of coherent detection without incurring the same level of receiver complexity.

5. CONCLUSION

An optically preamplified digital PPM receiver with an electrical domain filtering regime consisting of a matched filter in cascade with a PDD network has been rigorously analyzed for the first time. Under the assumption of Gaussian received pulse shapes, sensitivity curves and an examination of the pulse-shaping network behaviour have been presented. The penalty incurred by removing the pulse-shaping network has also been considered, and has been shown to be about 1.9 dB for high PPM coding levels, but is lower at the optimum coding level. The strong potential of the receiver configuration has been demonstrated by results surpassing not only a comparable optically preamplified OOK NRZ receiver, but also surpassing the fundamental sensitivity limit of such a receiver and approaching the sensitivity of coherent detection systems, though it should be remembered that such impressive performance is obtained at the cost of bandwidth.

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BROADBAND ACTIVE MICROSTRIP ANTENNA FOR LOWER UHF APPLICATIONS

S. S. Pattnaik[1], Swapna Devi[1], P. A. Satheesan[2], A. L. Das[2], and B. K. Sinha[2]
[1]N.E.R.I.S.T
Nirjuli-791109
Arunachal Pradesh, India
[2]Centre for Electromagnetics
Sameer, Madras, India

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ABSTRACT: *An impedance compensation method is used to integrate an active device with a microstrip patch antenna to design an active microstrip antenna for lower UHF applications. This method maintains the size-reduction aspect of the microstrip antenna. The fabricated active antenna is experimentally tested. The experimental findings reveal the suitability of this new method in broadband active microstrip antenna design for lower UHF applications. © 1997 John Wiley & Sons, Inc.* Microwave Opt Technol Lett 14, 28–31, 1997.

Key words: *active microstrip antenna; impedance compensation; broad bandwidth*

1. INTRODUCTION

Recent development in microwave and millimeter-wave solid-state devices and integrated circuits have made it possible to implement active devices directly behind a planar antenna element [1, 2]. The concept of the active microstrip antenna and its array is particularly attractive for radar, satellite, and mobile communication applications [3]. Attempts have been made by many researchers to design active microstrip antennas for various applications [4, 5]. The integration of microstrip circuits and antennas is now being considered for many current and future applications due to the perceived benefits of compactness and low cost [6]. In the present impedance compensation method, an attempt is made to design a broadband microstrip antenna by varying the bias voltage of the active device. This method maintains the size-reduction aspect of the microstrip antenna at lower UHF. Experimental findings are in good agreement with the proposed method.

Contract grant sponsor: DST (Government of India).

2. DESIGN TECHNIQUE

A rectangular microstrip antenna is fabricated with a dielectric material used as a substrate (RT/Duroid with $\varepsilon_r = 2.2$). With the expression [7]

$$f_r = \frac{c}{2L\sqrt{\varepsilon_{\text{eff}}}},$$

the dimensions of the patch ($L = W = 10.52$ cm) are determined, in order to resonate the antenna at 974 MHz. The feed point of the rectangular microstrip antenna is found with the expression [7]

$$R_{\text{in}} = R_{es} \cos^2(\pi x_0 / L).$$

Figures 1 and 2, respectively, show the return loss and the Smith-chart plot of the fabricated microstrip antenna. In the impedance compensation technique, the passive antenna is designed at a slightly higher frequency. Then, with the use of the Smith chart (impedance plot), a monolithic amplifier is selected whose input impedance compensates for the antenna impedance in the required frequency region. Thus, a reduced-size active antenna can be built for low-frequency applications. In this article, a monolithic amplifier is selected with the use of the Smith chart. Its input impedance compensates for the antenna impedance in the lower-frequency range (i.e., 400–700-MHz range).

An active patch antenna with devices integrated directly inside the patch suffers a very high cross-polarization field [6]. Also, it has been reported [8] that a transistor may affect the radiation pattern far less than the passive parts of the amplifier, such as matching stubs, bias circuits, and bends. With the

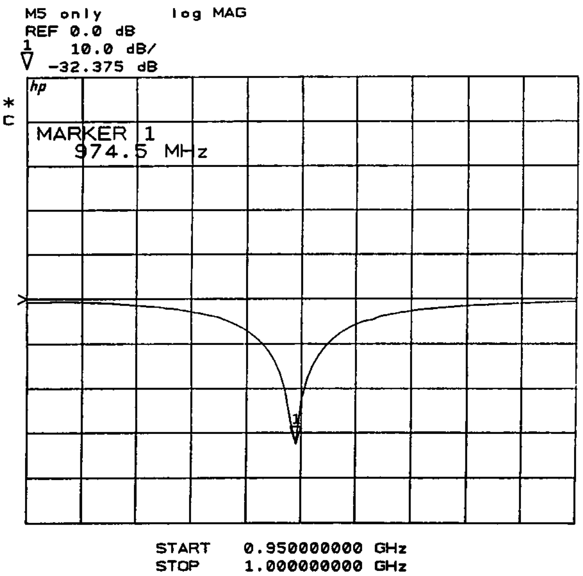


Figure 1 Return loss of the passive microstrip antenna

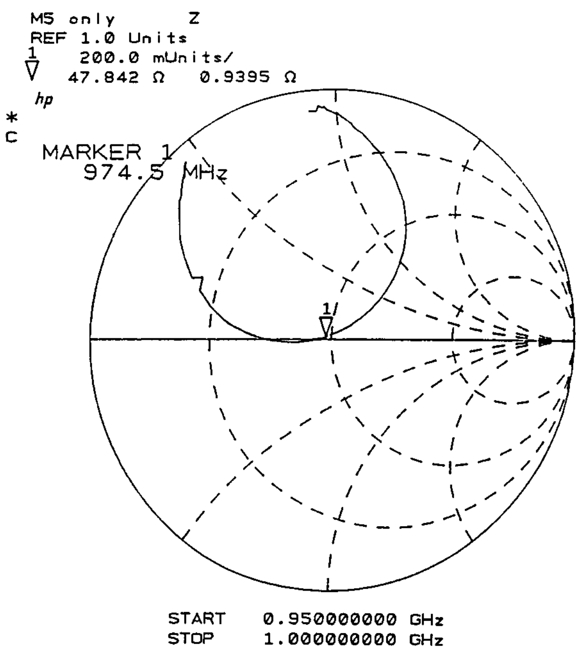


Figure 2 Smith-chart plot of the passive microstrip antenna

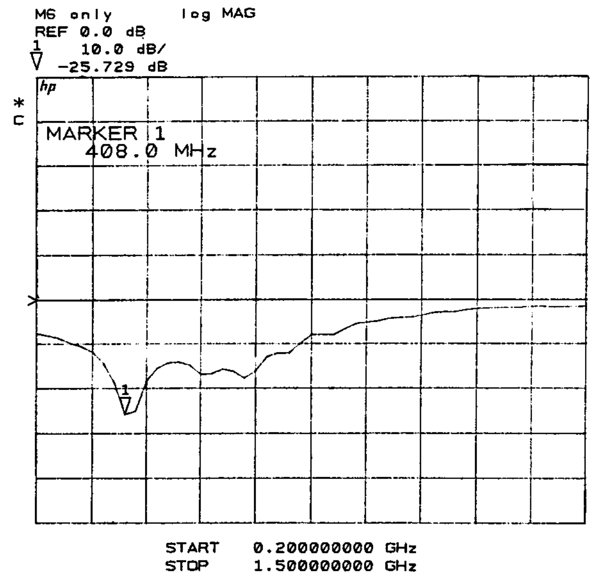


Figure 3 Return loss of the active microstrip antenna with 3-V bias voltage

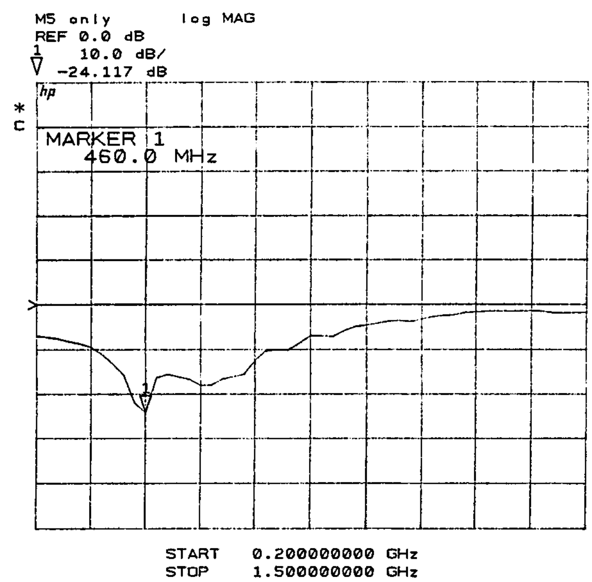


Figure 4 Return loss of the active microstrip antenna with 4.5-V bias voltage

above facts taken into consideration, a monolithic amplifier MAR-7 and bias circuits are placed in a suitable position on the ground plane so that there is no coupling present between the active part and the radiating element. The active device along with the biasing network is placed exactly at the center of the patch on the ground plane, where the field is assumed to be zero. Also, the discrete components are connected with the possible path size being kept to a minimum and with highly insulated coaxial wire being used. A comparatively large ground plane is used in the proposed method. Figures 3 and 4 show the return-loss plot of the active microstrip antenna (antenna with amplifier) when bias voltages of 3 and 4.5 V are applied, respectively.

3. RESULTS AND DISCUSSION

Open-air radiation pattern measurement is carried out for rectangular and active microstrip antennas. Figure 5 shows the H-plane radiation pattern of an active rectangular microstrip antenna. Figure 6 shows the active circuit and the microstrip antenna. The gain of the active microstrip antenna is found to be 11 dB; that is, 3 dB more than a passive microstrip antenna (without amplifier) when a bias voltage of 3 V is applied. For a bias voltage of 4.5 V, the gain is found to be 12.5 dB. The cross-polarization level is 16 dB lower in both cases. However, it is observed that the cross-polarization field increases with increasing bias voltage. An increase in the ground plane significantly contributes to pattern characteristics, and also plays a significant role in impedance compensation. The radiation patterns obtained for microstrip antennas and active microstrip antennas with different bias voltages are consistent. The return loss of the active microstrip antenna is found to be −15.5 dB (1.4:1 VSWR) over a wide range of frequency (395–700 MHz for 4.5-V bias and 370–740 MHz for 3-V bias). For microstrip antennas (without

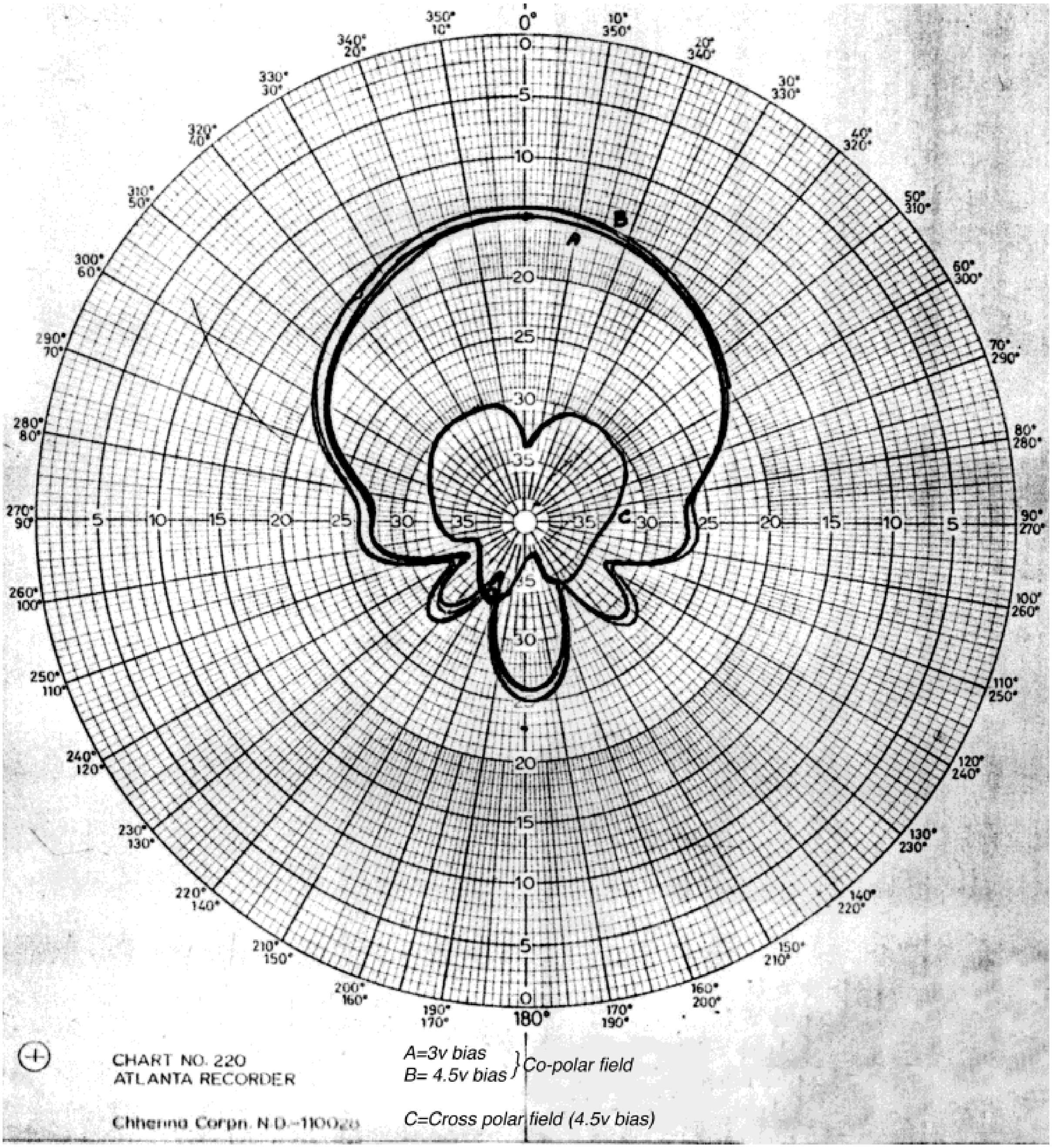
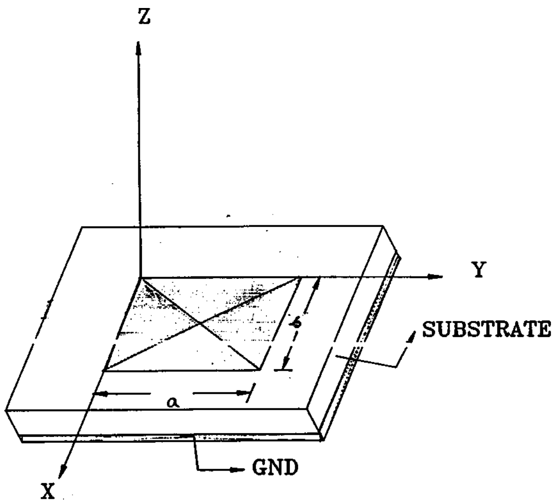


Figure 5 H-plane radiation pattern of active microstrip antenna



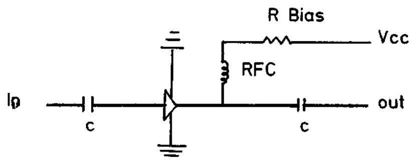


Figure 6 Microstrip antenna and the active circuit with biasing network

active device) the frequency range is measured to be 40 MHz. Thus it is observed that increasing the bias voltage of the amplifier decreases the bandwidth and increases the gain. Also, the cross field increases with increasing bias voltage, thus leading to radiation from the active device and the biasing network.

4. CONCLUSION

The impedance compensation technique is found to be a suitable method to design reduced-size microstrip antennas even at low frequency. The bandwidth of the active microstrip antenna is considerably higher, which is a notable, feature, as microstrip antennas are inherently narrow band. The enhancement of gain with suitable bias voltage is another important feature that can be exploited for many potential applications. The optical integration and the suggested impedance compensation technique will go a long way in the application of microstrip antenna in many emerging fields.

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USING EVOLUTIONARY RECURSION TO SOLVE AN ELECTROMAGNETIC PROBLEM WITH TIME-VARYING PARAMETERS

Alexander G. Nerukh[1], Igor V. Scherbatko[1], and Dmitriy A. Nerukh[2]
[1]Kharkov Technical University of Radioelectronics
Lenin Avenue 14
Kharkov 310726, Ukraine
[2]Kharkov State University
Svobody Square 4
Kharkov 310077, Ukraine

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ABSTRACT: *The method for handling a transient electromagnetic problem with arbitrary time dependence of a medium parameter is proposed. The method is based on the evolutionary approach, which reduces the problem to a Volterra integral equation. A parameter's arbitrary time variation is approximated by a stepped function. The problem is exactly solved at each step by virtue of the same resolvent. Various parameter time dependences are considered. © 1997 John Wiley & Sons, Inc.* Microwave Opt Technol Lett 14, 31–36, 1997.

Key words: *transient electromagnetic problem; evolutionary recursion; time-dependent permittivity*

1. INTRODUCTION

Exact consideration of electromagnetic processes in a medium with time-varying parameters is possible, as a rule, when parameters change abruptly [1–6]. If parameters change in a more complicated manner, exact solution can be obtained only in special cases [7]. In general cases such an analysis is carried out approximately. As this takes place, an initial electromagnetics problem is investigated either by numerical methods or within approximations corresponding to a small or great parameter value, such as in [8]. In this article a method for handling a transient electromagnetic problem with an arbitrary time dependence of a medium parameter is proposed. In the case of parameter's jump changing, the problem solution is obtained exactly by the use of a resolvent method [6, 9]. In so doing, no restrictions on the jump