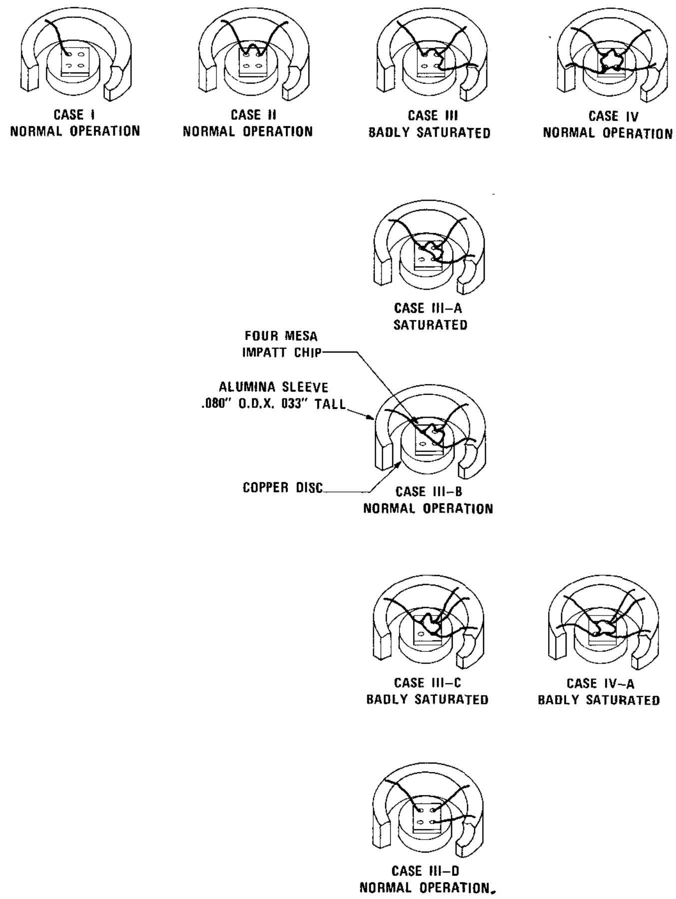

Fig. 2. Sketches showing four-mesa IMPATT diode with symmetrical and asymmetrical wire connections.

tion still occurred at a current density below that of I, II, or IV. Noting that the diagonal wire of III-A was approximately $\sqrt{2}$ times as long as the adjacent wires, it was decided to decrease the length of the diagonal wire by about 40 percent. This was accomplished by replacing the curved diagonal wire with a straight wire, giving the configuration of III-B. The configuration then did not exhibit saturation or low-frequency noise at any current density. Subsequent tests, where asymmetry was intentionally introduced in cases III and IV, also showed the saturation and noise described previously. Two such configurations are indicated by cases III-C and IV-A. A final test, III-D, where no interconnecting leads were used, performed without saturation or noise.

None of the saturation effects described (except for III-C and IV-A) would be expected based on fundamental frequency considerations. This assertion is based on the following factors.

1) The chips were fabricated at the same time, by the same process on a common heat sink.

2) No difference in either capacitance or breakdown voltage could be measured between the four devices using standard bridge and curve-tracer techniques.

3) The mesa spacing (0.016 center to center) is so small that the inductance due to the wire(s) connecting the mesas is on the order of 0.2 nH, a value much too small to allow fundamental frequency resonant effects among the respective devices.

4) Given 1)–3), the fundamental frequency voltages would be of the same amplitude and phase at each device as would the currents, resulting in negligible interaction among the devices at the fundamental frequency even in the presence of asymmetrical interconnections.

Conversely, the mesa spacing *is* large enough to permit resonance at the third or fourth harmonic. It is therefore suggested that the effects observed are probably a result of harmonic current components flowing among the devices via the interconnecting wires but not observed in the output. The aggregate conclusion suggested by these tests is that seemingly trivial asymmetry of the parasitic elements used in the device interconnection can result in gross saturation of the output power and in low-frequency noise.

Acknowledgment

The authors wish to thank R. T. Kemerley, program monitor, for his assistance. They are grateful to the United States Air Force for permission to publish this material.

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[1] J. Frey, "Multimesa versus anular construction for high average power in semiconductor devices," *IEEE Trans. Electron Devices*, vol. ED-19, pp. 981–985, Aug. 1972.
[2] J. C. Irvin, "GaAs IMPATT diodes in perspective," in *Proc. Fourth Biennial Cornell Electrical Engineering Conference*, 1973, pp. 287–298.

Comments on "A New Edge-Mode Isolator in the Very High Frequency Range"

ROBERT A. CRAIG

***Abstract*—Test data taken on production models of fixed-tuned isolators operating in the 225–400-MHz frequency range are presented for comparison to those given in the referenced paper. Better electrical performance of this isolator as well as a smaller size compared to the edge-mode unit is shown.**

In a recent paper,[1] Courtois *et al.* presented a novel approach to constructing an isolator in the VHF frequency range, but have obviously overlooked some of the prior work in this field. For example, in their introduction, the statement, "Until now, two conventional devices were necessary to cover this overall bandwidth," is not correct. Addington Laboratories, Inc., first completed a single broad-band unit to cover this frequency range without tuning in January 1973. It has been advertised in our ferrite device catalog for nearly two years.

Production models of this device were first tested in March 1975. We believe our specifications are better than those reported in the referenced paper and have listed them as follows, along with those of the unit described in the paper for ease of comparison. Neither unit is magnetically tuned.

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The author is with Addington Laboratories, Santa Clara, CA 95050.
[1] L. Courtois, N. Bernard, B. Chiron, and G. E. Forterre, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-24, pp. 129–135, Mar. 1976.

Specification	Courtois *et al.* Test Unit	ALI Model 101102306
Freq. range, MHz	225–400	225–400
Input VSWR, max	1.4:1	1.5:1
Isolation, min	11 dB*	18 dB
Insertion loss, max		
225 MHz	0.9 dB	1 dB
400 MHz	2.2 dB	1.5 dB
Input power, max	40 W	150 W
Reverse power	10 W	50 W
Temperature range	−40 to +70°C	−10 to +60°C
Size	9 × 13 × 6.5 cm	8.2 × 8.2 × 2.55 cm
Weight	3.3 kg	285 g

* Over most of the frequency range the isolation was at least 15 dB.

The test results quoted above were confirmed by the USAF using both a computer-controlled network analyzer and a special high-power test setup. Detailed test results can be furnished to interested persons upon request.

Feasibility of the isolator described herein was demonstrated by D. Jeong and a unit designed to meet environmental and production requirements by R. Billings. We believe it to be significantly smaller and perform better than the one described by Courtois *et al.*

Comments on "Transmission-Line Transformation Between Arbitrary Impedances"

M. H. N. POTOK

The solution given by the author of the above letter,[1] for the characteristic impedance of the line transformer, has been given before (see H. Jasik, *Antenna Engineering Handbook*, McGraw-Hill, 1961, paragraph 31.3, p. 9). Jasik also gives the correct length of the transformer whereas Milligan and also apparently Day (*IEEE Trans. Microwave Theory Tech.*, vol. MTT-23, p. 772, 1975) give the distance between load and source impedance along the impedance circle, which is not the length of the desired transformer since the transformer should produce at the source the conjugate of the source impedance if matching, which presumably means power matching is desired. Thus in the expression given by Milligan for length, X_2 should be given as $-X_2$, which will now agree with Jasik's expression.

Manuscript received April 19, 1976.
The author is with the Department of Electrical and Electronic Engineering, Royal Military College of Science, Shrivenham, Swindon, England.
[1] T. A. Milligan, *IEEE Trans. Microwave Theory Tech.* (Lett.), vol. MTT-24, p. 159, Mar. 1976.

Computer Program Descriptions

CIA (*Ci*rculator *A*nalysis)

PURPOSE: Frequency analysis and optimization of three-port waveguide junction circulators.

LANGUAGE: Fortran IV for the CDC 3800 computer; with 960 cards.

AUTHORS: R. P. Meixner and J. P. Lawrence are with the U.S. Naval Research Laboratory, Washington, DC 20375.

AVAILABILITY: A punched deck is available from the authors upon written request.

DESCRIPTION: A computer optimization routine using sequential-random-search techniques is developed for use with an existing frequency analysis program [1] in the computer-aided design (CAD) of a three-port waveguide junction circulator shown in Fig. 1. A simple error function is defined using the scattering coefficients [S] of each port of the circulator. Since the theoretical properties of any lossless circulator are completely described if the three scattering parameters S_{11},S_{12},S_{13} are known, the energy flow from port 1 to 3 is maximized if S_{13} is maximum while S_{11} and S_{12} are minimum. The following error function, using the absolute values of each scattering coefficient, is used to optimize each initial design over the range of frequencies from f_1 to f_n:

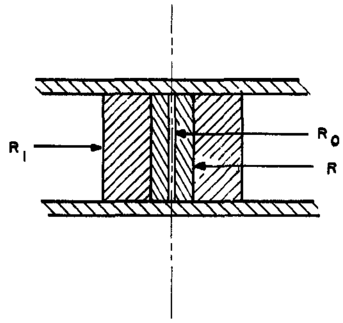

Fig. 1. Basic junction configuration.

$$\text{total error} = \sum_{f_1}^{f_n} (|S_{11}| + |S_{12}| + 1. - |S_{13}|).$$

The following constraints and/or boundary conditions are imposed on the CAD variables.

—The physical dimensions are $< 20/\sqrt{3}$ cm, the maximum radius of the radial line.

—The matching dielectric constant is $< 20/\sqrt{3}$, for ease of picking random numbers.

Manuscript received August 1976.
See NAPS document No. 02959 for 31 pages of supplementary material. Order from ASIS/NAPS c/o Microfiche Publications, P.O. Box 3513, Grand Central Station, New York, NY 10017. Remit in advance for each NAPS accession number. Institutions and organizations may use purchase orders when ordering; however, there is a billing charge for this service. Make checks payable to Microfiche Publications. Photocopies are $7.75. Microfiche are $3.00. Outside of the United States and Canada, postage is $3.00 for a photocopy or $1.50 for a fiche.