

Fig. 1.

Reply² by J. Q. Howell³

The purpose of my short paper¹ was to present an alternate method of measuring the dielectric constant of MIC substrates to that suggested by Napoli and Hughes [1]. My new scheme appeared to be more accurate and yet as easily implemented. I did not intend to imply that the error in the Napoli-Hughes technique was resistive in origin, but only that the measured resonant frequencies were found to be affected by the strength of the coupling and by radiation losses. This could be demonstrated by observing the shift in resonant frequencies when changing the coupling coefficient or when moving an object in the vicinity of the substrate. Ladbrooke *et al.* [2] did not

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³ The author is with the National Aeronautics and Space Administration, Langley Research Center, Hampton, Va. 23365.

TABLE I

Frequency	Mode	Permittivity
2.22	(2,1)	3.94
2.86	(2,2)	3.82
3.20	(3,1)	3.82
3.64	(3,2)	3.82

mention error due to the fringing fields along the open edge of the substrate and they implied that the dominant error was due to the perturbation of the fields in the vicinity of the feedpoint. Since the closed sidewall technique more closely approximates the theoretical model, I submit that this scheme is the more accurate of the two. At any rate, the solution to the question of whether the resistive loss or the field perturbation causes the largest error in the resonant frequency will depend on the properties of the sample and equipment being used. Either extensive theoretical analysis or comparison to some other accurate measuring scheme will be required to properly resolve this.

REFERENCES

- [1] L. S. Napoli and J. J. Hughes, "A simple technique for the accurate determination of the microwave dielectric constant for microwave integrated circuit substrates," *IEEE Trans. Microwave Theory Tech. (Corresp.)*, vol. MTT-19, pp. 664-665, July 1971.
- [2] P. H. Ladbrooke, M. H. N. Potok, and E. H. England, "Coupling errors in cavity resonance measurements on MIC dielectrics," this issue, pp. 560-562.

Contributors



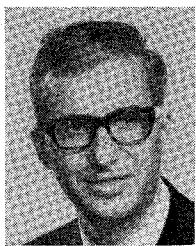
Carlo Atzeni was born in Cagliari, Italy, on November 10, 1940. He received the Dr. degree in physics from the University of Florence, Florence, Italy, in 1965.

Soon after graduation he joined the Istituto di Ricerca sulle Onde Elettromagnetiche (formerly Centro Microonde) of the Consiglio Nazionale delle Ricerche, Florence, Italy. Currently he is a Professor of information theory at the University of Florence. His interest is mainly in the area of information theory, with emphasis on application to radar. He has been con-

cerned with research in signal design and signal-processing systems, and he has been engaged in the development of opto-acoustic processors and of acoustic bulk- and surface-wave transversal filters.



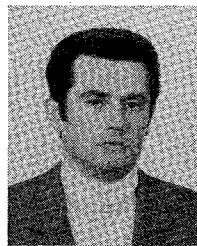
Joseph Helszajn (M'64) was born in Brussels, Belgium, in 1934. He received the Full Technological Certificate of the City and Guilds of



London Institute from the Northern Polytechnic, London, England, in 1955, the M.S.E.E. degree from the University of Santa Clara, Santa Clara, Calif., in 1964, and the Ph.D. degree from the University of Leeds, Leeds, England, in 1969.

He has held a number of positions in the microwave industry. From 1964 to 1966 he was Product Line Manager at Microwave Associates, Inc., Burlington, Mass. Currently, he is working as a consultant. He is also a Senior Research Fellow at Heriot-Watt University, Edinburgh, Scotland. He is the author of the book *Principles of Microwave Ferrite Engineering* (Wiley).

Dr. Helszajn is a fellow of the Institution of Electronic and Radio Engineers (England). In 1968 he was awarded the Insignia Award of the City and Guilds of London Institute.



Microonde of the Consiglio Nazionale delle Ricerche (CNR), Florence, Italy, where he was engaged in circuit theory. From 1964 to 1966 he was a Research Officer in the Italian Navy, assigned to Mariteleradar, Livorno, Italy. From 1966 to 1968 he was a Research Engineer working on ultrasonic dispersive delay lines and pulse compression applications. In 1968 he joined the Istituto di Ricerca sulle Onde Elettromagnetiche of the CNR, Florence, where he is currently working on radar signal design, surface acoustic delay lines, and signal-processing applications. Since 1966 he has been a Lecturer with the Electronics Department, Italian Navy Officer School, Livorno, Italy. During 1970 he was a Lecturer with the University of Bologna, and since 1971 he has been teaching electronics at the University of Florence.

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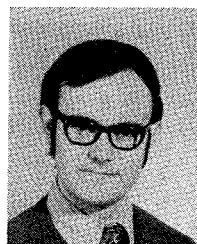
Ralph Levy (SM'64-F'73), for a photograph and biography please see page 119 of the February 1973 issue of this TRANSACTIONS.

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Leonardo Masotti (S'61-M'65) was born in Faenza, Italy, on March 12, 1939. He received the Dr.Ing. degree in electronic engineering from the University of Bologna, Bologna, Italy, in 1963.

In 1963, with a post-doctoral fellowship, he joined the Centro



Geoffrey O. Stone (S'67-M'73) was born in Melbourne, Australia on January 18, 1945. He received the B.E. and M.Eng.Sci. degrees in electrical engineering from the University of Melbourne, Parkville, Vic., Australia in 1967 and 1969, respectively.

Since 1969 he has been working towards the Ph.D. degree in the Department of Electrical Engineering, University of Melbourne, on field discretization methods for surface acoustic waveguides, and his dissertation is presently under examination.

Mr. Stone is a member of the Institution of Radio and Electronics Engineers, Australia.
