POLARIZATION ADAPTOR

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ABSTRACT

This paper describes the performance of a polarization adaptor. The polarization adaptor changes two orthogonally polarized signals into two co-pol signals. With this device commercially available RxTx units performing two way orthogonal polarization modes can be applied to two way co-pol satellite communication systems.

I. INTRODUCTION

Very Small Aperture Terminals (VSAT's) operating in the Ku-band frequency range are gaining popularity in commercial satellite communication applications. Their unique feature of offering the end user an alternative to leased terrestrial data lines makes them attractive from both a network management and cost standpoint.

Most North American domestic satellites use linear polarization to transmit and receive signals in vertical or horizontal planes (cross-polarization). However, some international satellites transmit and receive signals in the same plane (co-polarization). Recently, there is a demand to utilize these satellites for VSAT networks. However, off the shelf commercially available receive/transmit (RxTx) units are designed to operate with cross-polarized satellites. Internal design modifications are possible but require production volume commitments in order to justify the change.

This paper explains the design and principle of a passive microwave component called a polarization adaptor (PA). The use of the PA allows these commercially available RxTx units to operate with a co-polarized satellite without any modifications. The PA is located between the feedhorn and the RxTx unit. The PA consists of two filters, a twisted waveguide, an orthomode transducer (OMT), a transition adaptor and a 90 degree bent waveguide. Because several components are integrated, losses due to components cannot be neglected so that both insertion loss and return loss should be minimized. A prototype composed of the above components has been designed with an insertion loss -.5 dB and return loss -18 dB, respectively. Following the principle of this device, test results are presented.

II. DESIGN PRINCIPLE

To understand the design principle of the PA, a brief tracing through the components is required. (Refer to Figures 1 and 2).

In Figure 1, beginning at the RxTx unit, the Tx signal (14.0 - 14.5 GHz) is generated and enters the OMT. (Assume Vertical Polarization). The Tx signal propagates into the thru port of the OMT and its polarization is changed 90 degrees by the twisted waveguide. The signal continues thru the Rx reject filter and feed horn (now horizontally polarized). The Tx signal does not enter the side port since it is tuned to the Rx frequency and contains a Tx reject filter.

The receive signal (11.7 - 12.2 GHz) enters the feed horn (assume horizontal polarization) and propagates into the bottom waveguide components of the PA. The Rx signal passes through the filter and H-plane waveguide bend and is combined with the Tx signal at the OMT. (still horizontally polarized).

Output Section

The output section (see Figure 3) operates at the Tx band (14.00 - 14.5 GHz) at thru port of circular w/G and the Rx band (11.7 - 12.2 GHz) at side port of rectangular w/G. As shown in Figure 3, port 1 and port 2 use filters tuned their own bands and reject other frequencies so that isolation and return loss are maintained at a minimum (approximately -65 dB and -18 dB, respectively).

Filters used in this section are E-plane stripline inserts [1], and [2]. This type of filter is low cost and easy to fabricate. Filter design is on the basis of input admitance formulation given by [2] and [3] as

$$Y_{in} = \frac{\iint_0^{a/2} G(x/x')\,\mathcal{E}(x)\,\mathcal{E}(x')\,dx\,dx'}{Y_{01}\left[\int_0^{a/2} \mathcal{E}(x)\,\phi_1(x)\,dx\right]^2}$$

and this equation is changed into matrix form. By the method explained in [1], scattering parameter [S] is calculated for the one stripline, and if 5 striplines are symmetrically placed as shown in Figure 4, [S] parameters are manipulated as explained in [1] and [3].

Input Section

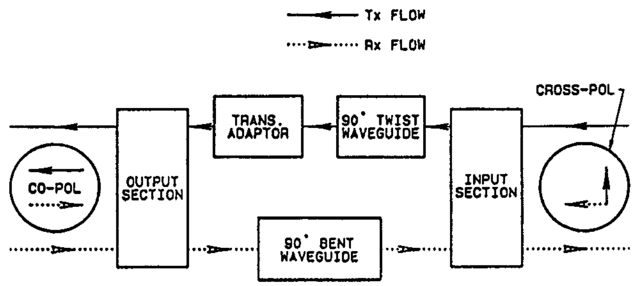
For the input section, an OMT is used. Isolation between two orthomode ports in the polarization adaptor is below -40 dB so that insertion loss of received signal can be minimized.

III. TEST RESULTS

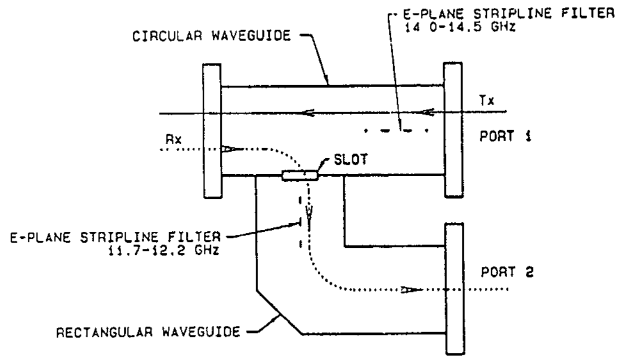
A prototype has been fabricated as shown in Figure 1 and tested. Test results of this prototype are shown in Figures 5-8. For return loss, maximum -18 dB (VSWR 1.28) at Rx frequencies and -16.5 dB (VSWR 1.35) at Tx frequencies are obtained as shown in Figures 5 and 6. Figure 7 shows -.3 and -.5 dB of insertion loss at Rx frequencies. The insertion losses at Tx frequencies are less than -.4 dB.

Reviewing overall test results, return loss looks all right and insertion loss is also the same as the values expected. Both insertion loss and return loss are expected to be held under -.4 and -18 dB if silver coating inside the waveguide is done.

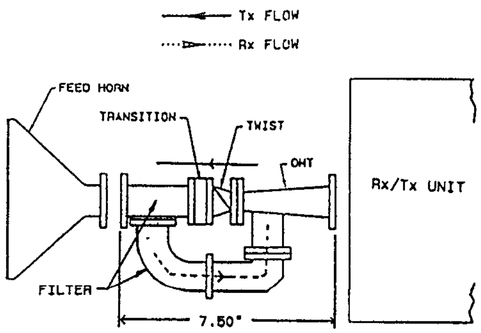
In summary, the polarization adaptor as a new device in satellite communication systems promises further cost savings and increased logistic and reliability feature. The function of the polarization adaptor will allow most commercially available RxTx units to operate with a co-polarized satellite without any modifications in ODU's.



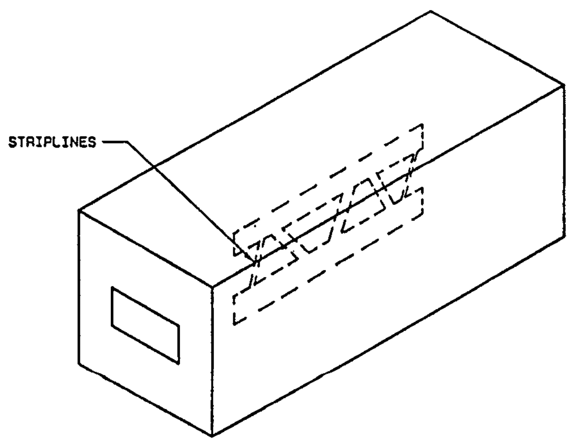
P.A. BLOCK DIAGRAM
FIGURE 2



CO-POL OUTPUT SECTION
FIGURE 3



POLARIZATION ADAPTOR
FIGURE 1



E-PLANE WAVEGUIDE FILTER
FIGURE 4

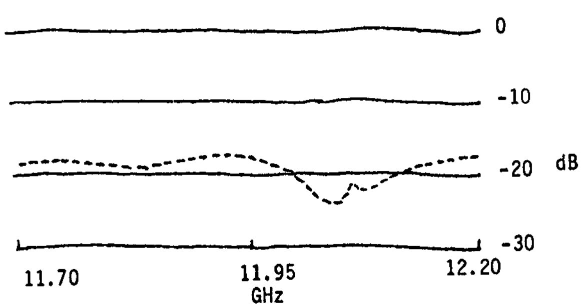


FIGURE 5 Rx Return Loss

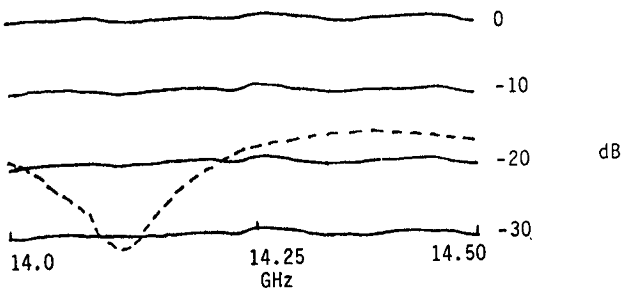


FIGURE 6 Tx Return Loss

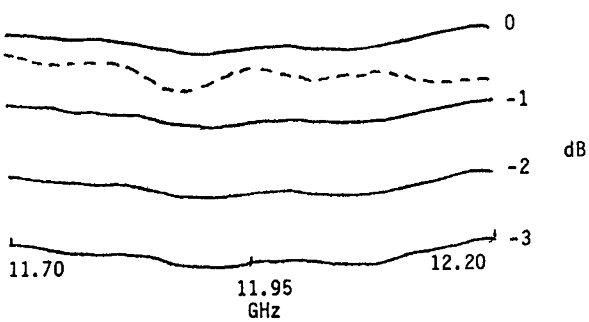


FIGURE 7 Rx Insertion Loss

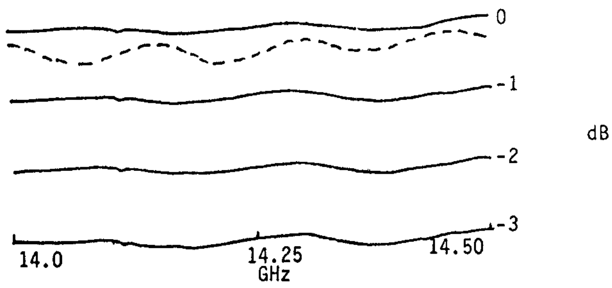


FIGURE 8 Tx Insertion Loss

IV. REFERENCES

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2. Y-Konoshi and K. Uenakada, "The design of a band pass filter with inductive strip-planar circuit mounted in waveguide," IEEE Trans. Microwave Theory Tech., Vol. MTT-22, pp. 869-873, Oct. 1974.
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