NASA TECH BRIEF

Synthesis of Electro-Optic Modulators for Amplitude Modulation of Light

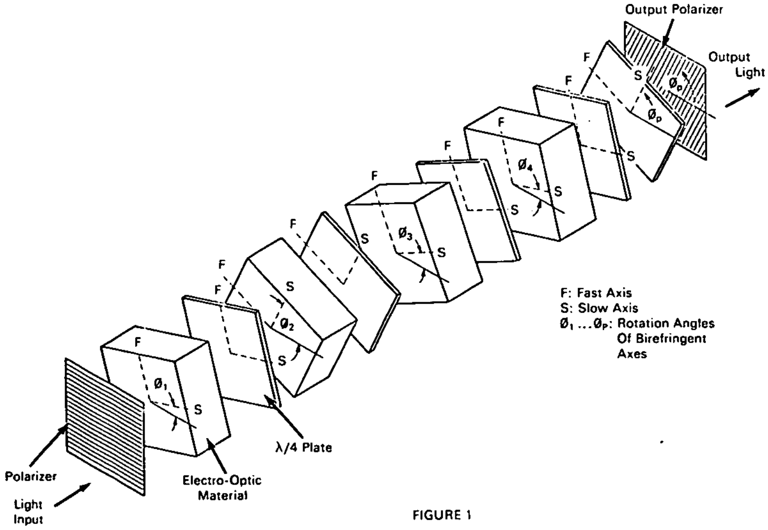

FIGURE 1

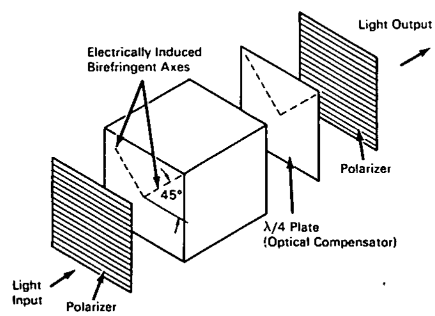

FIGURE 2

A procedure has been developed for synthesizing electro-optical amplitude modulators having arbitrary modulation characteristics. The technique is an adaptation of the procedure of Ammann and Yarborough for synthesizing naturally birefringent networks. With this procedure, a voltage transfer function K(v) expressed in terms of an exponential series can be realized by an electro-optic network of the form shown in Figure 1. The resulting modulator consists of a number of stages between an input and an output polarizer, with each stage consisting of an electro-optic element (Pockels or Kerr cell) and an optical compensator.

The manner in which K(v) is chosen is very important. If sufficient care is not taken in this choice, the performance of the synthesized modulator can easily be inferior to that obtained from the simple, conventional amplitude modulator of Figure 2. Several techniques for choosing K(v) were tried with varying degrees of success. The most satisfactory results were obtained when the C_i coefficients of the K(v) expression were chosen to directly optimize the modulator property (or properties) of greatest interest. This was done for two cases of interest: the design of a modulator for use with (a) an envelope detector and (b) a square-law detector.

The modulator properties which were chosen (arbitrarily) for optimization were the following. The modulating signal v was assumed to be of the form, $v = V\cos\omega_m t$. The demodulated signal from the detector will in general contain a dc term, a fundamental, and harmonics. It was deemed desirable for the

(continued overleaf)

fundamental to be linearly proportional to V, and for the harmonics to be minimized. Hence modulator performance was measured by calculating the deviation from linearity of the fundamental and the amplitudes of the harmonics.

Best results were obtained for both the envelope and square-law detector cases by writing the fundamental and harmonic amplitudes as power series in V. The C_i coefficients were then chosen to eliminate as many nonlinear terms from the fundamental expression and as many low-order terms from the second harmonic expression as possible. The K(v) transfer functions so derived do indeed give improved modulator performance; the modulator designs corresponding to these functions are presented in tables. However the improvement is, in some respects, less then might be hoped for. It is likely that still other approximation techniques will eventually be found which yield further improvement.

Note:

Complete details may be obtained from:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B68-10275

Patent status:

No patent action is contemplated by NASA.

Source: E. O. Ammann and J. M. Yarborough
of Sylvania Electric Products Inc.
under contract to
Marshall Space Flight Center
(MFS-14268)