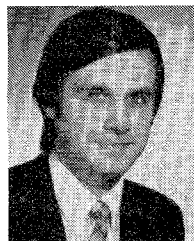


Patrick C. Arnett received the B.S. degree in mechanical engineering from Ohio State University, Athens, in 1961, and the M.S. and Ph.D. degrees in physics from the University of Southern California, Los Angeles, in 1965 and 1968, respectively.

He joined IBM at the Burlington Development Laboratory in 1968, initially working on magnetic thin films and later on semiconductor-based computer memories. In 1973 he went on assignment to the Thomas J. Watson

Research Center, Yorktown Heights, NY, to study properties of insulators of importance to solid-state devices, and subsequently, joined the Research Division in 1975. He is a Research Staff Member currently working on the exploratory cryogenic technology area of applied research.

Dr. Arnett is a member of the American Physical Society.



Christian Arnode was born in Paris, France, on March 20, 1942. He obtained the Diplôme Engineer degree in physical engineering from the Conservatoire National des Arts et Metiers, Paris, France, in 1971.

Since 1969, he has been a member of the Technical Staff at the Thomson-CSF Central Research Laboratory, Orsay, France. To 1976 he has worked mainly on the application of electron-beam lithography, ion-beam etching, and ion implantation to the fabrication on new

semiconductor Si devices. At present, his main activities have been concerned with GaAs IC technology.

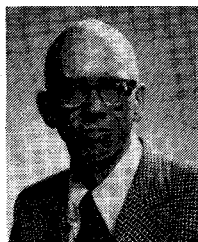


Walter R. Curtice (M'58-SM'69) received the BEE, MS, and Ph.D. degrees from Cornell University, Ithaca, NY, in 1958, 1960, and 1962, respectively. The subject of his Master's thesis was the ruby maser and the research for his doctoral thesis was concerned with noise in linear-beam microwave devices.

In September 1962, he joined the Microwave and Power Tube Division of Raytheon Company as a Senior Research and Development Engineer. At Raytheon he participated in programs for microwave tube development and performed experimental and theoretical research on linear-beam and cross-field devices. In August 1967, he became Visiting Assistant Professor of Electrical Engineering at the University of Michigan, Ann Arbor, and in August 1969 was appointed Associate Professor. In addition to teaching courses on physical electronics and microwave measurements, as a member of the Electron Physics Laboratory he was engaged in sponsored research on microwave semiconductors with emphasis on transferred-electron devices. In 1973, he joined RCA Laboratories, Princeton, NJ, as a Member of Technical Staff in the Microwave Technology Center. For several years he directed the development of second-harmonic-extraction TRAPATT amplifiers for X-band operation. He has developed two-dimensional computer models of transferred-electron logic devices and field-effect transistors and is currently directing the computer simulation effort in support of the development of gigabit-rate GaAs integrated circuits. He has authored 30 technical papers and has 8 patents issued to him.

Dr. Curtice is a member of the Tau Beta Pi, Eta Kappa Nu, and Sigma Xi. He was chairman of the Boston Section of the IEEE Electron Devices Group from 1966 to 1967, and Chairman of the Southeastern Michigan Section of the combined MTT, ED, and AP groups for 1972.

+



Burton E. Dobratz was born in Janesville, WI, on May 30, 1936. He received the B.S.E.E. degree in 1959 and the M.S.E.E. degree in 1961, both from the University of California at Berkeley.

From 1962 to 1970 he worked in the Laser Laboratories of Hughes Aircraft Company and was engaged in laser rangefinder development. Since 1970, he has worked in Hughes' Space and Communications Group, Los Angeles, CA, on communications satellite circuit development.

Presently, he heads the Advanced Development Department and is supervising multigigabit logic device and circuit development and application.

+



Richard C. Eden was born in Anamosa, IA, on July 10, 1939. He received the B.S. degree from Iowa State University, Ames, the M.S. degree from the California Institute of Technology, Pasadena, and the Ph.D. degree from Stanford University, Stanford, CA, all in electrical engineering. After receiving the M.S. degree, he worked at the Advanced Systems Development Laboratory of IBM, San Jose, CA. His Ph.D. thesis work involved detailed electronic energy band studies on GaAs, GaP, and Si using photo-

emission, work he extended to surface state observations in silicon by vacuum photoemission and internal photoemission in MOS structures, after joining Rockwell International Science Center, Thousand Oaks, CA, in 1968. Following this, he carried out development work on high-speed high-efficiency heterojunction III-V alloy, 1.06 μm avalanche photodiodes, and an ultra-high sensitivity high-speed hybrid-integrated preamplifiers for these detectors. He was also involved in the design and analysis of a number of special device structures including the recently successfully demonstrated GaAs CCD. His most recent efforts have focused toward the development of a very high-speed, ultra low-power

planar GaAs digital integrated circuit technology with gate densities and power dissipation levels compatible with LSI or VLSI.

Dr. Eden is a member of the American Physical Society, Eta Kappa Nu, Tau Beta Pi, Phi Kappa Phi, Phi Eta Sigma, Pi Mu Epsilon, and Sigma Xi.

+



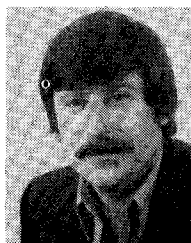
Masumi Fukuta (M'73) was born in Gifu, Japan, on December 25, 1940. He received the B.S. degree in electrical engineering from Nagoya Institute of Technology in 1963, and Ph.D. degree in electrical engineering from the Nagoya University, Nagoya, Japan, in 1977.

In 1963 he joined the Kobe Industries Company, which later merged with Fujitsu, Ltd. Since joining the company, he has been working in the field of semiconductor devices including Si RF power transistors, IC's, and MOSFET's.

In 1967 he invented and developed the Mesh Emitter Transistor. Since 1972 he has been engaged in developing low-noise and power GaAs MESFET's, and GaAs FET logic circuits at Fujitsu Laboratories, Ltd. He holds 13 patents on semiconductor devices.

Dr. Fukuta is a member of the IECE of Japan. In 1975 he received a prize medal from the Minister of Science and Techniques in Japan for outstanding contributions in the development of power GaAs MESFET's.

+



Maurice Gloanec was born in Tremeven, France, on January 4, 1945. He received the electrical engineering degree from the Conservatoire National des Arts et Metiers, Paris, France, in 1975.

In 1969, he joined the Thomson-CSF, Central Research Laboratory, Orsay, France. He worked on Si transducer integrated circuits and transferred electron logic devices. Presently, he is engaged in the development of GaAs digital integrated circuits with MESFET's.

+

Paul T. Greiling (S'64-M'69), for a photograph and biography please see p. 441 of this issue.

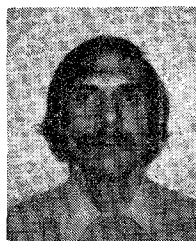
+



H. L. Grubin (M'77) was born in Brooklyn, NY, on March 1, 1939. He was educated in New York City and received the Ph.D. degree from the Polytechnic Institute of New York, Brooklyn, in 1967.

He has been at United Technologies Research Center, East Hartford, CT, since 1966, where his studies center on hot carrier effects in semiconductor devices. He has numerous publications, including a monograph, in this area.

Dr. Grubin is a member of the American Physical Society and the American Association for the Advancement of Science.



Dennis J. Herrell (M'72) received the B.Sc. degree in physics from Imperial College of Science and Technology, London, England, in 1964, and the Ph.D. degree in physics from Cambridge University, Cambridge, England, in 1969.

He joined the IBM (UK) Laboratories in 1964 where he worked on the design and development of various storage technologies. In 1970, he transferred to the IBM T. J. Watson Research Center, Yorktown Heights, NY, where he worked on amorphous semiconductors before

becoming principally interested in the Josephson effect. He is presently the Manager of the Power, Package, Cryosystems and Test Engineering Groups, having the responsibilities of the electrical evaluation of the Josephson package, logic circuit power supplies and test engineering both for Josephson circuits and package parts. He has 5 patents, 2 applications, and 40 patent publications in Josephson technology.

Dr. Herrell is a member of the American Physical Society and the British Institute of Physics.

✦



Nelson Ho (S'73-M'77) was born in Cleveland, OH, on April 17, 1954. He received the B.S. degree in electrical engineering from the University of California at Irvine in 1975, and the M.S. degree in electrical engineering from the University of California at Los Angeles in 1977.

In 1975, he joined Hughes Aircraft Company Space and Communications Group, El Segundo, CA, and had been working primarily in M.I.C. and high-speed logic research and development, in particular, GaAs FET logic. Since mid 1979,

he has been employed at Critikon, Inc., Irvin, CA, involved with research and development on biomedical monitors and sensors.

✦

Masao Ida, photograph and biography not available at the time of publication.

✦

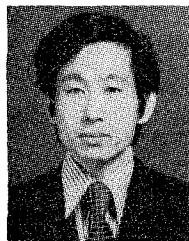


Masayuki Ino was born in Aichi, Japan, on July 22, 1948. He received the B.S. degree in electronic engineering from Nagoya Institute of Technology, Nagoya, Japan, in 1971.

Since joining the Electrical Communication Laboratory, Nippon Telegraph and Telephone (NTT) Public Corporation, Tokyo, Japan, in 1971, he has been engaged in the research works on millimeter-wave IMPATT diodes and the design of GaAs logic circuits. He is presently an Engineer of the Semiconductor Device Section,

Musashino Electrical Communication Laboratory, NTT.

Mr. Ino is a member of the Institute of Electronics and Communication Engineers of Japan.



Naoki Kato was born in Aichi, Japan, on July 11, 1949. He received the B.S. degree from Waseda University and the M.S. degree from Tokyo Metropolitan University.

He has been with Musashino Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation, Tokyo, Japan, since 1976. He has been engaged in research of GaAs MESFET's and his latest interest lies in fine lithography for GaAs IC's.

Mr. Kato is a member of the Japan Society of Applied Physics.

✦



Charles F. Krumm, (S'65-M'69) was born in Macomb, IL on August 3, 1941. He received the BSE degree in 1963, the MSE degree in 1965, and the Ph.D degree in 1970, all in electrical engineering from the University of Michigan, Ann Arbor.

In 1969, he joined Raytheon Co., Research Division, Waltham, MA, as a Senior Scientist. There he was responsible for developing plated heat-sink Gunn-device technology and later low-noise and power GaAs FET's. This work led to the fabrication of the first integral beam

lead power FET in 1975. In 1976 he joined Hughes Research Laboratories, Malibu, CA, as a Member of the Technical Staff. Initially he was responsible for fabrication of low noise FET's using electron beam lithography and this work led to the fabrication of the first 30-GHz FET amplifier. He is now Assistant Manager of the Electron Device Physics Department with responsibility for development of high-speed GaAs logic circuits and the supporting technology.

Dr. Krumm is a member of Eta Kappa Nu, Sigma Xi, and Phi Kappa Phi. He has served on the program committees for the International Electron Devices meeting and the Device Research Conference.

✦



Hirotugu Kusakawa was born in Tokyo, Japan, on April 8, 1951. He received the B.S. degree in applied physics from Waseda University, Tokyo, Japan, in 1974.

In 1974 he joined the Semiconductor Laboratory, Fujitsu Laboratories, Ltd., Kawasaki, Japan, where he has been engaged in research and development of GaAs field-effect transistor devices and GaAs digital integrated circuit.

Mr. Kusakawa is a member of the Institute of Electronics and Communication Engineers of Japan.

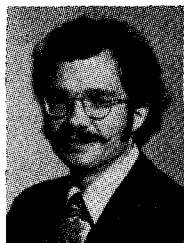
✦



Frank S. Lee received the B.S. degree in electrical engineering from the National Cheng-Kung University, Taiwan, in 1971, and the M.S. and Ph.D. degrees in electrical engineering from Southern Methodist University, Dallas, TX, in 1974 and 1978, respectively. While pursuing the Ph.D. degree, he developed a group of low-pass filters by utilizing the properties of Cesàro summations to improve the convergence of infinite summations.

During 1974, he worked as a Research Assistant in the study of thermal electrical power and temperature coefficient of resistivity of Au-Ag alloy thin films. He is presently a member of the Technical Staff, Integrated Circuits Section, Rockwell International/Electronics Research Center, Thousand Oaks, CA. Here his work involves GaAs integrated circuit design, testing, and computer-aided circuit analysis.

Dr. Lee is a member of Sigma Xi.

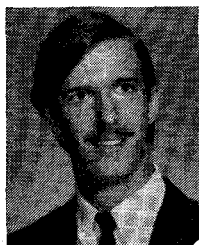


Stephen I. Long (S'73-M'73) received the B.S. degree in engineering physics from the University of California, Berkeley, in 1967, the M.S. and Ph.D. degrees in electrical engineering from Cornell University, Ithaca, NY, in 1969 and 1974, respectively. His thesis research dealt with steady-state liquid phase epitaxial growth of GaAs.

From 1969 to 1973, he served as a project engineer at the Rome Air Development Center, Griffiss Air Force Base, NY. There, he investigated and developed a steady-state liquid phase epitaxial growth process for thick, uniformly doped layers. From 1974 to 1977, he was a Senior Engineer and Manager of Semiconductor Engineering at Varian Associates, Palo Alto, CA, where he was involved in the development of vapor phase epitaxial growth of GaAs and InP, design and development of high-efficiency GaAs IMPATT devices, millimeter wave InP Gunn devices, and project management. In 1978, he joined the Rockwell International Science Center, Thousand Oaks, CA, and is currently a Project Leader in the integrated circuit group. His work involves design and evaluation of GaAs integrated circuits.

Dr. Long is a member of Tau Beta Pi and the Northern California Crystal Growers Society.

+



John A. Maupin (S'78-M'78) was born in Inglewood, CA, on March 5, 1954. He received the B.S. and M.S. degrees from the University of California, Los Angeles, in 1976 and 1979, respectively.

Since 1976, he has been employed by the Radar Systems Group of Hughes Aircraft Company, Malibu, CA, where he has been involved in the design of microstrip circuits.

Mr. Maupin is a member of Tau Beta Pi.

+



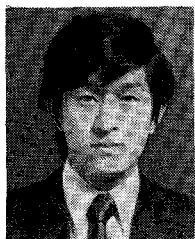
Takashi Mimura (M'73) was born on December 14, 1944. He received the B.S. degree in physics, in 1967, from the Kwansei Gakuin University, and the M.S. degree in physics, in 1970, from Osaka University, Osaka, Japan.

In 1970 he joined the Fujitsu, Ltd., Kobe, Japan, where he had worked on research and development of silicon and compound microwave semiconductor devices, including planar analog transistors. In 1975 he transferred to the Fujitsu Laboratories, Ltd., Kawasaki, Japan,

where he has been engaged in the research and development of microwave field-effect transistors.

Mr. Mimura is a member of the Physical Society of Japan.

+



Takashi Mizutani was born in Gifu, Japan, on October 12, 1948. He received the B.S. and M.S. degrees in electrical engineering from Nagoya University, Nagoya, Japan, in 1971 and 1973, respectively.

In 1973, he joined the Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation, Tokyo, Japan, where he has been engaged in the research and development of transferred electron devices and GaAs FET's.

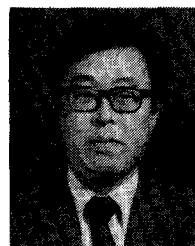
Mr. Mizutani is a member of the Institute of Electronics and Communication Engineers of Japan.



Gérard Nuzillat was born in Paris, France, on February 8, 1943. He was graduated from Paris-Sud University, Orsay, France, in electronics in 1966 and received the doctorat degree in 1968.

From 1966 to 1971, he was with the Paris-Sud University as a Teacher in the areas of signal processing and electronic circuitry. In 1968, he joined the Thomson-CSF Central Research Laboratory, Orsay, France, as a Research Fellow, and became a permanent member in 1972. Since 1974, he is responsible of a group working on design and development of fast digital integrated circuits. He is presently engaged in a program of research and development of monolithic GaAs digital IC's.

+



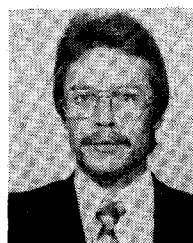
Masamichi Ohmori (M'77) was born in Ibaraki, Japan, on March 28, 1941. He received the B.S., M.S., and Ph.D. degrees in electronic engineering from Tohoku University, Sendai, Japan, in 1963, 1965, and 1976, respectively.

Since joining the Electrical Communication Laboratory, Nippon Telegraph and Telephone (NTT) Public Corporation, Tokyo, Japan, in 1965, he has been engaged in the research works on millimeter-wave IMPATT diodes and frequency multipliers, and GaAs logic circuits.

He is currently a Staff Engineer in the Semiconductor Device Section, Musashino Electrical Communication Laboratory, NTT.

Dr. Ohmori is a member of the Institute of Electronics and Communication Engineers of Japan, and the Japan Society of Applied Physics.

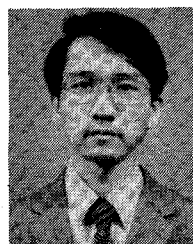
+



Michel Peltier was born in Colombes, France, on March 3, 1952. He received the engineer degree from the Ecole Nationale Supérieure des Telecommunications, Paris, France, in 1975.

He joined the Thomson-CSF, Central Research Laboratory in 1976. He is currently involved with the design and evaluation of high speed GaAs integrated circuits.

+



Katsuhiko Suyama (M'76) was born in Tokyo, Japan, on May 12, 1947. He received the B.S. and M.S. degrees in electrical engineering from Keio University, Yokohama, Japan, in 1970 and 1972, respectively.

In 1972 he joined the Semiconductor Laboratory, Fujitsu Laboratories, Ltd., Kawasaki, Japan, where he has been concerned with the design and development of GaAs field-effect transistor devices and GaAs digital integrated circuit.

Mr. Suyama is a member of the Institute of Electronics and Communication Engineers of Japan.



Theodore Van Duzer (S'52-A'54-M'60-SM'75-F'77) received the B.S. degree in electrical engineering from Rutgers University, New Brunswick, NJ, in 1954, the M.S. degree in engineering from the University of California, Los Angeles, in 1957, and the Ph.D. degree in electrical engineering from the University of California, Berkeley, in 1960.

He was employed by Stavid Engineering, Inc., Plainfield, NJ, for the installation and maintenance of electronic flight simulation equipment from 1947 to 1950. During 1954 and 1955 he was a member of the M.S. Fellowship Plan of Hughes Aircraft Co., and served there as a Member of the Technical Staff until 1957. His work included radar systems and circuit studies, weapons systems analyses, and the development of an electron trajectory computer. In 1960 he was appointed Acting Assistant Professor of electrical engineering at the University of California, Berkeley. During 1960-1961 he was at the Technische Hochschule, Vienna, Austria, as a National Science Foundation Post-Doctoral Fellow. He returned to Berkeley as an Assistant Professor in 1961, and engaged in research in noise and focusing in crossed-field electron-beam amplifiers. During 1965-1966 he taught electromagnetic field theory and initiated a laser research project at the Catholic University of Chile, Santiago, as a part of a Ford Foundation program. He spent 1969-1970 at Rutgers University and Bell Telephone Laboratories in research on superconductivity. He was a visiting Professor at Kyoto University and University of Paris during 1977-1978. He is currently a Professor at Berkeley where he is engaged in teaching and research in solid-state devices and superconductivity. His current research emphasis is on Josephson devices and their applications. He has published numerous papers on electron devices, is coauthor (with S. Ramo and J. R. Whinnery) of *Fields and Waves in Communications Electronics*, and is author and principal of an educational film, "Wave Velocities, Dispersion, and the ω - β Diagram."

Dr. Van Duzer is a member of Eta Kappa Nu, Tau Beta Pi, and Sigma Xi.

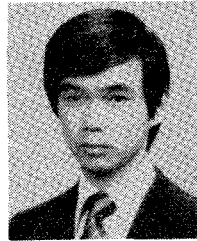


Bryant M. Welch (M'75) was born in New York, NY, on December 20, 1943. He received the A.A. degree in engineering from Miami Dade Junior College, Miami, FL in 1963 and a B.S. Degree in mathematics from California State University, Northridge, in 1968.

From 1963 to 1965 he was associated with Westinghouse Electric Corporation, where he was involved in the early development of Si bipolar integrated circuits. Since 1965 he has been employed with Rockwell International, Thousand Oaks, CA, and is presently the Project Leader for integrated circuit processing. His areas of research and development have included all phases of ion implantation in both Si and GaAs. Since 1972, he has concentrated on the development of a planar GaAs ion implantation technology. Highlights of his work include the development and fabrication of GaAs FET's, using implanted active layers, and fabrication of the first planar GaAs integrated circuits using multiple localized implanta-

tion techniques. He is currently involved with developing planar GaAs integrated circuit processes and responsible for the fabrication of these circuits. He holds two patents and has numerous publications in the field of ion implantation and its applications.

Mr. Welch is a member of the Electrochemical Society.



Naoki Yokoyama (M'78) was born in Osaka, Japan, on March 28, 1949. He received the B.S. degree in physics from Osaka City University and the M.S. degree in physics from Osaka University, Osaka, Japan, in 1971 and 1973, respectively.

In 1973 he joined the Semiconductor Laboratory, Fujitsu Laboratories, Ltd., Kawasaki, Japan, where he has been engaged in the research and development of GaAs field-effect transistors and GaAs digital integrated circuits.

Mr. Yokoyama is a member of the Physical Society of Japan, the Japan Society of Applied Physics, and the Institute of Electronics and Communication Engineers of Japan.



R. Zucca (SM'78) was born in Trieste, Italy, on February 7, 1936. He received the M.S. degree in engineering from the University of Rosario, Argentina, in 1960, and the Ph.D. degree in physics from the University of California, Berkeley, in 1971.

He initiated his research at Berkeley in the investigation of optical properties of solids by modulation techniques. This work which involved the construction of a wavelength modulation spectrometer with a very broad spectral range (1.75-6 eV), contributed to better understanding of the band structures of IV and III-V semiconductors, and noble metals. Later he held a position of Professor (in physics) at the University at Rosario, Argentina, where he continued his research in optical properties of solids in association with the University of California, Berkeley. Since joining Rockwell International, Thousand Oaks, CA, in 1972, he has been engaged in several aspects of semiconductor technology, focusing mainly on the electrical properties of semi-insulating GaAs, the substrate material for most GaAs high-frequency semiconductor devices. A major accomplishment in this area was the development of a model for the electrical compensation in semi-insulating GaAs. Most recently he has been involved in the development of a high-speed low-power planar GaAs digital IC technology with potential for LSI/VLSI applications. His work involves the development and application of testing techniques for process characterization and evaluation.

Dr. Zucca is a member of the American Physical Society.