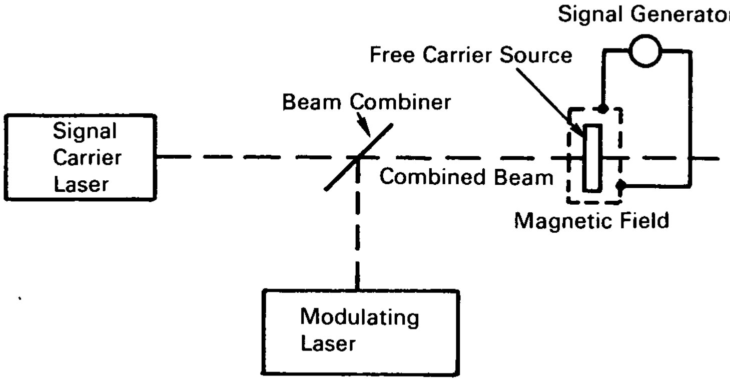
NASA TECH BRIEF

Optically Induced Free Carrier Light Modulator



A system has been devised that optically modulates a signal carrier laser beam by a second laser beam of different frequency acting on a free carrier source to which the signal carrier laser beam is directed. The second or modulating laser beam affects the transmission characteristics of the free carrier source to light from the signal carrier laser, thus modulating it.

Since development of the laser, efforts have been to modulate its beam in order to develop a laser communications system. Such devices as electro-optical and magneto-optical modulators, optical waveguides, electro-acoustic modulators, band gap modulators, and electrically depleted free carrier modulators have successfully modulated laser beams but have inherent disadvantages. For example, electro-optical and magneto-optical modulators require large amounts of drive power per unit bandwidth. Optical waveguides and electrically depleted free carrier modulators suffer from low power handling capabilities and low modulation indices. Electro-acoustic modulators are limited by narrow information bandwidths, while band gap modulators have low modulation indices. As a result, modulators of the foregoing types have found only limited use, usually in laboratory applications.

The solution is a laser beam modulating system with low drive power requirements per unit bandwidth. This invention provides such a system and makes possible a laser beam communications system. Referring to the illustration, the signal carrier laser generates a signal to which the light beam combiner is transparent, while the modulating laser generates a beam to which the light beam combiner is reflective. By positioning the combiner as shown, the two laser beams join on a mutual axis to form a combined beam that impinges on the free carrier source. The free carrier source is transparent to the signal portion of the combined beam but relatively opaque to the modulating portion. This is due to the difference in wavelengths of the two beams plus the constituent makeup of the free carrier source (a situation similar to the beams-to-combiner relationship).

Radiation from the modulating laser creates free carriers (relative to its wavelength) in the free carrier source to vary its degree of transparency to the signal carrier laser beam, thus modulating the latter. Control of the spatial distribution of the signal carrier beam is achieved by application of a d.c. magnetic field along

(continued overleaf)

the direction of propagation of the modulating light signal. This restricts free carrier diffusion to a path parallel to the direction of propagation of the modulated light.

Notes:

1. Drive power requirements for this system are calculated to be 3 watts for a 100 MHz bandwidth, while prior art optical modulators require approximately 20 kilowatts for that bandwidth. Additionally, the efficiency of this system is 7.5 % whereas other optical modulators have efficiencies of about 6×10^{-3} % making this system's theoretical efficiency almost 1000 times greater.
2. No further documentation is available. Inquiries may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B69-10114

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, non-exclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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